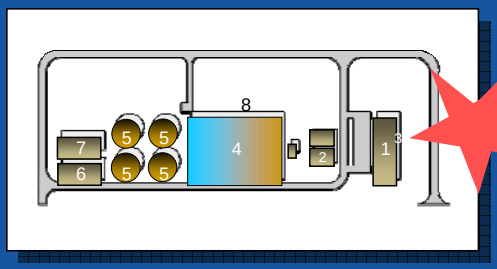
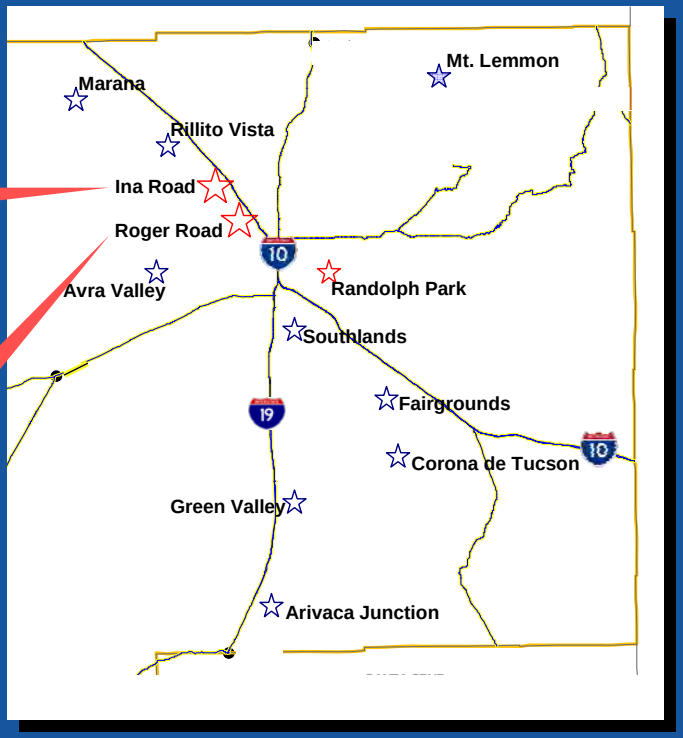
Pima County Regional Wastewater Reclamation Department

Regional Optimization Master Plan Final Report





GREELEY AND HANSEN

November 2007

Pima County
Regional Optimization Master Plan

Regional Optimization Master Plan Final Report

Executive Summary

Pima County Regional Wastewater Reclamation Department

FINAL–November 2007

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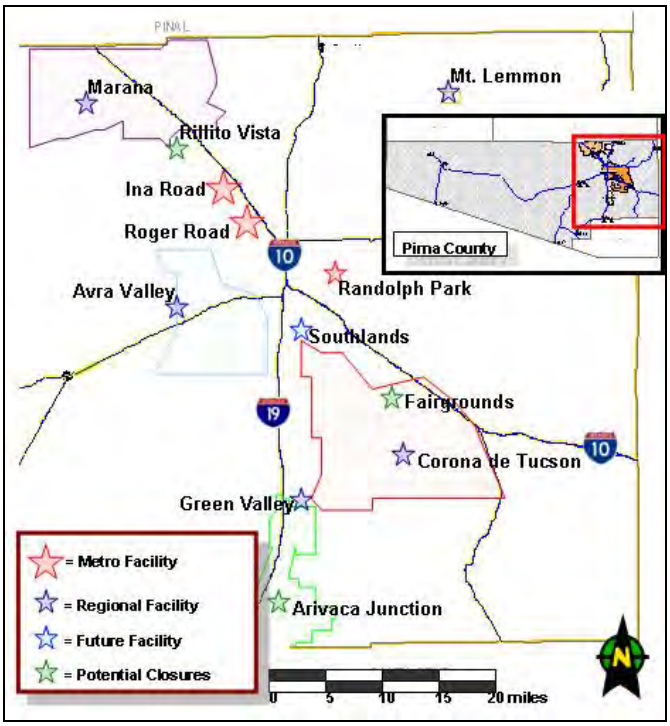
Executive Summary

Pima County Regional Wastewater Reclamation Department (PCRWRD) owns and operates regional wastewater conveyance and treatment systems serving Eastern Pima County. The regional systems consists of over 3,300 miles of sewer lines (of which 230 miles are major trunk lines or interceptors), 34 conveyance system lift stations, two major treatment facilities and one wastewater reclamation facility in the metropolitan (metro) area, and eight smaller wastewater reclamation facilities in the non-metro area. The mission of PCRWRD is to protect public health, safety and the environment by providing quality service and sound environmental stewardship of renewable resources.

PCRWRD recognizes the value of long-range planning in making timely, cost effective decisions; and the need for an effective treatment strategy for current and projected future wastewater flows to its facilities. A significant element in affecting the strategy is the need for a reduction in ammonia and nitrogen concentrations discharged into the Santa Cruz River to comply with current and future environmental regulatory requirements set forth by the Arizona Department of Environmental Quality (ADEQ). In addition, the County seeks to optimize biosolids treatment, reuse and disposal. To that end, PCRWRD commissioned the development of a master plan for future wastewater conveyance and treatment in the PCRWRD service area. **Figure ES-1** shows the current and future PCRWRD operated wastewater treatment facilities.

Figure ES - 1
Current and Future County Treatment Facilities



The purpose of the master plan is twofold. First is to determine an optimal strategy for regulatory compliance which includes: long-term flow and capacity management, treatment of future wastewater increases from the Pima County wastewater service basins, rehabilitation of existing facilities, optimization of solids handling, reuse and disposal, complete utilization of biogas, and optimal methods to provide reclaimed water. The second purpose is to develop a coordinated Capital Improvement Program (CIP) including cost estimates, schedules and a recommended project delivery and funding strategy for implementation of resulting projects and integration with the total PCRWRD CIP.

The master plan serves as a broad road map for future activities. It identifies potential pathways, as well as obstacles to the implementation of the master plan CIP. Through the appropriate level of evaluation, the best option is identified and selected for implementation, without precluding changes in direction that may be prompted by future needs. The Pima County Regional Optimization Master Plan forecasts needs for wastewater treatment capacity throughout the PCRWRD service area and the facilities required to meet those needs through the year 2030. The master plan builds upon the 2006 Metro Area Facility Plan Update in addition to several planning and engineering efforts previously performed for, or by the PCRWRD. The plan is based on current and potential future regulatory and PCRWRD customer requirements, and identifies how and when wastewater treatment facilities will be upgraded and expanded, as well as how existing facilities will be integrated into future expansions or de-commissioned through the year 2030. The plan recommends a comprehensive CIP with treatment components and systems, phasing schedules and cost apportionments for future implementation of PCRWRD wastewater infrastructure needs in accordance with individual ADEQ facility requirements. As the master plan was developed, two concurrent efforts were implemented focusing on Strategic Development and CIP Development. This executive summary presents the major findings, conclusions, and recommendations of the Regional Optimization Master Plan.

Regulatory Requirements

Regulatory requirements were examined as they pertain to the collection, conveyance, and wastewater treatment systems. Reviews of current regulatory requirements regarding wastewater treatment facility design and level of treatment were completed. Capacity and systems condition assessments for Roger Road Wastewater Reclamation Facility (WRF), Ina Road WRF, and their respective conveyance systems were undertaken to determine compliance with regulatory requirements and to draw conclusions regarding the suitability of the facilities to stay in service at existing, greater, or reduced capacity in the current treatment mode and in a converted nutrient removal mode.

To meet the future permit requirements, process modifications and changes are required to lower ammonia and total nitrogen discharge levels. Other relevant and pertinent issues include addressing odor control, safety and upgrades of the existing facilities to be compliant with environmental, regulatory and building code requirements.

Treatment Plant Evaluation

Roger Road WRF is the older of the two major wastewater treatment plants and symptoms of aging are apparent. From an operational and maintenance point of view, there are several drawbacks with the facility's current treatment unit operations, including the primary and final clarifiers. By modern

wastewater treatment practice, the clarifiers are too shallow to be effective in advanced wastewater treatment and the feed and withdraw systems are inadequate. Moreover, continued use of the system at Roger Road WRF would require a significant investment in rehabilitation. From detailed surveys significant rehabilitation is required for some process units to remain in long term service, and equipment and structures replacement is needed for some elements that are reaching the end of their useful service life.

The biological nutrient removal activated sludge (BNRAS) portion of the Ina Road WRF is new (operations started up in the 2006) and is in excellent physical and operating condition. However, the high-purity oxygen (HPO) system which is an older part of the plant has signs of aging in the structures and equipment, particularly the HPO Reactors. In addition, the high purity oxygen system is not compatible with modern, efficient multi-staged nutrient removal systems. Furthermore, the HPO reactor configuration and size is unsuitable for retrofitting to ammonia and nitrogen removal service. Moreover, save the HPO Reactors, the facilities at Ina Road are readily adaptable with some modifications and upgrades to the process needs of the future.

Overall Treatment Strategy

The overall treatment strategy for the Pima County Regional Optimization Master Plan addresses two primary issues, process selection and wastewater management. To address the first issue, the best process to meet current regulatory requirements as well as probable future regulatory requirements was selected. To address the second issue, a wastewater management configuration was selected to determine how much flow will be treated at Roger Road WRF and how much flow will be treated at Ina Road WRF.

Due to expected stringent effluent requirements and effluent reuse requirements, a high degree of treatment is required. To meet the effluent goals, a combination of biological nitrogen removal processes and, if required by future ADEQ regulations, biological phosphorus (Bio-P) removal was found to be the most cost effective. A review of biological nutrient removal (BNR) processes for nitrogen and phosphorus removal included in-depth considerations and evaluations of four processes: Bardenpho, Modified Ludzack-Ettinger (MLE), Integrated Fixed-Film Activated Sludge (IFAS), and Bio-Towers/Nitrifying Activated Sludge (BT/NAS). After consideration of a wide range of issues and combinations, the Bardenpho process was determined as the most reliable and cost effective process for both treatment plants.

Three options for dividing the projected year 2030 flow of 82 mgd between the treatment plants were selected for analysis including: 32 mgd to Roger Road WRF and 50 mgd to Ina Road WRF, 20 mgd to Roger Road WRF and 62 mgd to Ina Road WRF, and all 82 mgd to Ina Road WRF. Wastewater characteristics were determined based on the information contained in the 2004 – 2005 GPS-X modeling and a special testing program. Future loadings were predicated on water conservation and included consideration of the loadings from recycle flows from expected future biosolids operations.

Using the Bardenpho process, flow split options were compared using technical and economic criteria. The flow-split option of 32 mgd to Roger Road WRF and 50 mgd to Ina Road WRF was determined as the most cost effective option. Rehabilitating and modifying the aging Roger Road WRF involves cost uncertainties. In addition there are risks in operating the plant in compliance with regulatory permit

requirements while adhering to the regulated implementation schedule to convert the process. Thus, constructing a new Water Reclamation Campus (WRC) was determined to be the most favorable option for the Roger Road facility.

Biosolids

Current biosolids processing practices and future alternatives for complying with federal biosolids regulations were evaluated and recommendations for PCRWRD's future biosolids processing and disposal methods are provided. The overall goal of these evaluations is to provide a road map for biosolids processing and handling that will allow the County to continue with cost effective biosolids disposal and reuse options through the 25-year planning period.

The future biosolids management plan needs to be flexible and adaptable to changes in the reuse or disposal markets. Federal regulations define two levels of biosolids which are produced by various processing methods: Class B (the current level produced by PCRWRD) biosolids can be applied to agricultural lands and to other restricted uses, and Class A biosolids, which requires more extensive processing, can be beneficially reused with few restrictions.

The County is currently utilizing land application through a local contractor to reuse biosolids. This option appears to be viable through the planning period. However, there is concern that most of the agricultural lands for biosolids application in close proximity of the plants are controlled by a single contractor, and therefore controls the market and price of biosolids disposal; or that the agricultural land is disappearing because of population growth in the County.

A market that shows promise is a dry Class A biosolids product for mine reclamation. A current University of Arizona project utilizing Green Valley WRF biosolids for reclamation at the Asarco Mission Mine has been successful. This market should be investigated further as there are a number of mines located in Arizona, many in the southern region of Pima County. This disposal option may be most applicable to the non-metro regional facilities.

Although the current biosolids disposal strategy is cost effective, it is one dimensional. An extensive market study is required to provide PCRWRD with a flexible, multi-dimensional long-term disposal or reuse strategy. The market assessment needs to address long-term biosolids management, most notably to determine the demand for a Class A, or Class B product or both; identify multiple biosolids disposal options and outlets; and determine if processing on a sub-regional scale, as well as regional scale is viable.

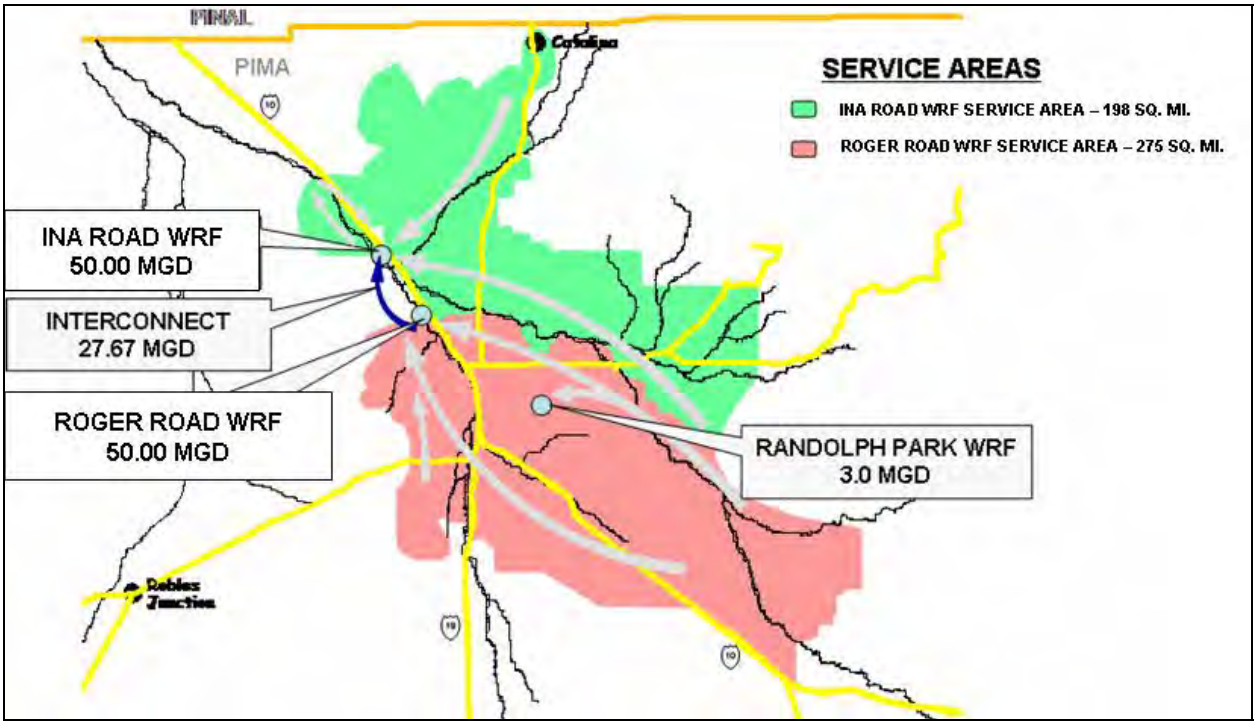
Conveyance System Evaluation

In 2003 PCRWRD commissioned a conveyance system condition assessment. This was part of PCRWRD's on-going asset management program to evaluate about 230 miles of trunk and interceptor sewers. Results of the assessment discovered sewer segments in need of rehabilitation/replacement in the Aviation Corridor, Canada del Oro, Old Nogales Highway, Pantano, Santa Cruz, South Rillito, Southwest and Tanque Verde Interceptors; as well as over 3,000 manholes, several siphon boxes and many of the lift

station wet-wells, which exhibited hydrogen sulfide corrosion. PCRWRD has an active program to address these issues.

In the very near future the Roger Road WRF will have insufficient capacity to accommodate additional flows generated by population growth in its service area. Therefore a major element of the conveyance evaluation was a detailed analysis of transferring flows from the Roger Road WRF to the Ina Road WRF. Three routing alternatives were considered. In the recommended least cost option, the plant interconnect pipeline parallels the existing sludge force main route from the Roger Road WRF to the Ina Road WRF. The major wastewater treatment facilities' locations, the metropolitan Tucson service basin areas, and the projected future treatment and conveyance system capacities are shown on **Figure ES-2**.

Figure ES - 2
Year 2030 Location of Major WRFs Relative to the Metropolitan Tucson Service Area



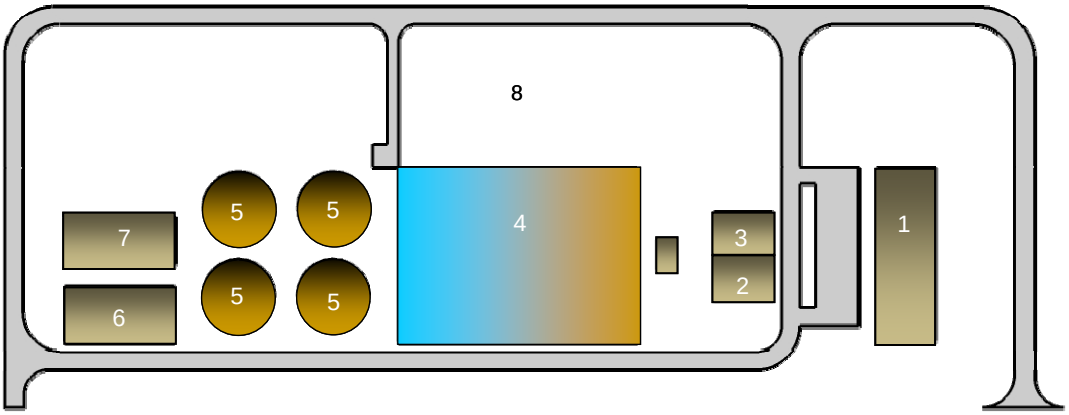
To evaluate the current and future conveyance system capacities, a hydraulic model was developed for routing existing and proposed future flows through the Pima County conveyance systems. While the Pima County conveyance system experiences an increase in flow in response to wet weather events, it has adequate excess capacity to convey both the normal wastewater flows and the additional stormwater induced flows in accordance with the Arizona Department of Environmental Quality's Capacity, Management, Operation, and Maintenance criteria. However, as the service area populations grow, excess system capacity currently available for wet weather flow will be reduced and the ability for the system to reliably convey peak wet weather flows will subsequently be reduced. Because of this capacity

reduction, some portions of the system will need to be augmented in the future to maintain adequate capacity for wet weather flows. These areas of future need are identified in the details of the master plan.

Recommended Treatment Plan

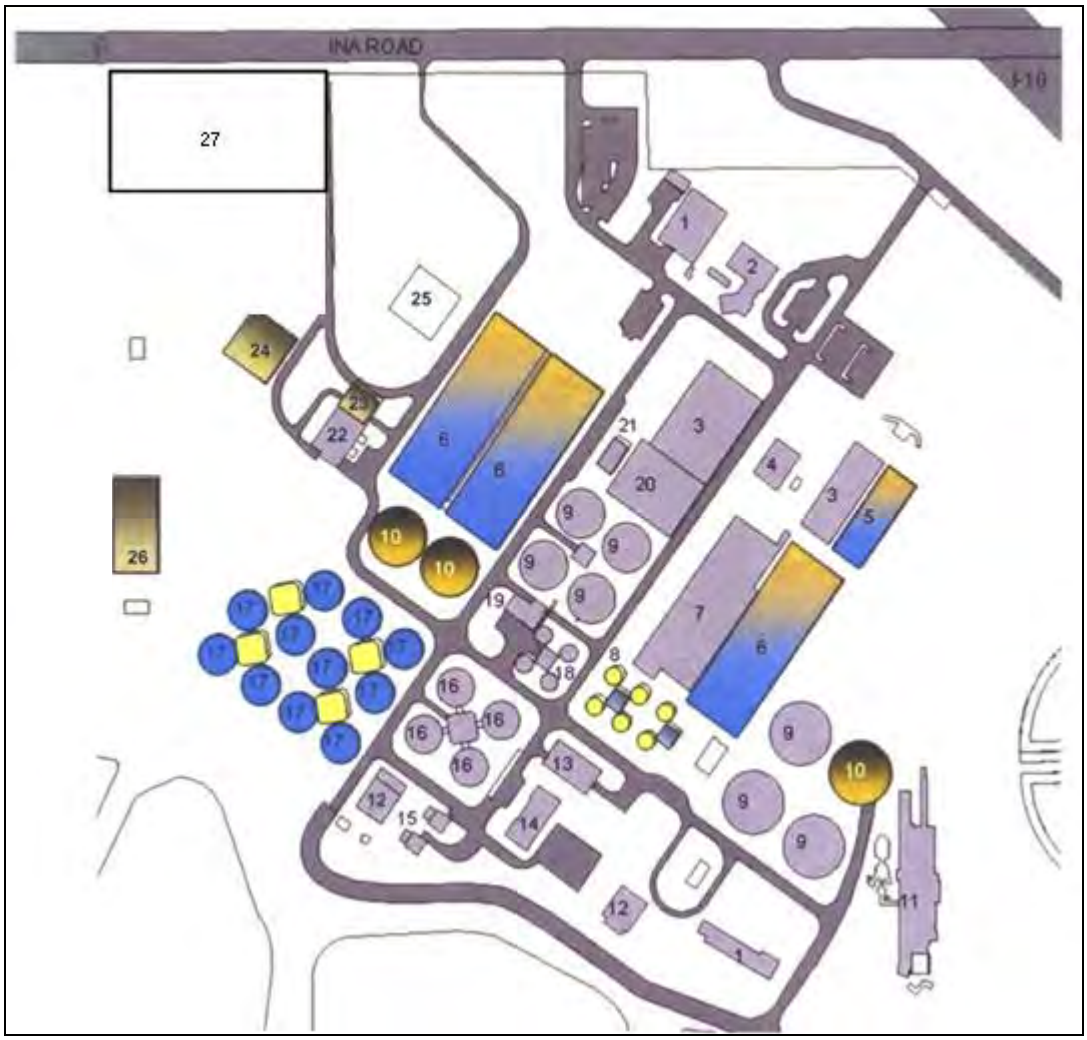
Recommendations for specific modifications, upgrades and replacements at the Roger Road WRF and the Ina Road WRF were developed to enable the wastewater treatment facilities to serve Pima County through the year 2030. The recommendations include upgrading the Ina Road WRF facilities with the Bardenpho technology and expanding capacity from 37.5 mgd to 50 mgd to treat additional flow created from regional population growth. In addition, a new 32 mgd wastewater reclamation plant, utilizing Bardenpho technology in the vicinity of the Roger Road WRF is recommended. Afterwards the existing treatment facilities at Roger Road will be decommissioned and demolished after the new plant is placed into service. The location of the new Water Reclamation Campus will be either north or south of the existing Roger Road WRF and County owned land. **Figure ES-3** and **Figure ES-4** show the Roger Road WRF and Ina Road WRF master plan layouts for the year 2030, respectively.

Figure ES - 3
New WRC – Year 2030 Master Plan Layout



Legend:
1. Administration Facility
2. Headworks (Influent PS, Screens)
3. Grit Removal Facility
4. Bardenpho Aeration Tanks
5. Final Clarifiers
6. Disinfection Facilities
7. Sludge Thickening/Transfer Facility
8. Area for Future Expansion

Figure ES - 4
Ina Road WRF – Year 2030 Master Plan Layout



Legend:

1. Existing Warehouse
2. Existing Administration Building
3. Existing Primary Clarifiers
4. Existing Blower Building
5. New Primary Clarifiers
6. New Aeration Tanks
7. Existing Aeration Tanks
8. New Sludge Thickeners
9. Existing Secondary Clarifiers
10. New Secondary Clarifier
11. Existing Headworks
12. Existing Chlorine Contact Basin
13. Existing Energy Recovery Building
14. Existing Training Center
15. Existing Chlorination Buildings
16. Existing Digesters
17. New Digesters
18. Existing Sludge Thickeners
19. Existing Vacuum Filtration Building
20. Existing Activated Sludge Reactor
21. Existing Oxygen Production
22. Existing Centrifuge Building
23. Extension to Centrifuge Building
24. New GBT Thickening Building
25. Existing Sludge Storage Basin
26. New Disinfection Facilities
27. Pima County Industrial Waste Offices
28. Tucson Water Facilities (not shown)

A new gravity plant interconnect pipeline (Santa Cruz Interceptor Phase IV) will be constructed between the two plants to transport raw wastewater from the Roger Road WRF service area to the Ina Road WRF. The existing sludge force main between the plants will continue to serve the facilities. A new effluent force main and pump station facility will be constructed by Tucson Water to transport treated effluent from the Roger Road facilities to existing water reclamation facilities to meet the City of Tucson's reuse water demand. At Ina Road WRF, Tucson Water will construct a new effluent pump station, force main and other facilities to provide additional treatment prior to distribution of reclaimed water to their existing reclaimed water service distribution system.

Population densities in the metropolitan areas located within close proximity to both treatment plants are expected to increase by the year 2030. A 350-foot buffer zone, required by ADEQ, for odor and noise control will be maintained between the treatment facilities and the property lines.

Non-Metro Treatment Overview and Strategic Management Plan

Non-metro wastewater reclamation facilities serve the wastewater treatment needs outside the metropolitan Tucson region. The non-metro service areas are experiencing rapid population growth. This growth is forecast to continue, thereby increasing flow into PCRWRD's non-metro conveyance and treatment systems. Therefore a strategy to treat current and projected future wastewater flows at the non-metro wastewater reclamation facilities was developed.

Existing non-metro wastewater treatment works were constructed to meet wastewater treatment demands of small housing and community developments. At the time of their construction, forwarding flow for treatment at the Roger Road WRF or Ina Road WRF was not an optimal solution because it would have required long stretches of conveyance structures transporting relatively low flows to serve a few customers. Also, as constructed the treatment technologies differ from facility to facility, but were usually relatively simple wastewater treatment systems permitted by ADEQ. As populations in the non-metro areas grow and wastewater flow increases, PCRWRD is required by ADEQ to reduce nutrient concentrations in the plant effluent. Thus, the wastewater treatment technologies at the non-metro facilities will need to be expanded or upgraded or both with a significant amount of capital investment.

The current and planned activities for each of PCRWRD's non-metro WRFs were evaluated. Five of the non-metro areas were identified to have significant growth. Projected future flows at each of these facilities are as shown in **Table ES-1**. The capacity of the existing facilities will be expanded to meet the projected increases in flows. A new Southland WRF will be required to meet the wastewater treatment requirements of that non-metro area.

Table ES - 1
2030 Non-metro Facility Projected Flow

Facility Location	Projected 2030 Flow (mgd)
Avra Valley WRF	3.0
Corona de Tucson WRF	2.1
Green Valley WRF	4.4
Marana WRF	4.4
Southlands WRF	10.5

CIP Elements

The recommended wastewater conveyance and treatment facilities outlined for the next 15 years in Pima County under the Regional Optimization Master Plan have capital costs estimated at $536 million in 2006 labor and construction dollars. Most of these facilities must be constructed over the next ten years to comply with a regulatory imposed compliance schedule. Project elements are broadly categorized under plant interconnect, new WRC, expansion and upgrade of Ina Road WRF, and support facilities.

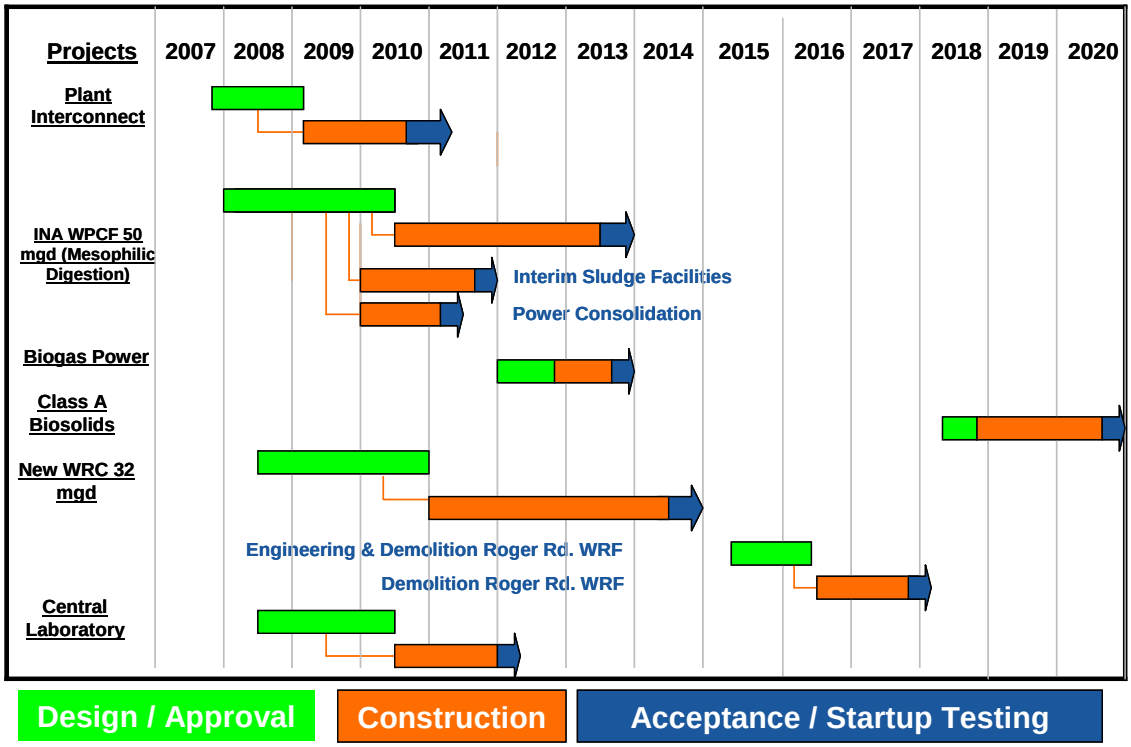
CIP Phasing and Cost Schedule

Master planning for the next 25 years has identified the need for PCRWRD to expand its wastewater treatment plant capacity and implement environmental controls to comply with more stringent requirements for effluent discharges into the Santa Cruz River or reclaimed water use. Detailed analysis and recommendations are provided for the optimal financial plan strategy to procure facilities to meet projected future wastewater flows delivered to the Roger Road WRF and the Ina Road WRF, and the ADEQ regulatory requirements. The financial plan includes specific costs and anticipated project phasing, which will be integrated ultimately into PCRWRD's comprehensive overall CIP. In addition, the strategic financial plan discusses alternative capital funding options and recommends of the most appropriate funding strategy that will meet PCRWRD's financial objectives.

Implementation Plan

Specific costs for required wastewater facilities and systems, and project phasing are integrated into PCRWRD's overall CIP to form the critical elements of the implementation plan. Phasing of the projects to meet the regulatory and growth needs of the community is required across the 25-year planning horizon. Some projects are immediate, such as the plant interconnect pipeline. Other projects will be delayed, such as the demolition of the existing Roger Road facilities, which cannot occur until the new Roger Road WRC is constructed and in service. The project timeline for completion of the new WRC and expansion and upgrades at Ina Road WRF to meet the ADEQ mandated reduction of ammonia toxicity requirements, as written in the ADEQ issued operating permits of the plants, are January 2015 and January 2014, respectively is shown in **Figure ES-5**

Figure ES - 5
Project Compliance Timeline



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ABBREVIATIONS / ACRONYMS

Abbreviations / Acronyms

Abbreviation / Acronym	Meaning
°C	Degrees Celsius
µg/L	Micrograms per Liter
2006 Facility Plan	Pima County Wastewater Management Department's 2006 Metropolitan Facility Plan Update
A&We	Aquatic and Wildlife Ephemeral
AAC	Arizona Administrative Code
ACC	Arizona Corporation Commission
ACSC	Aviation Corridor to Santa Cruz Interceptor
ADEQ	Arizona Department of Environmental Quality
ADWF	Average Dry Weather Flows
ADWR	Arizona Department of Water Resources
AF	Acre Feet
Ag	Silver
AL	Alert Level
APP	Aquifer Protection Permit
AQL	Acceptable Quality Level
AS/NTF	Activated Sludge/Nitrifying Trickling Filter
ASDM	Arizona Sonora Desert Museum
AT	Aeration Tank
AWQS	Aquifer Water Quality Standards
AZPDES	Arizona Pollution Discharge Elimination System
BACT	Best Available Control Technology
BADCT	Best Available Demonstrated Control Technology
BAF	Biological Aerated Filters
BAN	Bond Anticipation Note
BFP	Belt Filter Press
Bid-build	Design-Bid-Build
Bio-P	Biological Phosphorus
BNR	Biological Nutrient Removal
BNRAS	Biological Nutrient Removal Activated Sludge
BNROD	Biological Nutrient Removal Oxidation Ditch

Abbreviation / Acronym	Meaning
BOD	Biochemical Oxygen Demand
BOD_5	5-day Biochemical Oxygen Demand
BOO	Build/Own/Operate
BOOL	Build/Own/Operate/Lease
BOOT	Build/Own/Operate/Transfer
BT/NAS	Biotowers/Nitrifying Activated Sludge
CAB	Capital Appreciation Bond
CAP	Central Arizona Project
CASS	Central Arizona Salinity Study
CCTV	Closed Circuit Television
CDO	Canada Del Oro
CDU	Chemical Dosing Unit
CEP	Conservation Effluent Pool
cf	Cubic Feet
CFR	Code of Federal Register
cfs	Cubic Feet per Second
CFU	Colony Forming Units
Chem-P	Chemical Phosphorus
CHP	Combined Heat & Power
CIP	Capital Improvement Program
Cl_2	Chlorine
CMAR	Construction-Manager-At-Risk
CMOM	Capacity, Management, Operation and Maintenance
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COP	Certificates of Participation
CRRPS	Continental Ranch Regional Pump Station
CrVI	Chromium – Valence 6
CRWWPS	Continental Ranch Wastewater Pumping Station
CTP	Central Treatment Plant
Cu	Copper
CW	Campbell Wash
d/D	Depth to Diameter Ratio
DAF	Dissolved Air Flotation

Abbreviation / Acronym	Meaning
D/B	Design/Build
D-B-B	Design-Bid-Build
D/B/O	Design/Build/Operate
DEM	Digital Elevation Map
DEQ	Department of Environmental Quality
DHI	Danish Hydraulic Institute
DI	Deionized
DO	Dissolved Oxygen
DPF	Daily Peak Flow
DUPF	Diurnal Peaking Factor
DWP	Dewatering Pump
E. coli	Escherichia coli
e.g.	Exempli Gratia
EMS	Environmental Management System
ENR	Engineering News Record
EPA	Environmental Protection Agency
EQ	Equalization
etc.	Et Cetera
FASL	Feet Above Sea Level
FEP	Facultative/Evaporation Pond
fps	Feet per Second
GAN	Grant Anticipation Note
GBT	Gravity Belt Thickener
GDC	Generator Distribution Center
GIS	Geographic Information System
GMP	Guaranteed Maximum Price
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
GT	Gravity Thickener
GV	Green Valley
H_2S	Hydrogen Sulfide
HAA	Haloacetic Acid
HAMP	Houghton Area Master Plan
HAP	Hazardous (halogenated) Air Pollution

Abbreviation / Acronym	Meaning
HCU	Heating and Cooling Use
HDPE	High-Density Polyethylene
HEX	Heat Exhaust
hp	Horsepower
HPF	Hourly Peak Flow
HPO	High Purity Oxygen
hr	Hour(s)
HRT	Hydraulic Retention Time
HVAC	Heating, Ventilation, Air Conditioning
Hw	Hot Water
Hwy	Highway
I&C	Instrumentation and Control
i.e.	Id Est
I/I	Infiltration/Inflow
I/O	Input/Output
I-10	Interstate 10
IC	Internal Combustion
IFAS	Integrated Fixed Film Activated Sludge
IGA	Intergovernmental Agreement
in	Inch(es)
IOU	Investor-Owned Water Utilities
IR	Ina Road
IRS	Internal Revenue Service
IT	Information Technology
kV	Kilovolt
kVA	Kilo-Volt Ampere
kW	Kilowatt
kWh	Kilowatthour
lbs	Pound
LOX	Liquid Oxygen
LSCRMRP	Lower Santa Cruz River Managed
MACT	Maximum Achievable Control Technology
MBBR	Moving Bed Bioreactor
MBH	1,000 BTUs/hour

Abbreviation / Acronym	Meaning
MBR	Membrane Bioreactor
MCC	Motor Control Center
MCRT	Mean Cell Retention Time
MG	Million Gallons
mg/L	Milligrams per Liter
mgd	Million Gallons per Day
MH	Manhole
mL	Milliliter
MLE	Modified Ludzack-Ettinger
MLSS	Mixed Liquor Suspended Solids
MPC	Municipal Property Corporation
MPF	Monthly Peak Flow
MPN	Most Probable Number
NASSCO	National Association of Sewer Service Companies
ND	Non Detect
NdeN	Nitrification-Denitrification
NDMA	N-nitrosodiumdimethylamine
NEMA	National Electrical Manufacturer's Association
ng/L	Nano-Grams per Liter
NH_4-N	Ammonium as Nitrogen
Nitrate-N	Nitrate as Nitrogen
NO_3	Nitrate
NOI	Notice of Intent
NO_X	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
NRI	North Rillito Interceptor
NRI	North Rillito Interceptor
NTU	Nephelometric Turbidity Unit
NWO	Northwest Outfall
O&M	Operations and Maintenance
ORP	Oxidation Reduction Potential
PAB	private Activity Bonds
PAG	Pima Association of Governments
Pb	Lead

Abbreviation / Acronym	Meaning
PBC	Partial Body Contact
PCB	Polychlorinated Biphenyls
PCRFCD	Pima County Regional Flood Control District
PCWMD	Pima County Wastewater Management Department
PE	Population Equivalent
PF	Peaking Factor
PF_{DW}	Dry Weather Peaking Factor
PFRP	Process to Further Reduce Pathogens
PF_{WW}	Wet Weather Peaking Factor
pH	Measure of Acidity and Alkalinity
PLC	Programmable Logic Controller
PM10	Particulate Matter less than Nanometers
POC	Point of Compliance
PONT	Pontatoc Wash
Ppb	Parts per Billion
ppbv	Parts per Billion by Volume
ppm	Parts per Million
PQL	Practical Quantitation Level
PSA	Pressure Swing Absorption
psig	Pounds per Square Inch
PSP	Primary Sludge Pump
PSRP	Process to Significantly Reduce Pathogens
PTI	Pantano Interceptor
PW	Present Worth
$Q_{50\%}$	Median Peak Daily Flow
QA/QC	Quality Assurance and Quality Control
Q_{ADF}	Average Daily Dry Weather Flow
R.O.W.	Right of Way
RAN	Revenue Anticipation Notes
RAS	Return Activated Sludge
REC	Recognized Environmental Condition
RFEI	Request for Expression of Interest
ROMP	Regional Optimization Master Plan
rpm	Revolutions per Minute

Abbreviation / Acronym	Meaning
RR	Roger Road
RTU	Remote Terminal Unit
SAR	Specific Absorption Rate
SAT	Soil Aquifer Treatment
SAWRSA	Southern Arizona Water Rights Settlement Act
$sBOD_5$	Soluble 5-day Biochemical Oxygen Demand
SCADA	Supervisor Control and Data Acquisition
SCC	Santa Cruz Central Interceptor
SCE	Santa Cruz-East Interceptor
scfm	Standard Cubic Feet per Minute
SCI	Santa Cruz Interceptor
SDCP	Sonoran Desert Conservation Plan
SEI	Southeast Interceptor
sf	Square Feet
SO_X	Sulfur Oxides
SRC	South Rillito Interceptor-Central
SRF	State Revolving Loan Fund
SRI	South Rillito Interceptor
SROG	Subregional Operating Group
SRT	Sludge Retention Time
SRWC	South Rillito Interceptor-West, Central Line
SRWN	South Rillito Interceptor-West, North Line
SRWS	South Rillito Interceptor-West, South Line
SSO	Sanitary Sewer Overflow
SWI	Southwest Interceptor
SWIP	Southwest Infrastructure Plan
TAN	Tax Anticipation Notes
TAZ	Traffic Analysis Zone
TCLP	Toxicity Characteristics Leachate Procedure
TDS	Total Dissolved Solids
TEP	Tucson Electric Power
THM	Trihalomethane
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen

Abbreviation / Acronym	Meaning
TOC	Total Organic Carbon
TP	Total Phosphorus
TPAD	Temperature Phased Anaerobic Digestion
tpd	Tons per Day
TPU	Third Party Use
TRAN	Tax and Revenue Anticipation Note
TSS	Total Suspended Solids
TUCDIV	Tucson Boulevard Diversion
TVSS	Transient Voltage Surge Suppression
UCMR	Unregulated Contaminant Monitoring Rule
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
UV	Ultraviolet
V	Volt
VA	Vulnerability Assessment
VFD	Variable Frequency Drive
VOC	Volatile Organic Carbon
VRDO	Variable Tax-Exempt Debt
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WERF	Water Environment Research Foundation
WET	Whole Effluent Toxicity
WF	Weighting Factor
WIFA	Water Infrastructure Finance Authority
WPCF	Water Pollution Control Facility
WRC	Reclamation Campus
WRF	Water Reclamation Facility
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

CHAPTER 1

Introduction

Chapter 1 - Introduction

The Pima County Regional Wastewater Reclamation Department (PCRWRD) commissioned the development of a master plan to identify the optimal strategy for the treatment of current and projected future wastewater flows to the Roger Road Wastewater Reclamation Facility (WRF) and the Ina Road WRF. Most importantly, the plan addresses the current and future regulatory requirements of the Arizona Department of Environmental Quality (ADEQ) to reduce the ammonia and nitrogen concentrations discharged into the Santa Cruz River by the year 2014 for the Ina Road WRF and the year 2015 for Roger Road WRF.

PCRWRD owns and operates two major wastewater reclamation facilities and a smaller wastewater reclamation facility in the metropolitan (Metro) area of Tucson, and manages a sewerage conveyance system that includes over 3,300 miles of sewer pipes, 66,000 manholes and 34 lift stations. Further, the County owns and operates eight (8) Non-Metropolitan (Non-Metro) wastewater reclamation facilities in areas of rapidly growing populations. The Non-Metro facilities were evaluated in the master plan for regulatory compliance, system performance and for consolidation or expansion to meet the future needs of the County. In addition, the County through the master planning activities sought to optimize current and future biosolids treatment and disposal as it relates to its wastewater treatment facilities.

In parallel to the master plan activities PCRWRD commissioned a system-wide odor control plan development to address the long lingering issues of wastewater infrastructure induced odors in the community. The odor control plan addresses the current and future needs for odor control, optimizes the operations of systems utilized for odor control and identifies future odor control system needs. Results of the system-wide odor control plan are incorporated into various project elements of the master plan.

1.1 Purpose of Study

The master plan purpose is twofold. First is to determine an optimal strategy for long-term flow/capacity management, recommend a treatment strategy for the increasing quantities of pollutants as wastewater flows increase in the future, identify existing facility rehabilitation needs, optimize solids handling and address the optimal methods to provide reclaimed water. Second is to develop a coordinated Capital Improvement Design and Construction Program, including estimates of construction costs, schedules and a recommended project delivery and funding strategy for implementation of resulting projects from the master plan development. These resulting projects are to be integrated into the overall PCRWRD Capital Improvement Program (CIP). As necessary, hydraulic and process modeling were used in the evaluation of alternatives.

PCRWRD recognizes the value of long-range planning in making timely, cost effective decisions. To that end, PCRWRD retained Greeley and Hansen LLC to create a master plan for future wastewater treatment in the PCRWRD service area. The master plan serves as a broad road map to the future activities. It identifies potential pathways, as well as obstacles to the implementation of PCRWRD's CIP. Through a detailed evaluation process, the best option is identified and selected for implementation, without precluding changes in direction that may be prompted by future needs. This master plan forecast

needs for wastewater treatment capacity throughout the PCRWRD service area, and identified the facilities required to meet those needs through the year 2030. The master plan builds upon numerous planning and engineering efforts previously performed for or by the PCRWRD. The plan identifies when wastewater treatment facilities will be upgraded and expanded, as well as how existing facilities will be integrated into future expansions or be decommissioned through the year 2030. The plan is based on current and potential future regulatory and PCRWRD customer requirements.

The plan recommends a comprehensive CIP with treatment component and system alternatives, phasing schedules and cost apportionments for future implementation of PCRWRD wastewater facilities needs. A series of facilitated workshops (consisting of PCRWRD staff, consultants and other stakeholders) were conducted to implement this study. The workshops were central to the decision making process for the development of the master plan. Key PCRWRD decisions were developed through a consensus process in facilitated workshops. The workshop summaries and presentations are provided on a CD, located in **Appendix A**. As the master plan developed, concurrent efforts focused on Strategy Development and CIP Development. The project elements associated with each of these efforts were:

- Strategy Development
  - Project Workshops/Public Meetings
  - Information Gathering, Regulatory/Customer Requirements/Permitting
  - Flow Projection/Capacity Needs
  - Treatment Plant Evaluations
  - Overall Treatment Strategy
  - Treatment Plan Recommendations
  - Conveyance System Evaluation
  - Non-Metro Plants Area Evaluation
  - Flow Management and Non-Metro Plants Area Treatment Plan Recommendations

- Capital Improvement Plan Development
  - CIP Elements Identification and Economic/Financial Analysis
  - CIP Delivery Methods Determination
  - CIP Phasing and Cost Schedules Preparation
  - Implementation Plan Development

1.2 General Background

Roger Road Wastewater Reclamation Facility (WRF)

The Roger Road WRF is the older of the two major metropolitan wastewater treatment facilities. It is a combination of several expansions and has a permitted capacity of 41 million gallons per day (mgd). Currently the average winter influent flow (peak season) is approximately 39.7 mgd. The facility is located at 2600 W. Sweetwater Drive, Tucson, Arizona 85705, just north of Prince Road between Interstate 10 and the Santa Cruz River. The Roger Road WRF was first operated in 1951 as a 12-mgd activated sludge facility and was expanded with a separate 13-mgd trickling filter plant in 1960. A

13-mgd activated sludge/contact stabilization facility was added in 1967. In 1979 the facility was consolidated into a single facility with the major biological treatment process consisting of two, 165-foot diameter by 26-foot deep, plastic media biofilters with return activated sludge capability. This increased the rated capacity to 41 mgd. The facility is required to continuously meet secondary treatment limits as set forth by ADEQ.

By-products (sludge) of wastewater treatment are thickened and anaerobically digested on site. Digested sludge meeting Class B biosolids criteria for agricultural land application disposal are conveyed via force main to the Ina Road WRF, where it is combined with digested biosolids from the Ina Road WRF. After thickening and dewatering biosolids are hauled and applied to agricultural land as a beneficial reuse soil amendment.

As flow and influent loadings have increased at the facility, the activated sludge tanks have been placed into continuous service. Prior to the late 1980s, the activated sludge tanks were used only during the winter months when the reaction rates slowed in the biofilters due to lower temperatures and higher influent loadings.

Before the effluent is released to the Santa Cruz River, a portion of the flow is pumped to reclaimed water treatment facilities owned and operated by Tucson Water. The reclaimed water facilities are located on the east side and adjacent to the Roger Road WRF. Flow to the reclaimed water facilities receives further treatment prior to distribution to reclaimed water users through an extensive regional pipeline distribution network.

For the Roger Road WRF process modifications and changes are required to lower ammonia and total nitrogen discharge levels to meet future effluent quality regulations. At a minimum, rehabilitation is needed to repair process units, replace equipment and structures that are beyond useful service life, address odor control and safety issues, and upgrade the facility to be compliant with environmental, regulatory, and building code requirements. An alternative to rehabilitating the aging Roger Road WRF is to replace the existing WRF. As the assessment of current conditions and systems were evaluated for the Roger Road WRF, consideration was given to the operational relationship between the Randolph Park Water Reclamation Facility (WRF) and the Ina Road WRF. Currently the Randolph Park WRF has a capacity of 3 mgd.

Ina Road WRF

The original Ina Road WRF was designed in 1973 and constructed from 1975 to 1977. The facility is located at 7101 North Casa Grande Highway, Tucson, Arizona 85743, just south of Ina Road, between Interstate 10 and the Santa Cruz River. The facility was designed to produce a treated effluent meeting secondary treatment quality requirements as set forth by ADEQ.. The original treatment plant uses a 25-mgd high-purity oxygen (HPO) Activated Sludge Process, sludge digestion and centrifuge thickening/ dewatering for solids handling and processing (to meet Class B biosolids agricultural land application disposal criteria), and a combined energy-recovery system for heating, cooling and on-site generation of electrical power. The energy–recovery system uses methane generated as a by-product of the solids treatment process. Modifications to the original design to enhance equipment performance and reliability were completed in 1990.

The headworks serving this facility, along with appropriate odor control facilities, were recently expanded to a capacity of 50 mgd. A Biological Nutrient Removal Activated Sludge (BNRAS) treatment works with a design capacity of 12.5 mgd was placed in service at the end of 2006. Effluent from the 25-mgd HPO treatment process and the 12.5-mgd BNRAS treatment process are combined prior to chlorination/de-chlorination disinfection and discharged into the Santa Cruz River. Current average winter influent flow (peak season) is approximately 23.8 mgd.

Process modifications/changes will be required to lower the ammonia and total nitrogen discharge levels to meet new discharge standards. Rehabilitation is needed to replace some equipment and upgrades are necessary for the facility to be compliant with future environmental, regulatory, and building code requirements. Other needed modifications include back-up power provisions, expanded plant laboratory facilities, improved personnel areas and a centralized laboratory facility.

1.3 Strategy Development

The master plan strategy development included the investigation of options and impacts of various treatment and conveyance configurations, while considering both major wastewater reclamation plants as one interconnected treatment system. This investigation included the evaluation of the transfer of all, or a transfer of a portion of the wastewater flow from the Roger Road WRF service basin area to the Ina Road WRF for treatment. Cost elements included new facilities, rehabilitation, odor control, nutrient removal, and future capacity needs. Studies and investigations included model-based evaluations, preliminary cost estimating, operation and maintenance (O&M) costs, an understanding/optimization of total community cost impacts (e.g., other water utility provider costs – Tucson Water, Metro Water, and Oro Valley Water), a pros/cons assessment of alternatives, and the generation of a net present value analysis.. All derived estimates and concepts were developed at a planning level, and based on existing published and PCRWRD information. An independent cost evaluation was conducted on treatment facilities costs. Based on a complete analysis, a recommended configuration was developed.

The following options were evaluated as part of the master plan.

1. “Existing Plan” option was for both plants to continue operating with Roger Road WRF at a somewhat reduced capacity (32 mgd) and Ina Road WRF at an increased capacity (50 mgd). Evaluations included characterization and projection of sewage strength, projected flows, optimization of plant operations, and value and worth of existing structures and systems.

2. Maintain a smaller wastewater treatment facility at the Roger Road WRF (20 mgd) to continue to provide effluent to the adjacent Tucson Reclaimed Water Treatment Plant, and direct the remainder of the influent flows and solids to the Ina Road WRF.

3. Transfer of all wastewater flow from the Roger Road WRF service basin area to the Ina Road WRF, followed by a decommissioning and closure of the Roger Road WRF. This option included reclaimed water conveyance facilities from the Ina Road WRF to the existing Tucson Reclaimed Water Treatment Plant adjacent the existing Roger Road WRF.

4. Each of the above options included an evaluation of an upgrade of the PCRWRD facilities to produce reclaimed water quality of Class A+, to allow decommissioning of the pressure filter system at Tucson Water Reclamation Facility. Implementation of this option would require an agreement between Tucson Water and PCRWRD.

"***Existing Plan"***
The plan under the Department's 2006 Metropolitan Area Facility Plan Update (Existing Plan) was to complete the necessary rehabilitation and process optimization at both facilities, construct the required process changes to meet the effluent limits for nutrient removal, incorporate enhanced odor control facilities at the Roger Road WRF and the Ina Road WRF, transfer all biosolids processing to Ina Road WRF, via a modified sludge line, develop a centralized biosolids processing facility with a potential to produce a Class A biosolids, and add a 28-mgd (average dry weather) gravity flow interconnect pipeline between the two facilities. A sub-option for additional consideration is to build a new water reclamation campus (WRC) to serve Roger Road WRF flows and abandon the existing facility.

Under this option and in the others below, water rights to the effluent are addressed in existing intergovernmental agreements among the City of Tucson (Tucson Water), the Conservation Effluent Pool (CEP), Southern Arizona Water Rights Settlement Act (SAWRSA), Pima County, and other reclaimed water owners.

"Transfer Some" Wastewater Flow, Leaving a Portion for Reclaimed Use
Based on economics or other issues such as reclaimed water use a smaller treatment facility at the Roger Road WRF (20 mgd) may be desirable, while directing the majority of the flows to the Ina Road WRF (62 mgd). Under this option some of the existing facilities would be modified to treat only a portion of the flow in the service basin area, while directing all wastewater process solids (primary solids, and waste activated sludge) along with the remainder of the plant influent to the Ina Road WRF. This would allow shutdown of a large portion of the facilities presently located at the Roger Road WRF, and reduce operations and maintenance expenses at this facility. A sub-option is to build a new facility to serve Roger Road WRF at reduced flows and abandoned the existing facility.

"Transfer All" Wastewater Flows to Ina Road WRF
In this option, all wastewater (82 mgd) is directed by gravity flow from the Roger Road WRF to the Ina Road WRF. The two facilities are approximately 5 miles apart, and the Roger Road WRF is located at a point approximately 75 feet higher in elevation than the Ina Road WRF. The transfer of flows could be achieved by a gravity flow pipeline. Significant plant expansion and process modifications at the Ina Road WRF would be required to accommodate the additional flows. All flows will need to meet the effluent limits for nutrient removal. This option would eliminate the treatment plant age and related odor issues at the Roger Road WRF.

Biosolids
Environmental Protection Agency (EPA) Part 503 Regulations lists various methods and approaches to achieve a Class B or Class A biosolids. Each option considered in the master plan includes the potential of processing biosolids to Class A. Consolidation of the biosolids processing and treatment centralizes operations, minimizes operations and maintenance expenses and enhances third party interest in biosolids

disposal. Furthermore, expanding the county-wide biosolids disposal market by securing additional disposal outlets are needed to provide a robust long term biosolids management program. Disposal practices of the biosolids generated from the wastewater facilities and a preliminary evaluation for producing marketable end products was conducted. In all cases obtaining Class A biosolids involves reducing vector attraction and pathogens through additional process treatment.

Further, each of the options addressed associated conveyance system modifications and the impact of reduced discharges from the Roger Road WRF on the Santa Cruz River riparian habitats.

Permits
The Roger Road WRF and Ina Road WRF operate under Arizona Pollution Discharge Elimination System (AZPDES) permit numbers AZ0020923 and AZ0020001, respectively, issued by the ADEQ. ADEQ operates the AZPDES program under a delegation agreement with U.S. EPA. Pursuant to state law, ADEQ also issues permits under a state-wide aquifer protection permit (APP) program. The Roger Road WRF and Ina Road WRF operate under APP permit numbers P-100655 and P-100630, respectively.

Compliance with permitting requirements for each of the options, including plant upgrades to either Class B+ or Class A+ reclaimed water and land setback requirements are part of the master plan program. Permits that regulate wastewater treatment systems and effluent quality include:

- National Pollutant Discharge Elimination System (NPDES)/AZPDES permits
- Aquifer Protection Permit (APP)
- Arizona (State) Surface Water Quality Standards
- State Reclaimed Water Quality Standards
- State Aquifer Water Quality Standards
- State Rule 2.05 General Permit: Capacity, Management, Operation and Maintenance of a Sewerage Collection System

For effluent disinfection the County facilities will need to meet Best Available Demonstrated Control Technology (BADCT) requirements in future expansions and upgrades. For planning purposes consideration is given to the status of regulations of emerging contaminants.

Flow Projection and Capacity Needs
Expected future flows and wastewater loads for the Pima County wastewater service areas were developed from population projections prepared by the Pima Association of Governments (PAG). In particular, the overall conveyance system capacity needs within and between the service basin areas of Roger Road WRF and Ina Road WRF through the year 2030 were evaluated. In addition, the population projections were utilized to project flow, loads, and capacity needs in the Non-Metro areas (areas beyond the Roger Road WRF and Ina Road WRF service basin areas).

Wastewater Treatment Process
Alternative treatment schemes for the removal of chronic toxicity caused by ammonia are evaluated to achieve the reduction of the amounts of ammonia and nitrogen concentrations discharged into the Santa Cruz River to comply with current and future environmental regulatory requirements. Detailed outlines

of the treatment facilities expansion, rehabilitation and nutrient removal process changes for future permit compliance are identified. Site layouts, including future setback requirements, and opinions of probable construction and O&M costs were identified for the most promising nutrient removal processes.

Expansion options include considerations for the production of Class B+ and the possibility of the production of Class A+ effluent water quality, to meet the nutrient effluent limits. For Roger Road WRF a determination of the facility closure requirements as required by the options, as well as, facility needs to allow the plant to remaining service were examined in detail. Plans showing processes remaining, as well as those that would be eliminated, and other modifications required to allow the plant to operate were developed

Plant Interconnect
Each of the alternatives involves a transfer of some flow from the Roger Road WRF service basin area to the Ina Road WRF. Capacities of the flow management structures between service basin areas and a new plant interconnect between the two plants were evaluated. Sizing of the plant interconnect, based on gravity flow, was developed for each option. Flow requirements were determined from existing and future populations served, flow allocation per capita and from the wet weather response in the conveyance system. Preliminary routing alignments were prepared to investigate various planning and design issues related to each alternative route.

Power Generation
Evaluation of the bio-gas utilization for engine driven equipment and power generation facilities at Roger Road WRF and Ina Road WRF was conducted. The advantages and disadvantages of onsite bio-gas utilization for engine driven equipment and power generation versus purchased power from the local utility were evaluated. Consideration was given to the costs of having power available from the local power utility in the event that onsite power outage occurs. For Roger Road WRF and Ina Road WRF a decision by Pima County is required to either continue the practice of bio-gas utilization for engine driven equipment and power generation onsite, or to purchase power from a local utility and to utilize bio-gas for heating and cooling functions, or to sell all bio-gas to a third party for commercial use. Through an expression of interest process Pima County invited the marketplace to address the potential of third party operations of its power utility or utilization of the biogas.

System-Wide Odor Control Plan
Odor abatement and control across the entire system is a major issue that faces the department as many odiferous compounds, primarily hydrogen sulfide, are generated from the conveyance and treatment of sewage. With respect to the sewerage conveyance system within the Tucson metropolitan area, wastewater generally flows from southeast to the northwest. Because both major treatment plants are located on the northwest side of Tucson, a portion of the wastewater travel time can exceed 24 hours. Over such long distances most of the oxygen available within the wastewater is depleted along the way. In turn, any sulfates present are reduced to sulfides, and hydrogen sulfide is generated.

The Department owns and operates chemical dosing units (CDUs) and one biofilter within the conveyance system to minimize the generation and emission of hydrogen sulfide gas. With continuing metro area in-fill development and growth in the Non-Metro areas the number of odor complaints is likely to increase unless additional efforts are taken to mitigate this issue across the system. Therefore, a

comprehensive, system-wide evaluation of the conveyance systems and treatment facilities to review the odor control strategies/efforts, industry technologies available for the control of odors, and development and generation of a comprehensive overall strategy for odor was commissioned by PCRWRD.

The odor control and abatement recommendations will provide for an integrated system-wide odor abatement strategy. Instead of focusing on the sewage conveyance system or on the treatment plant, odor control for the entire system will operate as a single unit process. In other words, the recommendations will ensure that odor control for the sewage conveyance system will work in concert with those used for the treatment facilities. Additionally, recommendations for odor control within the conveyance system will not adversely impact treatment operations. The recommendations for the conveyance system and treatment plants are included within the recommendations for the regional optimization master plan.

ADEQ Letter of Intent

The AZPDES operating permits for the Roger Road WRF and Ina Road WRF require the facilities to comply with ammonia removal standards by January 30, 2015 and January 30, 2014, respectively. The ammonia removal requirements are the impetus for the master planning process. In January 2007 PCRWRD submitted letters to ADEQ describing its intention to meet the proposed permit requirements for ammonia and total nitrogen at Roger Road WRF and Ina Road WRF. Using the information and data developed from the master plan studies and investigations, the correspondence identified the capacity and probable treatment approach at each site. .

1.4 Capital Improvement Plan Development

All of the Department's capital costs, including project costs recommended from this master plan, are evaluated in a 15-year CIP. Funding sources were identified as part of a Baseline Financing Plan that used traditional public financing vehicles including revenue bonds, connection charges, and revenue financed capital. A projection of operating and maintenance costs was developed that considered the effects of inflation, increased operating costs, increased demand, and the operational impact of the Department's CIP. Total revenue requirements, both operating and capital, were projected over the forecast period to assess the potential impacts on user rates and charges.

Capital Improvement Plan

From the master plan recommendations for wastewater facilities throughout the Pima County, project elements are identified for the capital improvement plan. The basic elements of the program are:

- Ina Road WRF rehabilitation/modifications/upgrades
- A new water reclamation campus
- Plant interconnect pipeline
- Support facilities
- Conveyance system augmentation
- Non-Metro area treatment facilities

Each of the elements is divided into multiple sub-elements that comprise the whole program. Capital costs on a sub-element basis are escalated to correlate with the schedule of design and construction. Each sub-element consists of costs for administration, engineering design, phased construction and startup.

CHAPTER 2

Regulatory and Customer Requirements

Chapter 2 - Regulatory and Customer Requirements

2.1 Introduction

Regulatory agencies and customers requirements set the level of design and treatment for wastewater treatment facilities. Regulatory agencies influence wastewater treatment facility design by setting requirements on the degree of redundancy, flexibility, security and reliability integrated into wastewater treatment facility design. The level of treatment is governed by major legislation, such as the federal Clean Water and Clean Air Acts, State of Arizona environmental quality standards, as well as specific quality demands of local customers. PCRWRD has its own set of wastewater treatment facility design requirements. Both the regulatory agencies and the customer have broad impacts on the level of treatment required and thus the type and layout of process systems, structures, and equipment needed to achieve it.

This chapter reviews current regulatory and customer requirements regarding wastewater treatment facility design and level of treatment as they relate to Pima County.

2.2 Wastewater Conveyance / Treatment

Many factors influence wastewater conveyance and treatment design including federal, state and customer requirements. Within various federal regulations are requirements for meeting system capacity, redundancy, reliability and security. Specific customer requirements influence system flexibility, aesthetics, operation and maintenance considerations and other aspects of design and future operations.

2.2.1 Conveyance System Capacity

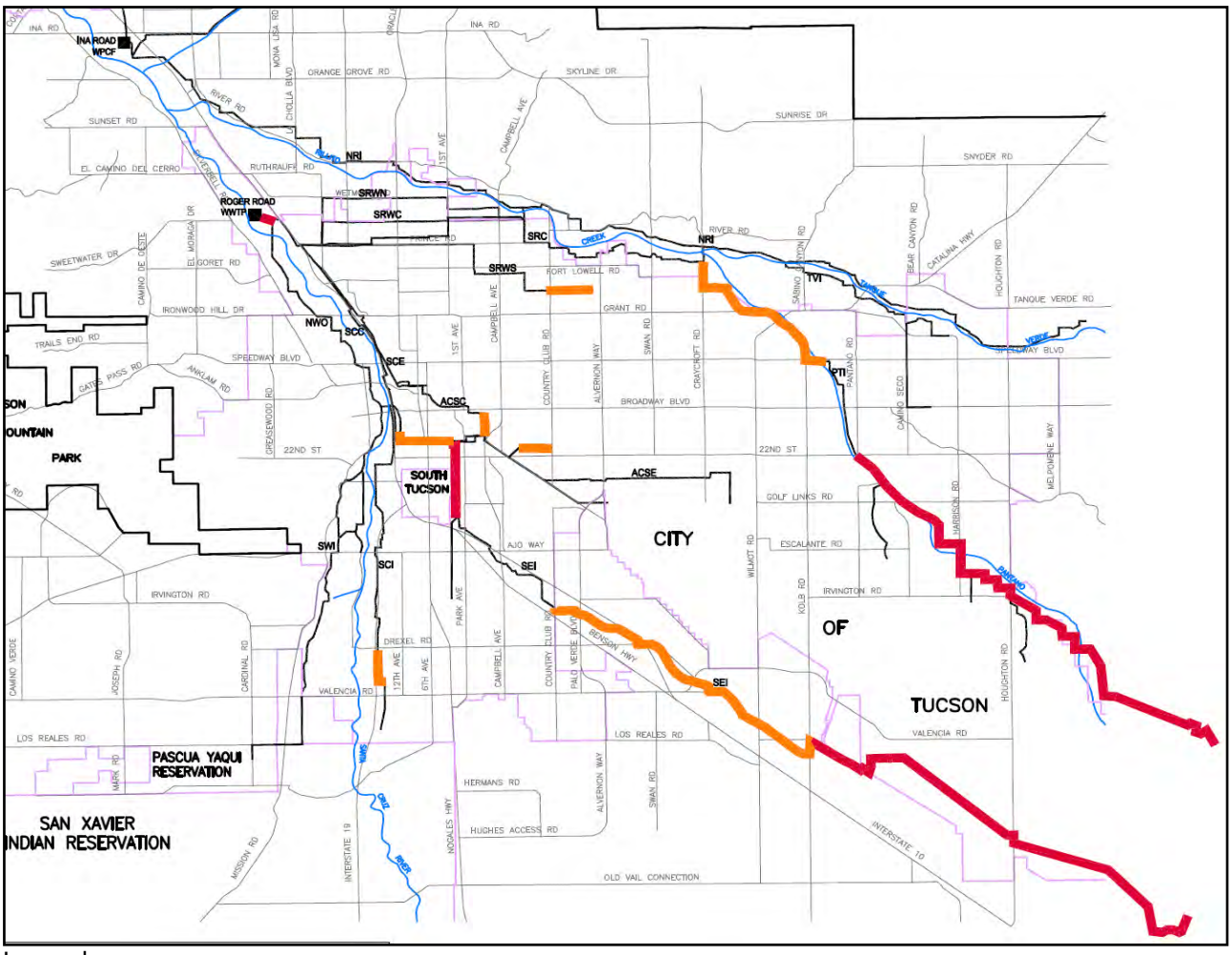
In January 2001, the U.S. EPA approved draft regulation modifying the NPDES to include Sanitary Sewer Overflow (SSO) regulations. The proposed SSO regulations included a set of requirements for municipal wastewater collection systems, known as CMOM, for Capacity (C), Management (M), Operation (O), and Maintenance (M).

Although the federal rule was withdrawn in March 2004 from the Federal Register, the ADEQ implemented state CMOM rules on November 12, 2005. In accordance with the rule, if an owner or operator of a sewage collection system wants to be covered by the new 2.05 General Permit, the owner or operator must develop a CMOM Plan that addresses operation and maintenance, capacity improvements, and spill response. The Plan should quantify hydraulic deficiencies in the collection system, develop measures to assure capacity in light of deficiencies, and provide a rationale for prioritization and scheduling. The state rule (R18-9-C305, 2.05 General Permit: Capacity, Management, Operation, and Maintenance of a Sewage Collection System) requires specifically that the CMOM Plan identify "components of the sewage collection system that have insufficient capacity to convey, when properly maintained, the peak wet weather flow of a 10-year, 24-hour storm event. For those identified components, a capital improvement plan exists for achieving sufficient wet weather flow capacity within ten years of the effective date of permit coverage." Pima County Regional Wastewater Reclamation

Department (PCRWRD) obtained CMOM coverage under the 2.05 general permit on November 11, 2006.

PCRWRD's conveyance system (see **Figure 2-1**), including sewer lines, manholes, flow management structures and lift stations service the Pima County Metropolitan Area and the Cities of Tucson and South Tucson; the towns of Marana, Oro Valley and Sahuarita; and unincorporated communities such as Summerhaven (Mt. Lemmon), Arivaca Junction, Avra Valley, Green Valley, Corona de Tucson and Catalina as well as Pima County. Portions of the system date back to 1900.

Figure 2-1
Pima County Conveyance System



Legend:

- Exit Q Deficient (calculated basin exit flow is greater than 85% of full pipe capacity at the basin exit)
- Inlet Q Deficient (calculated basin inlet flow is greater than 85% of full pipe capacity somewhere within the basin)

Minimal capacity issues were identified in the 2006 Metropolitan Facility Plan Update [2.1]. This can be attributed to the conveyance system consisting of mature basins within the urban area (little or no projected population growth) and installation of interceptors with greater capacity than that needed to serve the current population. Tremendous growth is currently occurring outside of the urban area, in locations served by the (satellite) Non-Metro treatment facilities or basins on the extreme upstream reaches of the metropolitan conveyance system. The conveyance system is discussed in greater detail in Chapter 6.

2.2.2 Treatment System Capacity

The Metropolitan Area Wastewater Reclamation Facilities are the Roger Road WRF, Ina Road WRF, Randolph Park WRF. The other wastewater reclamation facilities are listed as Non-Metro treatment facilities.

Roger Road WRF is a 41-mgd trickling filter and activated sludge facility. The Roger Road WRF currently operates under an APP issued by ADEQ on May 26, 2005. The alert level for this facility is 40-mgd average monthly flow. Exceedance of the alert level for flow requires a response comparable to exceeding alert levels for pollutants with numeric Aquifer Water Quality Standards (AWQS).

Ina Road WRF consists of a 25-mgd high purity oxygen activated sludge facility and a new 12.5-mgd biological nutrient removal activated sludge train capable of nitrification/denitrification. The Ina Road WRF currently operates under an APP issued by ADEQ on July 14, 2006. The alert level for this facility is 35-mgd average monthly flow. Exceedance of the alert level for flow requires a response comparable to exceeding alert levels for pollutants with numeric AWQS.

State code (Arizona Administrative Code, or AAC, R18-9-A211, Permit Amendments) requires a significant permit amendment to the APP if an existing facility with a permitted design flow greater than 5 million gallons per day but less than or equal to 50 million gallons per day undergoes a physical change or change in its method of operation that results in an increase in design flow of four percent or more. Expansion at the Ina Road WRF will meet this criterion, and Best Available Demonstrated Control Technology (BADCT) rules for pathogen removal applies according to “the part of the facility that has not been required to conform to BADCT requirements for new facilities, if a facility or part of a facility has undergone or will undergo” any such change (AAC R-18-9-B206, Treatment Performance Requirements for Expansion of a Permitted Facility). The impact of BADCT requirements are discussed in more detail in Chapter 2.4.

The Non-Metro facilities consist of small capacity plants located throughout eastern Pima County, including Avra Valley WRF, Corona de Tucson WRF, Fairgrounds WRF, Green Valley WRF, Marana WRF, Rillito Vista WRF, Arivaca Junction WRF and Mt. Lemmon WRF. Population growth is of great concern at these facilities as treatment capacities currently range from less than 0.01 mgd to 4.1 mgd. The Non-Metro facilities are discussed in detail in Chapter 8.

2.3 System Condition Assessment

Existing condition assessments of the liquid and solid streams; unit processes; structural; electrical; instrumentation and control (I&C); heating, ventilation, air conditioning (HVAC)/plumbing; support facilities; and geotechnical aspects of the Roger Road WRF and Ina Road WRF are valuable in process and system developments. These conditions are presented in **Appendix B**. The evaluations aid in drawing conclusions regarding the suitability of the facilities to stay in service at existing, greater, or reduced capacity in the current treatment mode and in a converted nutrient removal mode.

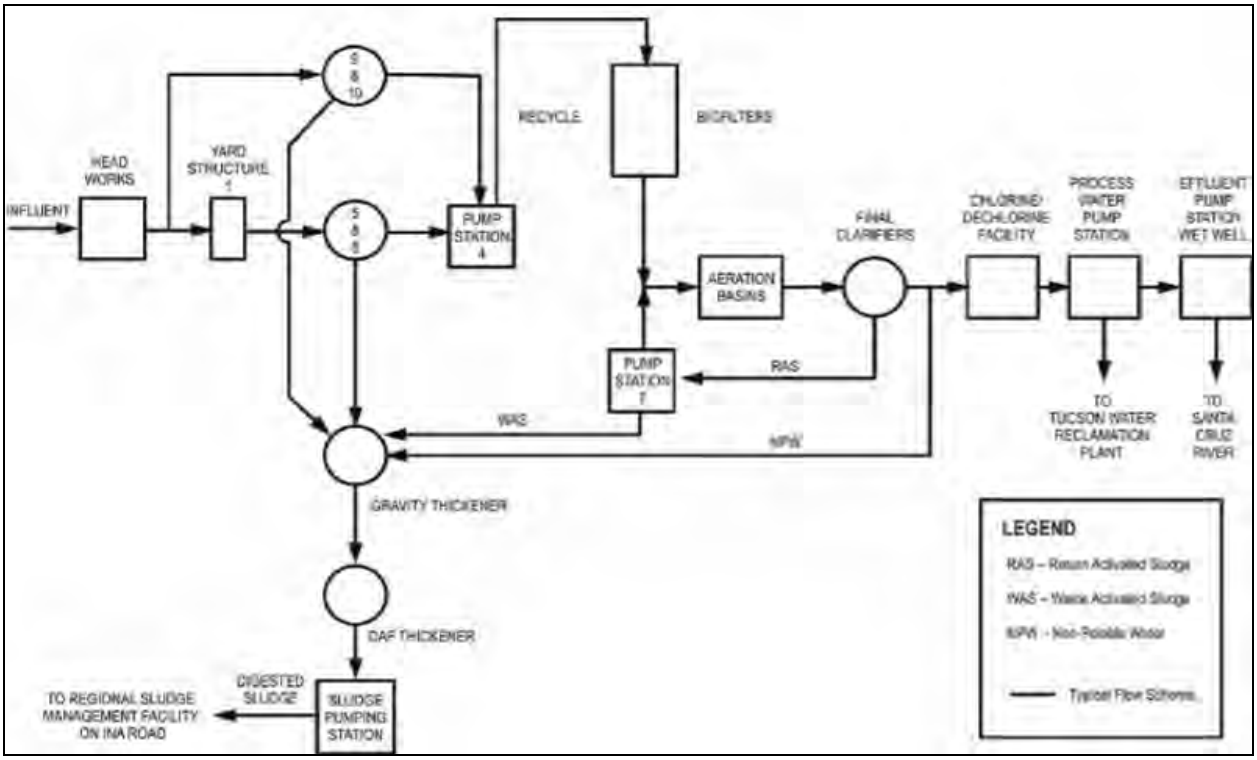
2.3.1 Conveyance System

As described in the 2006 Metropolitan Facility Plan Update [2.1]: in 2003, PCRWRD commissioned an assessment of the collection system condition as part of their on-going asset management program to evaluate about 230 miles of trunk and interceptor sewers. This assessment was performed utilizing the National Association of Sewer Service Companies (NASSCO) condition codes ranging from "excellent" to "immediate attention required." The biggest areas of concern are segments of the collection system with unlined reinforced concrete pipe. While these segments only constitute 2 percent of the entire collection system, this pipe material is prone to failure in arid conditions with long wastewater travel times. Hydrogen sulfide gas causes significant corrosion of the concrete, which can result in piping structural failure. Segments of the collection system were rated as "poor" or "immediate attention required." The portions of the collection system with these ratings include portions of the Aviation Corridor, Canada del Oro, Old Nogales Highway, Pantano, Santa Cruz, South Rillito, Southwest and Tanque Verde Interceptors. Other segments included in the initial condition assessment were rated at a "fair" or "good" condition and were recommended for reevaluation in 2008. Additional rehabilitation/replacement needs identified for the conveyance system includes over 3,000 manholes; several siphon boxes and many of the lift station wet-wells, which exhibit signs of hydrogen sulfide corrosion.

2.3.2 Roger Road WRF

The Roger Road WRF is the older of the two major treatment facilities. The Roger Road WRF was first operated in 1951 and was expanded and upgraded in 1960, 1967 and 1979. **Figure 2-2** illustrates the process flow at this facility.

Figure 2-2
Roger Road WRF Process Flow Diagram



Wastewater treatment by-products include sludge, which is thickened and digested into beneficial biosolids. Digested biosolids are conveyed via force main to the Ina Road WRF and combined with digested biosolids from the Ina Road WRF; where it is thickened then hauled and applied to agricultural land as a soil amendment.

Until the late 1980s, the activated sludge tanks were used only during the winter months when the reaction rates slowed in the biofilters due to lower temperatures and higher influent loadings. As flow and influent loadings have increased at the facility, the activated sludge tanks have been placed into continuous service. The facility is required to continuously meet secondary treatment limits.

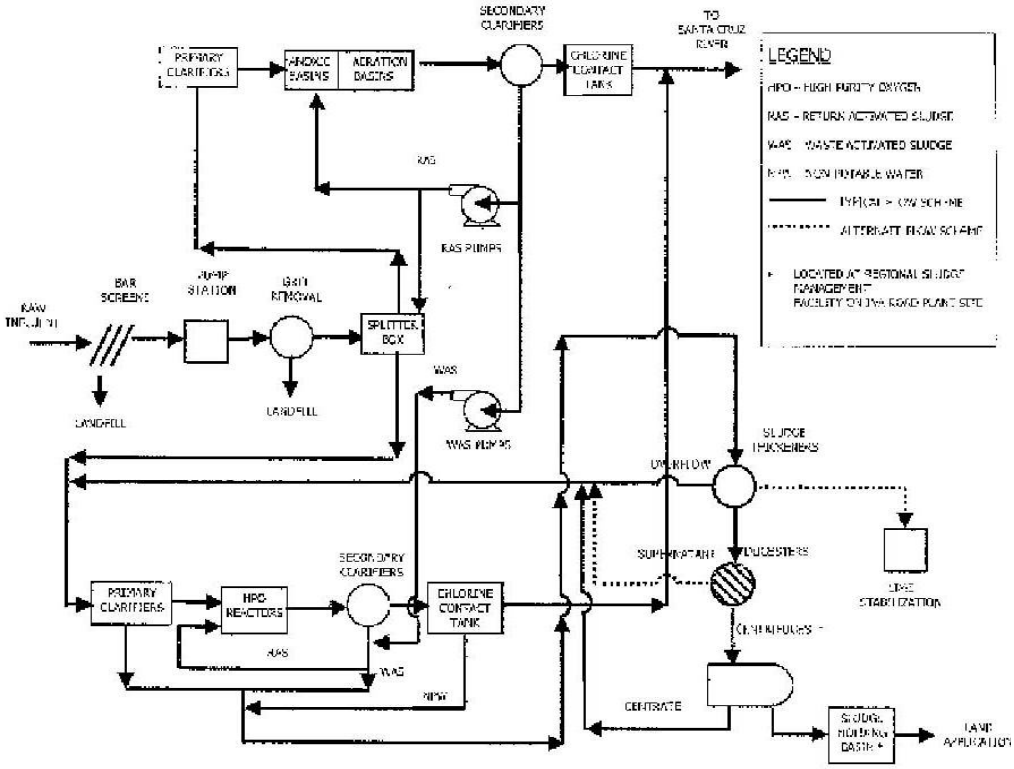
In general the facility is well maintained and in satisfactory condition with a few exceptions considering its age. The facilities, with continued good operations and maintenance practices, should provide satisfactory service for an additional 10 years or until new facilities are brought on line. Although, the electrical system is not serviceable for the long term without significant modifications and upgrades. Additionally, there is a significant lack of instrumentation and control. Programmable Logic Controllers (PLCs) and other Supervisor Control and Data Acquisition (SCADA) devices to permit remote monitoring or operation are not available.

A detailed evaluation of the Roger Road WRF: Structures, Equipment, Electrical and Civil are provided in Chapter 3.

2.3.3 Ina Road WRF

The original Ina Road WRF was designed and constructed from 1973 to 1977 with additional facilities designed in the late 1990's and placed into operation in 2006. The existing treatment plant includes a 25-mgd HPO Activated Sludge Process and a 12.5-mgd BNRAS process. Modifications to the original design to enhance equipment performance and reliability were completed in 1990. Average winter influent flow (peak season) is currently 23.8 mgd. **Figure 2-3** illustrates the process flow at this facility.

Figure 2-3
Ina Road WRF Process Flow Diagram



This facility is much newer than Roger Road WRF. This facility was generally rated in good condition. Concrete and mechanical equipment appeared to be in good condition throughout. The existing instrumentation and control system was rated as good, but appeared to be underutilized for a facility this size. An electrical motor control center requires some attention. Any wastewater facility must continually renew and replace components and systems to remain a viable operation. Additionally, any modifications need to consider back-up power provisions and existing/expanded need of laboratory facilities.

A detailed evaluation of the Ina Road WRF is provided in Chapter 3.

2.4 Effluent Quality

2.4.1 Permit Requirements

Regulatory objectives for effluent quality are currently established by each facility's AZPDES and APP permits. Limits in the AZPDES permits are driven by State Surface Water Quality Standards. Limits in the APP permits are driven by numeric State Aquifer Water Quality Standards and BADCT requirements.

The foremost goal is to meet permit requirements for elimination of ammonia toxicity and anticipated future total nitrogen limits at the Roger Road WRF and Ina Road WRF, determining the probable treatment approach at each site before the January 2007 submission of a Letter of Intent to the ADEQ. Specific Letters of Intent with capacity and wastewater treatment processes for the Roger Road WRF and Ina Road WRF were both issued on January 26, 2007, and can be found in **Appendix C**. In the future, the existing treatment system may require upgrades to meet more stringent regulatory criteria and the demand by customers for higher quality effluent and to reduce risk. Key factors in determining future treatment strategies include pathogen removal, salinity, contaminants of concern, future customer requirements, and risk associated with chlorine use.

In the absence of a specific permit numeric ammonia limitation, an estimated value calculated to avoid toxicity has been used to set the treatment objective for ammonia since the mid-1990s. The estimated value, under 2.0 milligrams per liter (mg/L) total ammonia-nitrogen, is based upon maintaining an effluent concentration of less than 0.02 mg/L un-ionized ammonia under worst-case conditions (i.e., measure of acidity and alkalinity (pH) of 7.2 and temperature of 32 degrees Celsius (°C)).

Regulatory permit requirements for Roger Road WRF, Ina Road WRF, Randolph Park WRF, and the Non-Metro facilities can be found in **Appendix D**,

2.4.2 Pathogen Removal

The AZPDES permits issued for the Roger Road WRF, Ina Road WRF, Randolph Park WRF, Avra Valley WRF, Green Valley WRF, and Mt. Lemmon WRF include *E. coli* limits of 126 CFU/100 milliliter (mL) (four of seven samples collected per week) and 576 CFU/100 mL (single-sample maximum). Arivaca Junction WRF, Corona de Tucson WRF, Pima County Fairgrounds WRF, and Rillito Vista WRF do not have AZPDES permits; the NPDES permit for Marana WRF includes microbial discharge limits that match those of its APP.

The APP permits for Roger Road WRF, Ina Road WRF, Randolph Park WRF, and Avra Valley WRF include fecal coliform discharge limits of non-detect in four of seven samples collected per week and 23 CFU fecal coliform/100 mL or 15 CFU *E. coli*/100 mL (single sample maximum). The APP permit for the Arivaca Junction WRF include fecal coliform discharge limits of 1000 CFU/100 mL (four of last seven samples collected) and 4000 CFU/100 mL (single sample maximum). The APP permits for the

Green Valley WRF and Marana WRF include fecal coliform discharge limits of 200 CFU/100 mL or most probable number (MPN) (four of seven samples collected per week) and 800 CFU/100 mL or MPN (single sample maximum).

Future expansions of the Roger Road WRF, Ina Road WRF and Non-Metro facilities may be subject to new facility BADCT requirements (refer to AAC R18-9-A211(B)(2)(b)), which apply to the following:

- Existing facilities discharging more than 5 mgd but less than or equal to 50 mgd that have undergone or will undergo a four percent increase in design flow
- Existing facilities discharging more than 0.5 mgd but less than or equal to 5 mgd that have undergone or will undergo a six percent increase in design flow
- Existing facilities discharging less than 0.5 mgd that have undergone or will undergo a ten percent increase in design flow

For facilities discharging greater than 0.25 mgd, the BADCT requirements (set forth in AAC R18-9-B204 through B206) include fecal coliform/*E. coli* limits of no organisms detected in four of seven samples collected per week and a single sample maximum concentration of 23 cfu/100 ml for fecal coliform or 15 cfu/100 ml for *E. coli* bacteria. An owner or operator may use unit treatment processes, such as chlorination-dechlorination, ultraviolet, and ozone to achieve the pathogen removal performance requirements. The facilities may also be able to use soil aquifer treatment (SAT) and an alternate point of compliance (POC) to meet the more stringent microbial standards. Use of SAT will require significant permitting discussions and approvals before acceptance by ADEQ.

2.4.3 Salinity

Salinity, as measured by total dissolved solids (TDS), is not directly regulated by permit but is a potential concern in meeting biomonitoring requirements and potential customer quality requirements. Indicator microorganisms used in biomonitoring are sensitive to TDS concentrations, and TDS at a concentration of 1100 mg/L have been identified as a cause of persistent effluent toxicity to *Ceriodaphnia*. End uses, including irrigation, cooling, and indirect reuse (via recharge and recovery), may ultimately require a reduction in effluent TDS levels.

TDS in wastewater originates from a number of sources, including the water supply, urban additions (for example, discharges from residential and commercial water softeners, residuals and brines from upstream water and wastewater treatment plants, and cooling tower blowdown), and farming additions. Several studies have recently been conducted or are in progress to characterize sources and impacts of salinity [2.2]:

- Central Arizona Salinity Study (CASS) – This four-year study, conducted by the Subregional Operating Group (SROG) in partnership with the Bureau of Reclamation, as well as other Arizona Cities (Tucson, Arizona), completed in 2005, evaluated the extent and nature of the salinity problem and recommended corrective actions.

- West Valley Brackish Groundwater Quantification Study – This study will identify the feasibility of supplementing current water supplies with desalinated brackish groundwater.

- City of Phoenix Cooling Tower TDS Study [2.3] – This study, undertaken by the City of Phoenix and completed in 2003, characterized the salt contribution of cooling towers to the 91st Avenue WWTP.
- The Reverse Osmosis/"Devaporation" Pilot Study – A cooperative effort between Arizona State University and the City of Phoenix, this study, being conducted at 23rd Avenue WWTP, is designed to accomplish nearly complete recovery of solids from membrane process reject streams.

- Phoenix Area Membrane Pilot Study – This study seeks to maximize production of reverse osmosis systems through increased recovery rates.

2.4.4 Contaminants of Concern

Emerging contaminants of concern include N-nitrosodiumdimethylamine (NDMA); pharmaceuticals, hormones, and other organic wastewater contaminants; and unregulated contaminant monitoring rule (UCMR)-listed pollutants.

NDMA is classified by EPA as a possible human carcinogen, and the current AZPDES permits for the Roger Road WRF and Ina Road WRF require that it be monitored in the effluent. A potential byproduct of chlorine disinfection, its generation is apparently enhanced by the presence of chloramines in the wastewater [2.4]. Detection of NDMA in the effluent could drive changes in the disinfection process at the wastewater treatment facilities. The detection limit and resulting notification limit of this contaminant is very low; 20 nano-grams per liter (ng/L) in the state of California.

Pharmaceuticals, hormones, and other organic contaminants are not currently regulated by permit at the wastewater treatment facilities but are of growing concern nationwide. While requirements for photodegradation and biodegradation of pharmaceuticals have yet to be investigated, studies on emerging contaminants are receiving funds to begin testing ultraviolet and ozone effectiveness in reducing contaminant levels.

High levels of perchlorate can cause adverse health effects such as interference with thyroid function. As a result, it was added to the list of unregulated chemicals for which monitoring is required under the UCMR. Arizona's current advisory health based guidance level for perchlorate is set at 14 ppb. Another contaminant shown to have cancerous effects is Arsenic. The EPA has set the maximum contaminant level for arsenic at 10 ppb.

2.4.5 Future Customer Requirements

2.4.6 Risk

To reduce the risk associated with transporting and handling large volumes of gaseous chlorine, Pima County utilizes sodium hypochlorite which is safe to transport and effective for effluent disinfection.

2.5 Biosolids Quality

Sludge generated at the Roger Road WRF and Ina Road WRF meets federal requirements for Class B biosolids. CFR Title 40 Part 503 regulations list various methods and approaches to achieve a Class B or Class A biosolids. Common approaches to achieve the highest class are: thermophilic digestion, heat drying, adding lime and composting. An evaluation will compare existing biosolids practices with the 503 regulations listings. An evaluation of the future spatial equipment needs to achieve a Class A standard are included in this 25-year master plan study.

The most common method available through the Part 503 regulations to meet Class B requirements is to use a Process to Significantly Reduce Pathogens (PSRP). These include aerobic and anaerobic digestion and alkaline stabilization processes. The most common method available to meet Class A requirements is to use a Process to Further Reduce Pathogens (PFRP). These processes include composting, heat drying, certain digestion processes, and certain alkaline stabilization processes. EPA further defines "Exceptional Quality" biosolids as products that are treated by a Class A process and have a relatively lower concentration of heavy metals. In addition to accepted PFRP and PSRP processes, the regulations allow demonstration of other treatment methods that are equivalent in pathogen and vector reduction.

Decisions to be made include when to implement Class A treatment and which process to select.

2.6 Air Quality

This chapter discusses the impact of air quality regulations, summarize the current status of the WRF's source classification and discuss the impact of potential project developments resulting from this study.

The Roger Road WRF and Ina Road WRF are currently subject to the air quality regulations of the Pima County Department of Environmental Quality and the EPA. Facility upgrades may trigger permit modifications and require extensive emissions modeling for the wastewater treatment processes. Additional emission controls and lean burn technologies will likely be required for new engines to comply within limits and BACT/MACT. Permit modifications may also be required if additional HAP standards are promulgated by EPA. Costs of re-permitting the power generation facilities may cost in excess of $100,000. This will be included in the costs to upgrade/expand or rehabilitate the existing power systems.

Roger Road WRF is currently categorized as a synthetic minor source for NO_X, CO, and other criteria pollutants. Ina Road WRF is currently categorized as a major source for NO_X and CO and a minor source for other criteria pollutants.

Roger Road WRF and Ina Road WRF have almost identical air quality operating permits regarding odor control. Within the air quality operating permits are regulations involving both emissions from diesel generators and odor/hydrogen sulfide emissions at the facilities. The air quality operating permit (#1913) for Roger Road WRF was issued on February 23, 2005 and expires on February 22, 2010. The air quality operating permit (#1903) for Ina Road WRF was issued on September 12, 2005 and expires September 11, 2010.

The following summarizes the requirements of *Part A: General Provisions* and *Part B: Specific Conditions* of both facilities' Air Quality Operating Permits regarding odor control issues.

> *Part A Sub-Section II, A.1. states that the Permittee shall install, operate and maintain air pollution control equipment or use good modern practices to minimize gaseous or odorous materials from being emitted in such quantities or concentrations as to cause air pollution. This is listed as a federally enforceable condition.*
>
> *Part A.3. states that no person shall allow hydrogen sulfide to be emitted from any location in such manner and amount that the concentrations of such emissions into the ambient air at any occupied place beyond the premises on which the source is located exceeds 0.030 PPM by volume for any averaging period of 30 minutes or more. For Ina Road WRF, the permit states this requirement is a locally enforceable condition. For Roger Road* WRF*, there is no statement on enforcement.*

Setback areas are required for each of the treatment plants for odor and noise control. The *Arizona Administrative Code's Title 18, Chapter 9, Part B: BADCT for Sewage Treatment Facilities* section discusses general considerations and prohibitions regarding setback requirements for facilities undergoing new construction and major modifications. New facilities or facilities undergoing major modifications must abide by the *A.A.C. Title 18 Chapter 9 Part B* setback requirements.[1, 2] These requirements include providing 1,000-foot setbacks for facilities with No Odor Control and 350-foot setbacks for facilities with Full Odor Controls.[3] The Code also states that operation of sewage treatment facilities shall not cause emission of offensive odors on a persistent basis beyond the setback requirements. Land area for the setback requirements will be included at each of the wastewater treatment plants.

2.7 Redundancy, Flexibility, and Reliability

Redundancy, flexibility, and reliability are significant factors in the successful day-to-day operation of any wastewater treatment facility. Redundancy and flexibility provide processing reserve when units must be taken out of service, and reliability sustains performance under unusual operating and environmental conditions.

Redundancy is provided by multiple process units and support equipment in each system. As a facility is expanded, redundant units and equipment should be added as appropriate.

Flexibility is provided by designing a plant piping system that allows redistribution of flows when a treatment train is out of service.

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[1] Setbacks are measured from the treatment and disposal components within the sewage treatment facility to the nearest property line of an adjacent dwelling, workplace, or private property.
[2] Arizona Administrative Code Title 18 Chapter 9 Part B: R18-9-B201. General Considerations and Prohibitions.
[3] Full Odor Control means all odor-production components of the sewage treatment facility are fully enclosed and odor scrubbers or other odor-control devices are installed on all vents.

Reliability is provided by use of high-quality, rugged equipment, stocking of spare equipment and parts, and access to an alternate source of electric power. ADEQ currently requires that all WRFs provide, at a minimum, adequate dual power supply to maintain primary treatment and disinfection. In the future, it is possible that the State may extend its requirement for adequate power supply to include secondary treatment. In the process of site development, area will be reserved to locate the substations, generators, and duct banks necessary to provide backup power for secondary treatment, including effluent disinfection.

2.8 Environmental Habitat Considerations for the Santa Cruz River

Reduced discharge from Roger Road WRF may have an impact on the Santa Cruz River riparian habitats. Potential riparian impacts were derived from the Arid West Water Quality Research Project's "Habitat Characterization Study Final Report" [2.5] and other sources such as the recent Corps of Engineer (Tres Rios del Norte) studies of the Santa Cruz River.

Both the Roger Road WRF and Ina Road WRF discharge into the Santa Cruz River. The Santa Cruz River originates as a small southerly flow in the San Rafael Valley, flows down into Mexico, and then north into the United States. Historically, the Santa Cruz was a perennial stream until it reached Tubac, where it went subsurface. The main sources of flow in the Santa Cruz watershed are precipitation, groundwater discharge, irrigation return flow, and treated sewage effluent.

The majority of the river and tributary streams are intermittent or ephemeral. Flows in the Santa Cruz River below the Roger Road WRF result from the discharge of effluent and any storm waters that are discharged to the riverbed. From the Rillito area downstream to the its confluence with the Gila River, the Santa Cruz River is ephemeral, and only once every 10 to 20 years does sufficient storm flow occur to allow the Santa Cruz River to flow to the Gila River.

Mean monthly stream flow above the Roger Road WRF outfall ranges from 0 cubic feet per second (cfs) (May) to 94 cfs (August) and mean monthly stream flow below the Ina Road WRF ranges from 15 cfs (May) (plant effluent) to 128 cfs (August). The estimated average annual precipitation in the region is 12.4 inches.

Since the 1950s, the Santa Cruz channel has undergone severe sediment degradation in Tucson, while downstream reaches have experienced a period of aggradation. Gradual arroyo cutting over the past century has produced a channel that is now up to 33 feet below the historical floodplain. Effluent discharge has caused increased channel roughness due to vegetation and increased incision in the low-flow channel. Storm scouring can occur up to depths of 26 to 33 feet. Furthermore, uncontrolled vegetative growth slows downstream velocities which effectively reduces capacity and increases flooding potential during rainfall events with shorter reoccurrence frequencies.

Riparian habitat data were collected at five sites on the Santa Cruz River near Tucson. Site 1, upstream of the Roger Road WRF outfall, is ephemeral and did not contain any flow on May 2, 2000. Perennial vegetation at Site 1 is dominated by riparian vegetation that is typical of large, ephemeral drainages in southern Arizona. The perennial, woody vegetation at Site 1 consists of burrowweed (*Hymonoclea salsola*), desert broom (*Baccharis sarothroides*), and scattered individuals of desert willow (*Chilopsis*

linearis) and Mexican palo verde (*Parkinsonia aculeata*). Understory species are a mix of woody shrubs and herbaceous species including burroweed (*Haplopappus tenuisectus*) and cocklebur (*Xanthium stumarium*) and a variety of annual and perennial grasses and forbs. Conversely, riparian habitats at Sites 2 through 5, all of which were influenced by effluent flows, are variously dominated by willow (*Salix gooddingii*), mesquite (*Prosopis velutina*), and salt cedar (*Tamarix chinensis*) or combinations thereof. Individuals of blue palo verde (*Cercidium floridum*), cottonwood (*Populus fremontii*) and tree tobacco (*Nicotiana glauca*) are also present. Understory species include small individuals of the dominant species along with catclaw acacia (*Acacia greggii*), wolfberry (*Lycium* sp.), desert hackberry (*Celtus pallida*), and others. At Sites 3 and 4 (Ina and Cortaro Roads) emergent vegetation in the form of cattail (*Typha dominingensis*), Bulrush (*Scirpus* sp.), and smartweed (*Polygonum* sp.), and others form a very lush aspect of the vegetation.

Mammals, or sign thereof, observed along the Santa Cruz River at Tucson included raccoon (*Procyon lotor*), coyote (*Canis latrans*), pocket gopher (*Thomomys* sp.), and round-tailed ground squirrel (*Spermophilus tereticaudis*). Birds included four species of ducks, white-faced ibis (*Plegadis chihi*), black-necked stilt (*Himantopus mexicanus*), and several species of shorebirds, songbirds, and raptors. Observations of reptiles included individuals of western whiptail (*Cnemidophorus trigris*), sideblotched lizard (*Uta stansburiana*), and tree lizard (*Urosaurus ornatus*). No amphibians were observed along the Tucson reach of the Santa Cruz River.

The effect on aquatic communities of anthropogenic attempts to control the physical dynamics of these streams cannot be overstated. NPDES permit effluent limitations, based on water quality standards, traditionally form the basis for protection of aquatic life in all waters, regardless of the waterbody type (e.g., coldwater or effluent-dependent). A regulatory dilemma arises when one considers what level of water quality is needed to protect the designated beneficial use. The water quality standards regulation and EPA guidance distinguish between an “existing use” and a “designated use” (i.e., a potential use). However, water quality criteria do not reflect that distinction. The same high level of water quality is deemed necessary to protect both. That is probably not true for effluent-dependent streams. In a naturally ephemeral stream that occasionally would be dry but for flow augmentation derived from perennial effluent discharges, all existing uses have arisen under ambient water quality conditions – conditions created by the discharge of effluent. Therefore, one can conclude that existing water quality fully protects existing uses. However, it may be that better water quality would increase the richness and/or abundance of aquatic species in the effluent-dependent stream. Therefore, it is also possible to conclude that all of the potential beneficial uses are not fully supported by existing ambient discharge quality.

Regardless of discharge quality, the aquatic habitat supported by those effluent dependent flows will be materially reduced if discharge is reduced. Thus, where water quality was the factor precluding full attainment of the potential beneficial use, inadequate flows and insufficient habitat will severely reduce the maximum potential itself. All things being equal, better water quality may improve the biological productivity and diversity of a stream. But, all things are not equal. The conclusion that the aquatic population will benefit from improved water quality is premised on the static assumption that everything else (including volume of effluent discharged) will remain the same. The reduced capacity of treatment at the Roger Road WRF or increase in reclaimed usage or both will effectively reduce flow in the Santa Cruz River. This change alone will potentially change the riparian habitat. In addition, physical and

chemical factors associated with the creation of effluent-dependent waters also limit biological potential. Effluent-dependent waters and their associated riparian communities have significant potential to become an important habitat resource for aquatic and terrestrial species, including those species considered sensitive or listed as threatened and endangered.

According to information from the Pima County Regional Flood Control District regarding a recent Corps of Engineers Santa Cruz River Study, estimates of effluent flows to sustain the existing riparian habitat along the Santa Cruz River below the Roger Road WRF discharge range from 2 mgd up to 16 mgd.

2.9 Water Reuse Considerations

The average demand (year 2006) in the Tucson water reclaimed water distribution system is approximately 11 mgd. The future demands for reclaimed water are expected to significantly increase from the year 2006 averages. Peak demands are 2.3 times the average. Storage in the conveyance system is 15 million gallons plus storage at local golf course lakes. The system experiences both seasonal and daily demands. The peak seasonal demands are in June and July. The low demand is in the winter. Daily demands peak at night when wastewater flows at the plant are low, making system storage necessary. Additionally, there are several "pinch" points in the existing distribution system that limit the capacity of the pipelines to deliver flow. If a source is developed at Ina Road WRF, then there would be relief on the distribution system to the north of Roger Road WRF and enable the system to be more flexible in meeting the customer demands. If all treatment is provided at Ina Road WRF, there will need to be additional reclaimed water distribution piping to the south as the 24-inch line between Ina Road WRF and Roger Road WRF has a capacity of only 10 mgd.

Additional considerations include:

- Effluent from the Sweetwater pressure filter treatment plant is blended with the recovered water from the recharge basin to achieve the Class A reclaimed water rating.
- There is no regulatory requirement for a minimum volume of discharge to the Santa Cruz River at Roger Road WRF.

Based on these requirements, this subchapter will discuss the effluent flow and infrastructure needs required at the Roger Road WRF and/or the Ina Road WRF to accommodate the needs of the Tucson Reclaimed Water Treatment Plant (Tucson Water Reclaimed System), Pima County, the CEP, SAWRSA, and other reclaimed water owners.

2.9.1 Intergovernmental Agreements

As described in the 2006 Metropolitan Facility Plan Update [2.1]:

> *Four IGAs between Pima County and the City of Tucson governing their effluent ownership and distribution: the 1979 Intergovernmental Agreement (1979 IGA), the 2000 Supplemental Intergovernmental Agreement, (2000 IGA, which governs the Conservation Effluent Pool), and the 2003 Intergovernmental Wheeling Agreement (2003 Wheeling IGA). As the dates of these IGAs suggest, they were sequentially passed and each succeeding IGA builds upon the previously*

granted agreement. A fourth IGA, the Intergovernmental Agreement titled Permitting and Operating Managed In-Channel Recharge of Effluent in the Santa Cruz River Channel (2003 Managed Recharge IGA), governs the recharge of effluent allotted to the nine participants of the Lower Santa Cruz River Managed Recharge Project.

The 1979 Intergovernmental Agreement (IGA), signed on June 26, 1979, was the original agreement between PCRWRD and the City of Tucson. This agreement assigned control of wastewater conveyance and treatment activities to PCRWRD. In exchange, the City of Tucson would receive rights to the effluent produced at the PCRWRD Metropolitan Treatment Facilities, which were limited at that time to the Ina Road WRF, Roger Road WRF and Randolph Park WRF.

The SAWRSA was the settlement between the City of Tucson, Pima County and the United States Bureau of the Interior (on behalf of the water rights of the tribal nations in Pima County). The 2000 Supplemental Intergovernmental Agreement signed on February 8, 2000, placed restrictions on how PCRWRD could use the effluent from the Ina Road WRF and the Roger Road WRF. This agreement also identified the need for reopening the Randolph Park WRF, which had been shutdown in 1995. It provided an avenue for PCRWRD to deliver effluent to Pima County facilities. This supplemental agreement also established a Conservation Effluent Pool for use with riparian habitat projects and identified how the SAWRSA effluent water rights would be treated in determining effluent allocations. The 2000 IGA identifies up to 10,000 acre feet (AF) of effluent that will be set aside for use on environmental restoration projects. These projects will be in accordance with the criteria of the 2000 IGA, or must have the approval of both the City of Tucson and Pima County.

The 2003 Intergovernmental Wheeling Agreement, signed December 16, 2003, governs reclaimed water transactions between PCRWRD, the effluent provider; City of Tucson, the distributor and a reclaimed water user/owner; and other Pima County facilities, reclaimed water users. The effluent enters the system at the City of Tucson's Sweetwater Recharge Facilities and the Tucson Reclaimed Water Treatment Plant and through direct delivery from the Roger Road WRF; from there it is piped to various locations. The Randolph Park WRF discharges its effluent directly into the City of Tucson reclaimed water system. The agreement governs the costs (per acre-foot) that will be charged to Pima County for distribution of Pima County effluent to Pima County sites from either of these two locations.

The 2003 Managed Recharge IGA governs the recharge of effluent and the associated credits granted by Arizona Department of Water Resources (ADWR) for the Lower Santa Cruz River Managed (LSCRMRP) between the Ina Road WRF and Trico Road in Marana. Participants include the Town of Marana, Cortaro-Marana Irrigation District, Avra Valley Irrigation and Drainage District, Metropolitan Domestic Water Improvement District, Flowing Wells Irrigation District, Oro Valley, Pima County, City of Tucson, and the Bureau of Reclamation.

In accordance with the 1979 IGA, Tucson Water was awarded a majority percentage of all effluent after the SAWRSA distribution and Pima County was awarded a minority percentage. However, under the SAWRSA and separate IGAs between Tucson Water, Metropolitan Domestic Water Improvement District, and Oro Valley Water, a new distribution formula was created and also incorporated into the 2003 Managed Recharge IGA. In accordance with this new formula, of the total effluent generated from all Metropolitan and Non-Metropolitan Treatment Facilities, SAWRSA had rights to the first 28,200 AF,

and then the CEP had rights to up to 10,000 AF on an as-needed basis for environmental restoration projects. Since CEP is allotted after the United States receives its SAWRSA share and before either Tucson Water or PCRWRD receive their share, any allocation to CEP effectively reduces the remaining share available to Pima County and Tucson Water. As part of a settlement, Oro Valley and Metropolitan Domestic Water Improvement District provide a portion of Tucson Water's CEP share, and therefore they indirectly contribute to CEP. However, at the maximum CEP allocation, PCRWRD provides 1,000 AF, while Tucson Water and other providers are required to provide up to 9,000 AF.

Although a final agreement has not been reached between Tucson Water and Pima County as to how the CEP will be administered, it is currently anticipated that City of Tucson and Pima County CEP projects could reach the maximum CEP allotment of 10,000 AF of effluent by 2015. As not every restoration project will qualify or attempt to qualify for CEP, it is difficult to say with certainty the CEP allocation will be consumed as quickly as anticipated. It is possible that qualifying for CEP allocations could be a lengthy process involving the United States Fish and Wildlife Department. If the CEP effluent remains unused as an environmental water source, it could become very difficult for PCRWRD to predict its own long-term effluent balance.

2.9.2 Alternatives

To determine the optimal treatment alternative the following evaluation criteria are considered. Details of the alternatives are covered in Chapter 4

- Compatibility with Tucson Water reclaimed water distribution system
- Proximity of reclaimed water customers
- Use of existing infrastructure
- Volume of wastewater available at the site vs. potential reuse demand served by the site
- Effect on quantity of reclaimed water
  - Effect on Roger Road WRF and Ina Road WRF capacities
  - Effect on Santa Cruz River habitat
- Effect on overall system reliability
- Effect on overall system operability
- Impact on raw wastewater conveyance system
- Site availability
- Site compatibility with adjacent land uses
- Compatibility with ultimate injection of reclaimed water into potable groundwater supplies
- Probable capital cost impacts
- Probable O&M cost impacts

2.9.3 Underground Storage Recharge/Recovery Considerations

The benefits of underground storage and recovery include SAT, blending of reclaimed water with groundwater, cost-effective storage, and ability to recover water when needed. Recharge methods for

underground storage include infiltration in a stream channel (e.g., Santa Cruz River), infiltration in constructed basins, and injection wells.

For injection wells an effluent turbidity of 2 NTU or more will cause clogging over time, require periodic well maintenance and potential re-drilling of injection wells (especially for vadose zone injection wells) to keep viable. Further, the injection wells will require chlorination to prevent biological growths within the well. Lastly, injection wells are not permissible by regulation in the Tucson Aquifer Management Area.

Constructed recharge and recovery basins can get credit for recovery of up to 100 percent of the effluent for use. Managed recharge can at best get credit for recovery up to 50 percent of the effluent for use in the community. To maximize effluent water utilization in the community, direct use and recharge/recovery will need to be located adjacent to each other...

The existing Sweetwater Recharge and Recovery Facility meets a critical need to maximize effluent reuse by treating, storing and withdrawing plant effluent to meet peak demands of reclaimed water during the summer months.. It is a proven facility that is isolated from the potable water supply system because of favorable hydrogeologic conditions. When considering new storage and recovery facilities the following criteria should be met:

- Site of at least 40 to 50 acres
- Favorable hydrogeologic conditions
- Compatible with adjacent land and water uses

Conceptually, from a hydrogeologic perspective, underground storage facilities could be placed at Ina Road WRF if land is available and other concerns and issues are met satisfactorily. Managed recharge for annual or longer-term storage could be sustained and seasonal storage and recovery could be maintained. However, it is important to consider that underground storage effluent will impact groundwater levels and groundwater movement (affecting contaminant migration) in the local area.

Costs were estimated to create a SAT system with underground recharge and recovery features that is large enough to accommodate 32-mgd flow from the Roger Road WRF. The costs to construct the basins and the piping network to distribute effluent to the basins were well over $500 million in 2006 construction dollars. This far exceeds the costs of other forms of effluent treatment.

2.10 Cultural and Historic Preservation

Pima County has an active program to preserve historic and cultural resources. The County's objectives include:

- Protect cultural identity
- Preserve cultural and historic heritage
- Retain and maintains cultural diversity
- Save the past for the future

Currently, over 3541 archaeological sites have been identified while only 12 percent of eastern Pima County has been examined. This leaves a large amount to be surveyed that could unveil many more locations of cultural and historic heritage.

Construction or demolition activities resulting from the master planning effort may reveal uncatalogued burials or some other cultural identity area. If the location of construction or demolition is of archeological interest, a detailed survey of the area will need to be performed by State and local regulations early on to identify the potential for archeological discoveries.

Examination of the Roger Road WRF and Ina Road WRF parcels in Pima County's MapGuide identifies both Roger Road and Ina Road areas within highly sensitive archeological areas.

An extensive cultural resources overview for the Tres Rios del Norte Feasibility Study project, which covers the areas along the Santa Cruz River upstream of the Roger Road WRF to well below the Ina Road WRF, was performed in 2002 further supports the archeological sensitivity of the area.

As a testament to the archeological richness of the area, in April 2007 the Pima County Cultural Resources Department located 35 items of archaeological significance adjacent the eastern border of the Roger Road WRF, which substantiates the need for careful examination of the undisturbed areas along the Santa Cruz River for cultural resources. Mitigating measures are planned to clear or preserve the areas of new construction of archeological finds to permit construction of new facilities.

2.11 Regulatory Closure Requirements at Roger Road WRF

If the existing Roger Road WRF is to be decommissioned as an future action of the master plan, pursuant to Roger Road WRF's APP (#100655), closure requirements must be followed. These requirements include:

- Submit a written notice of closure to the Water Quality Compliance Section.
- Submit Detailed Closure Plan to the Water Quality Compliance Section meeting the requirements of A.R.S. 49-252 and A.A.C. R18-9-A209(B)(1)(a) (within 90 days of the notification of closure).
- Submit a written notice, with supporting documentation, indicating the approved Closure Plan has been implemented fully to the Water Quality Compliance Section (upon completion of closure activities).

To achieve clean closure, Post Closure requirements need to be followed. A Preliminary Phase I Environmental Site Assessment was performed for an area including the Roger Road WRF and the surrounding County-owned area in an effort to identify recognized environmental conditions (RECs) that could cause a delay in completing Clean Closure requirements for the property. The Preliminary Assessment identified potential issues of concern that may cause problems in achieving a Clean Closure for the area. For example, at Roger Road WRF asbestos removal will need to be considered prior to demolition work. Overall the issues of concern identified in the site assessment did not appear to pose serious problems to obtaining approval for a clean closure of a decommissioned Roger Road WRF. Upon successful completion of the closure activities, a letter of approval for closure will be issued by the ADEQ.

2.12 Community Involvement Program

The community involvement program activities consist of two public meetings and stakeholder interviews held during the course of the master plan development.

Early in the project the first pubic meeting addressed the scope and approach of the investigations and was designed to solicit concerns from the community. The second public meeting reviewed plan recommendations, along with results and actions for additional improvements to the County's wastewater operations. A brief summary of the Open Houses are provided below:

- ROMP Open House – October 17, 2006
  PCRWRD successfully held an open house for the general public on the project objectives and alternatives under consideration for the ROMP. The event was advertised widely. Citizens who attended the open house were encouraged to visit the different stations setup to address the different aspects of the project and ask team members project-specific questions. After the event comments and questions were collected by the project team for consideration in the planning activities. Local media representatives were present.

- ROMP Open House & Press Conference – May 21, 2007
  PCRWRD successfully held an open house and press conference, which was advertised for the general public to attend. Citizens who attended the open house were encouraged to visit the different stations describing the direction of the master planning efforts and ask team members project-specific questions. Local media representatives interviewed John Bernal, Deputy County Administrator, regarding ROMP details.

Individual interviews were conducted with various stakeholders at the beginning of the study to gather their views and input for evaluation during the study. Each interview varied from one-half hour to over one hour depending on the individual. Key questions asked in every interview were:

- What will success look like?
- What are the goals and needs?
- What needs to happen for success?
- What are the three most difficult/important issues that have to be worked through?
- What issues can be addressed with confidence; with no confidence?
- What has worked well; what hasn't?
- What additional topics need to be addressed in each of the workshops?

Results of these interviews are compiled and used as part of the evaluation of study alternatives. The interview results are presented in **Appendix E**.

2.13 Summary

In development of the master plan the requirements and needs of the PCRWRD stakeholders, including regulatory agencies, customers and the general public were extensively reviewed. The master plan results

meet the regulatory requirements and community needs as set forth and determined from the various stakeholder investigations. In the future, the existing treatment system may require upgrades to meet more stringent regulatory criteria and levels of redundancy, flexibility, and reliability; and the demand by customers for higher quality effluent and to reduce risk to the environment.

References

2.1 Brown and Caldwell, "2006 Metropolitan Area Facility Plan Update," February 2006

2.2 Gritzuk, Michael, City of Phoenix Water Services Department, "Planned Desalination Programs by the City of Phoenix," presented at the Bi-National Desalination Conference 2004, October 21, 2004

2.3 TNT Technology Company, *City of Phoenix Cooling Tower TDS Study*, WS90120017, February 2003

2.4 California Department of Health Services, "Studies on the Occurrence of NDMA in Drinking Water," March 15, 2002

2.5 Arid West Water Quality Research Project, "Habitat Characterization Study Final Report," December 2002

2.6 Sonoran Desert Conservation Plan

CHAPTER 3

Treatment Plant Evaluation

Chapter 3 - Treatment Plant Evaluation

3.1 Introduction

This chapter provides a overview of the two major existing treatment plants, Roger Road WRF and Ina Road WRF, including descriptions of:

- Existing treatment capacity
- Peaking factors and plant influent characteristics
- Plant recycle flows and loads
- Existing plant system arrangements and conditions

3.2 Existing Treatment Capacity

3.2.1 Roger Road WRF

The Roger Road WRF is the older of the two major treatment facilities and has a permitted capacity of 41 mgd. It is located at 2600 W. Sweetwater Drive, Tucson, Arizona 85705. It was first operated in 1951 as a 12-mgd activated sludge facility and was expanded with a separate 13-mgd trickling filter facility in 1960 and a 13-mgd activated sludge/contact stabilization facility in 1967. In 1979 the facility was consolidated into a single facility with new two, 165-foot diameter by 26-foot deep, plastic media biofilters with return activated sludge capability.

Digested biosolids are conveyed via force main to the Ina Road WRF and combined with digested biosolids from the Ina Road WRF for further processing prior to final disposal.

In the late 1980s, the activated sludge tanks were used only during the winter months when the biofilter alone could not handle the load due to lower temperatures and higher influent loadings. As the flow and influent loadings increased, the activated sludge tanks have been placed into continuous service to meet secondary treatment permit requirements.

3.2.2 Ina Road WRF

The existing Ina Road WRF was designed in 1973 and construction was completed in 1977. The facility is located at 7101 North Casa Grande Highway, Marana, Arizona, just South of Ina Road, between Interstate 10 and the Santa Cruz River. It consists of a 25-mgd HPO activated sludge process, a sludge digestion and centrifuge thickening/dewatering facility for solids handling, and a complete energy-recovery system for heating, cooling and on-site generation of electrical power from digester gas. Modifications to the original design to enhance equipment performance and reliability were completed in 1990.

Recently a BNRAS treatment facility with a design capacity of 12.5 mgd was added. The BNRAS process includes primary treatment and a multi-staged wastewater treatment system capable of partially removing nitrogen and ammonia from the waste stream. Flows to the HPO treatment system and BNRAS

treatment facility are treated and disinfected separately and then combined prior to dechlorination and discharge into the Santa Cruz River Roger Road WRF.

3.3 Peaking Factors

The plant operating data for Roger Road WRF and Ina Road WRF during January 2004 through April 2006 were used to analyze the peaking factors of the raw wastewater flow and characteristics parameters, including, BOD, TSS, total kjeldahl nitrogen (TKN) and total phosphorus (TP). The results are summarized in **Table 3-1**.

Table 3-1
Peaking Factors for Influent Wastewater Characteristics Parameters

	Roger Road WRF	Ina Road WRF
Wastewater Flow		
Average, mgd	37.8	23.9
Monthly Peak Flow (MPF)	1.10	1.14
Daily Peak Flow (DPF)	1.37	1.33
Hourly Peak Flow (HPF)	2.00	2.00 (3)
BOD(1)		
Average, mg/L	249	252
MPF	1.13	1.07
DPF	1.18	1.17
TSS(1)		
Average, mg/L	249	271
MPF	1.05	1.05
DPF	1.32	1.38
TKN(1)(2)		
Average, mg/L	33.5	47.8
MPF	1.28	1.11
DPF	-	-
TP(1)(2)		
Average, mg/L	5.4	7.3
MPF	1.31	1.03
DPF	-	-

(1) Mass loading based peaking factors adjusted with flow peaking
(2) TKN and TP data were available only once per month for both plants and daily peaking factors were not computed
(3) Assumed same as Roger Road WRF

The influent (raw) flow data were used to analyze the average flow, monthly peaking factor (MPF) and daily peaking factor (DPF). Although the average flow rate to the Roger Road WRF was substantially higher than that of the Ina Road WRF, the monthly peak flows and daily peak flow factors for the two

plants were similar. The diurnal flow data for the same operating period were available for the Roger Road WRF and were used to compute the average diurnal peaking factor (DUPF). Then the DUPF was multiplied by DPF to compute the hourly peaking factor (HPF). Diurnal operating data were not available for the Ina Road WRF and the HPF for the Ina Road WRF was assumed to be same as that of the Roger Road WRF due to the fact that the MPFs and DPFs factors of both plants were similar.

Peaking factors for BOD, TSS, TKN and TP were analyzed based on the mass loading, such as lbs/day, of each parameter. The peaking factor based on the mass loading was then divided by the flow peaking factor to obtain the flow adjusted peaking factor. Therefore, these peaking factors are concentration peaking factors adjusted with flow peaking.

The peaking factors for the two plants were similar for flow, BOD and TSS, but somewhat different for TKN and TP. While the operating data for flow, BOD and TSS were available on a daily basis, only a single value was available for each month for TKN and TP. Therefore, the peaking factors for TKN and TP may not be as reliable as other parameters. Monthly peaking factors only for TKN and TP were analyzed since only a single daily value was available for each month.

3.4 Recycle Flows and Loads

At the Roger Road WRF, the primary sludge and waste activated sludge (WAS) is gravity thickened or thickened by a gravity belt unit and anaerobically digested. The digested biosolids are conveyed via force main to the Ina Road WRF for further processing and final disposal. The thickener overflow is recycled to the plant influent stream.

At the Ina Road WRF, the primary sludge and WAS are thickened by gravity thickeners or with dissolved air flotation (DAF) thickeners and the anaerobically digested. The digested sludge (biosolids) is combined with the digested sludge (biosolids) from the Roger Road WRF and dewatered using centrifuges. The thickener and centrate recycle flows are returned to the plant influent stream. Due to the centrate return from the digested sludge dewatering operation, the BOD and TSS concentrations in the Ina Road WRF influent are moderately higher, but TKN and TP concentrations are substantially higher than those of the Roger Road WRF influent as shown in the above table.

3.5 Existing Plant Systems

For each of the two major wastewater treatment facilities, a detailed assessment of each system was performed to provide baseline information for developing alternatives and options for future consideration. The system descriptions are summarized below.

3.5.1 Roger Road WRF

3.5.1.1 Systems Description

The Roger Road WRF system descriptions are organized into the following areas:

- Septage Dump Station

- Headworks
- Primary Clarifiers
- Biofilter Pumping Station and Biofilters
- Aeration Basins
- Final Clarifiers
- Chlorination/Dechlorination Facilities
- Gravity Thickeners
- Digesters
- Odor Control
- Electrical
- Instrumentation and Control

3.5.1.2 Septage Dump Station

The Septage Dump Station was originally designed with multiple dump tanks where septage hauling trucks could discharge septage into these tanks and tests could be performed on the septage to determine the septage composition. The dump tanks are pitched the wrong way, so the dump tanks do not drain properly and consequently the dump tanks are no longer in use. Instead the septage is dumped into a wet well. Two Essco cyclone feed pumps pump the septage from the wet well to a grit separation unit. Two cyclones degrit the septage and send the liquid to an equalization basin. The grit is discharged to a dumpster. A mixer is used in the equalization basin to keep the septage from settling. Two Essco Degritted Septage Pumps are supposed to send the septage from the equalization basin to the front of the plant, but rags, greases, and other material continuously clog the equalization basin. Consequently once per month plant staff are required to enter the wet well and equalization basin and clean them out.

As stated above the Septage Dump Station does not work as originally designed. Therefore. consideration should be given to having the septage trucks dump into the influent stream upstream of the Headworks, rather than continuing to discharge into the Septage Dump Station. This would mean that the septage no longer needs to be degritted and pumped to the Headworks and that a crew of plant personnel would not have to monthly declog the wet well and equalization basin which would reduce maintenance. Furthermore, this would remove a source of odors identified at the facilities.

3.5.1.3 Headworks Facilities

Influent flows are split and conveyed through three Parkson Aquaguard influent climber screens. The influent screens discharge onto a belt conveyor that has manually adjustable plows that can send the screenings to one of two new JWC Washmonster washer/compactors. The screenings may bypass the compactors and travel straight to a dump body truck for landfill disposal. The screened wastewater flows to two Smith and Loveless Pista Grit Tanks. Grit is pumped to two cyclone grit separators where the grit is taken by two grit classifying screw conveyors. The grit is then discharged onto the screenings belt conveyor where the grit and screenings are then dumped into a dump body truck for landfill disposal. The screened and degritted wastewater then flows to a set of three parshall flumes. Parshall flumes No. 1 and No. 2 meter the influent flow to yard structure No. 1 and the primary clarifiers. Parshall flume No. 3 is provided for future flow to Ina Road WRF through the future plant interconnect and is not currently in service. The influent channels, screens, grit tanks, flow channels, and Parshall flumes are all totally enclosed with removable solid cover plates for odor control and will be discussed in greater detail later in

this chapter. Rodney Hunt sluice gates are used to isolate screens, grit tanks, parshall flumes, and flow to the primary clarifiers.

Plant personnel have indicated that the influent screens have worked very well since they were installed approximately 10 years ago. The screenings compactors, the cyclone grit separators, and the grit classifying screw conveyors were replaced in early 2007.

3.5.1.4 Primary Clarifiers

Rectangular Primary Clarifiers No. 1 though 4, which were constructed as part of the original plant, have been converted to emergency overflow basins. Normally the overflow basins are empty, but they are placed into service during July-August monsoon season when peak flows exceed the pumping capacity of pump station #4.

Primary Clarifiers No. 5 through 10 are 105-feet diameter circular clarifiers. Primary Clarifiers No. 5, No. 6, No. 7, and No. 8 are fed from yard structure No. 1 and Primary Clarifiers No. 9 and No. 10 are fed from the common influent channel downstream of the Headworks Parshall flumes. Pump Station No. 5 contains three Moyno Primary Sludge Pumps (PSPs) and one Dewatering Pump (DWP). Two PSPs pump sludge from Primary Clarifier No. 7 and No. 8 to the Biofilters and one PSP pumps scum from Primary Clarifier No. 7 and No. 8 to the Digesters. The Dewatering Pump is used to dewater Primary Clarifiers No. 7 and No. 8. Pump Station No. 3 contains three PSPs and one DWP that pumps from Primary Clarifiers No. 5 and 6 similar to Pump Station No. 5. Pump Station No. 14 contains seven Seepex PSPs. Five PSPs pump primary sludge from Primary Clarifiers No. 1, No. 2, No. 3, No. 4, No. 9, and No. 10 to the Digesters or the Gravity Thickeners. Two PSPs pump scum from Primary Clarifiers No. 1, No. 2, No. 3, No. 4, No. 9, and No. 10 to the Digesters. Due to a lack of motorized gates and flow meters, influent flow is visually split between the primary clarifiers. Primary Clarifiers No. 5 and No. 6 are deeper than the other primary clarifiers and consequently have a higher solids loading than the other clarifiers.

Hydraulically, the plant cannot take a primary clarifier out of service during the July and August period of high influent flows; therefore it is difficult to remove a clarifier from service for cleaning during this period. Plant personnel have noted that they are very pleased with the performance of all of the Moyno pumps. Noticeably absent were odor containment features on the primary clarifiers.

3.5.1.5 Bio Recirculation Building (Pump Station No. 4) and Biofilters

Primary effluent flows from the primary clarifiers to a wet well at the Bio Recirculation Building. The Bio Recirculation Building contains four Fairbanks Morse pumps, three of which are gas engine driven pumps (~25 mgd each) and one is a 350 hp motor driven pump (~33 mgd). The engine driven pumps can be run on either digester gas or natural gas. There are no scrubbers on the digester gas lines, so a “dirty” digester gas is used, which contributes to higher than normal maintenance for the engines. Additionally, concentrations of siloxanes in the sludge gas have recently increased and have become a problem at Roger Road WRF causing additional wear and tear on engines and other equipment that use digester gas. Consequently, the engines have not been operated on digester gas for nearly a year and operate on natural gas only. Plant personnel indicated that there is significantly less maintenance on the engines when they are fueled with natural gas rather than digester gas because the natural gas is cleaner than the digester gas.

Like most other facilities at Roger Road WRF, equipment at the Bio Recirculation Building is operated manually. The engine driven pumps are manually operated. Speed is adjusted manually to maintain the wet well level in an acceptable range. One engine driven pump is generally run until the engine reaches 900 revolutions per minute (rpm). Once the engine gets to 900 rpm a second engine driven pump is turned on. This occurs at approximately 32 mgd. The two engine drive pumps are then manually throttled to balance the flow. The motor driven pump is used for emergency backup or when plant flow gets above 55 mgd.

Originally, the control system modulated valve BF-7 which allowed return activated sludge (RAS) to flow back into the wet well to feed the biotowers. The Bio Recirculation pumps were to run at a constant speed and capacity while a bubbler system controlled the bleed-back of RAS through BF-7 into the wet well to satisfy the pumping rate and keep the wet well level in an acceptable range. This control is no longer used and as a result, the pump station must be operated manually with continual manual monitoring of the wet well level.

The discharge piping for the Bio Recirculation pumps does not contain any isolation valves to allow a pump to be taken out of service. The only valve separating a pump from the discharge header is the pump's power operated discharge valve. If that valve ever needed to be removed for service, the entire station would need to be shut down.

The pumps in the Bio Recirculation Building send flow to two Biofilters. Each Biofilter is 165 feet in diameter by 26 feet deep plastic media biofilters. At the top of the Biofilters a large rotary distributor arm sprays primary effluent over the plastic media in the biofilters.

The rotary distribution arms were replaced 5 or 6 years ago, and are reportedly in good operating condition. The media in the biofilters has not been changed since 1979. For the last two years plant operations have sent the biofilter effluent to the aeration tanks before the final clarifiers for additional treatment.

Pump Station No. 7 is located between the two biofilters and contains three ITT A-C WAS Pumps. Typically WAS Pump No. 3, which has a variable frequency drive (VFD), is used to pump WAS. If Pump No. 3 is out of service, then both constant speed Pumps No. 1 and No. 2 are used together to pump WAS. WAS is currently sent to the Ashbrook three meter gravity belt thickener .

3.5.1.6 Aeration Basins

There are two sets of Aeration Basins; the South Aeration Basins (Aeration Basins No. 1 and No. 2) and the North Aeration Basins (Aeration Basins No. 3, No. 4, No 5, and No. 6). The South Aeration Basins are single pass plug flow basins that were part of the original plant construction. The North Aeration Basins are dual pass plug flow basins; which have the capabilities of being run as step feed basins. Both the North and South Aeration Basins have inefficient coarse air diffusers. The Aeration Blowers are located in the Blower Building to the east of the North Aeration Basins. Three Turblex engine driven blowers are used to provide air to the aeration basins. The blowers are capable of being driven by digester gas or natural gas. Similar to the engines in the Bio Recirculation Building the blower engines are run on natural gas because of higher maintenance when run on digester gas.

Blowers are manually controlled by throttling the inlet guide vanes with the blowers operated at a constant 1,200 rpm. Of the available isolation valves on the main air header in the blower building, only one is reportedly operable. This limits which blowers can serve which aeration basins.

The air flow meters inside the Blower Building show 7,600 standard cubic feet per minute (scfm) of air being sent to the two South Aeration Basins and 3,250 scfm being sent to the four North Aeration Basins. There is only one operable isolation valve on the main air header in the building able to separate flow to the two aeration batteries.

Noticeably, there is a lack of overhead conveyance equipment and the doorways are inadequate for servicing the engine driven blowers and the engines.

The blowers are scheduled to be replaced with two new skid mounted blowers in 2007/2008. The existing blowers will remain as backups in case service from the new blowers is interrupted.

3.5.1.7 Final Clarifiers

There are nine 105 feet diameter Final Clarifiers each with two rake arms. Flow from the South Aeration Basins is sent to Final Clarifiers No. 1 and No. 2. Flow from the North Aeration Basins are sent to flow splitting structures that distribute flow to Final Clarifiers No. 3, No. 4, No. 5, No. 6, No. 7, No. 8, and No. 9. The splitting structures have downward operating gates that act as weirs to distribute flow to the various final clarifiers. Final Clarifiers No. 1, No. 2, No. 3, and No. 4 have a single exterior weir, while the newer Final Clarifiers No. 5, No. 6, No. 7, No. 8, and No. 9 have a double exterior weir. Pump Stations No. 6, No. 8, No. 9, No. 10, and No. 12 contain Fairbanks Morse, Pacific Pumping Co., and Allis-Chalmers return sludge pumps and Netzsch and Moyno scum pumps. Final Clarifiers No. 1, No. 2, No. 3, No. 4, No. 5, and No. 6 each have four floc mixers that can be used for polymer addition; however these have not been used for some time.

Plant personnel noted that the rake arm catches on welds on the weirs for Final Clarifiers No. 8 and No. 9. A temporary patch has been put on the welds, so the rake arms no longer catch on the welds. Similar to the primary clarifiers, hydraulically the final clarifiers can not be taken out of service.

There appears to be an unnecessary flow split structure for Clarifiers No. 1 and 2. It's similar to all the other splitters except the flow re-combines directly downstream from the two splitter gates and flows through a common conduit to yet another splitter structure between the tanks where the actual flow split occurs.

3.5.1.8 Chlorination/Dechlorination Facilities

The Roger Road WRF originally used gaseous chlorine to disinfect its effluent; however, a few years ago it was decided to switch to liquid sodium hypochlorite for disinfection and to use liquid sodium bisulfite for chlorine neutralization to meet chlorine residual discharge limits. Presently two temporary sodium hypochlorite storage tanks are located adjacent to the influent of the Chlorine Contact Tank in a temporary earthen berm in case of a leak. Roger Road WRF has two permanent sodium hypochlorite tanks on site that will be installed within a concrete containment area in the near future. The temporary sodium hypochlorite tanks will then be removed once the permanent tanks are in place.

Two U.S. Filter Water Champs are used in the Chlorine Contact Tank common influent channel to deliver the sodium hypochlorite to the liquid stream. The feed rate of hypochlorite to the Water Champs is controlled by two U.S. Filter liquid chemical feeders located in a chemical feed structure adjacent to the contact tanks. Feed rate is controlled to maintain a chlorine residual as discussed later under Instrumentation and Control. Two sample pumps send samples to analyzers located in the adjacent Chlorine Feed and Storage Building, previously used for gaseous chlorine.

The contact tank influent channel distributes flow to a North and South Chlorine Contact Tank each of which is comprised of two halves. The interior dividing walls of the Chlorine Contact Tanks are made of masonry block.

Effluent is extracted from the contact tanks with pumps prior to de-chlorination for use by Tucson Water in its reclaimed water system. The extracted effluent is transported to the nearby water reclamation facility where the effluent is filtered, disinfected and pumped into the reclaimed water distribution system, or is directed into soil aquifer treatment basins for underground storage, later recovery and use.

Adjacent to the Chlorine Contact Tank is a bulk sodium bisulfite storage tank that is enclosed with a concrete containment wall. The sodium bisulfite bulk storage tank is pumped into a sodium bisulfite day tank also within a concrete containment wall near the effluent end of the contact tanks. Two U.S. Filter Water Champs feed sodium bisulfite from the day tank into the effluent channel for chlorine neutralization. Chemical feeders, similar to those used for hypochlorite feed, are located in a chemical feed structure adjacent to the bisulfite day tank. These meter sodium bisulfite to the Water Champs in response to an effluent oxidation reduction potential (ORP) signal.

The effluent channel then discharges by gravity to the Santa Cruz River. In the event that the river is flowing high there are three Fairbanks Morse Effluent Pumps to pump the effluent to the river. Since the Effluent Pumps are not required very often, flap gates for each pump have a tendency to seal shut from nonuse. Consequently, when the pumps are operated, if the flap gates are not freed, they pump against these sealed gates and motor damage has occurred. The plant personnel indicated that it is planned to routinely operate the pumps and gates so that the gates will not seal shut.

3.5.1.9 Gravity/GBT Thickeners

Roger Road WRF has three covered circular Gravity Thickeners. Gravity Thickeners No. 1 and No. 2 have three Moyno Thickened Sludge Pumps and two Muffin Monster grinders on the scum lines. Gravity Thickener No. 3 has three Moyno Thickened Sludge Pumps and one Muffin Monster grinder on the scum line. The pumps are all located outdoors on a concrete slab exposed to the elements.

Emergency concrete repair work was performed on Gravity Thickeners No. 1 and No. 2 a few years ago. It was deemed at that time that the concrete had deteriorated to a point that the Gravity Thickeners were in imminent danger of collapsing. The existing three (3) gravity thickeners have been repaired and are in satisfactory condition for continued operation. Plant staff advised that the pumps and grinders are in good operating condition. The Gravity Thickening Tank Mixers could be susceptible to corrosion in the enclosed environment.

Adjacent to the Gravity Thickening Tanks is the Flotation Thickening Building. Two Komline Sanderson DAF Thickeners are located in this building. The DAF units have not been operated in a couple of years. The DAF units have some broken parts that can no longer be ordered from the manufacturer. The DAF units could be operated, but plant staff have advised that the DAF units require continuous monitoring and adjustments which is very labor intensive.

One (1) new three meter Ashbrook GBT has been added to the sludge thickening operations with startup in 2007. The GBT unit and associated pumping systems and piping are located outside on a concrete pad.

3.5.1.10 Digesters

There are six anaerobic digesters (four primary digesters and two secondary digesters). Digested sludge is pumped to Ina Road WRF for dewatering and disposal. Until recently the digesters could not be taken out of service due to hydraulic limitations until the GBT was placed into service. Prior to this the digesters had not been emptied and cleaned in approximately 20 years. There may be significant solids deposition within the digesters, effectively reducing the tank volume and hydraulic detention time. Each digester has its own associated waste gas burner. The engine generators in the On Site Power Generation Facility are the only equipment currently running on sludge gas. Since the engine driven pumps and blowers are not using digester gas, a significant amount of the gas is being flared. Since the onsite assessment PCRWRD modified their operating procedures to utilize more gas onsite. The waste gas burners all have a white ring around the top of the burners, which is indicative of siloxanes being present in the gas.

Digesters No. 1, No. 2, No. 3, No. 4, and No. 5 have roof mounted mixers. Digester No. 6 has external draft tube mixers for mixing. There are four Control Houses adjacent to the digesters that contain the heat exchangers, sludge gas equipment, and sludge pumps for all the digesters.

Digesters No. 1, No. 2, No. 4, No. 5, and No. 6 show signs of shrinkage cracks in the concrete structure. Also, Digester No. 3 has a gas leak on the top of the tank. When standing on the digester roof, gas could be heard hissing through the cracks. This could potentially be a dangerous location with the digester gas capable of being igniting or causing an explosion. This situation was promptly addressed by PCRWRD after the onsite assessment. Since the digesters haven't been emptied in 20 years, no one is certain of the condition of the inside of the tanks.

The Gravity Belt Thickener (GBT) for thickening Waste Activated Sludge (WAS) will permit primary and WAS sludges to be thickened separately. This process change is expected to increase the overall sludge concentration to the digesters so that a digester may be drained, cleaned and inspected. The external draft tube mixers in Digester No. 6 plug frequently with solids. The external draft tube mixers require excessive maintenance to keep unplugging and repairing the mixers. The heat exchangers, gas equipment, and pumps appear to be in fair to good operating condition, based on visual inspection. Plant personnel advised of no problems other than routine maintenance.

3.5.1.11 Odor Control

The Roger Road WRF has a history of odor complaints from the surrounding community. Odors appear to be released most noticeably from the sewage at the headworks, primary clarifiers, biotowers and sludge

thickening facilities. An odor control program confirmed these sites as primary contributors to offsite odors.. The System-Wide Odor Control Plan gave a more comprehensive look where nuisance odors are generated and what type additional odor control is required.

3.5.1.11.1 Septage Dump Station

A small chemical scrubber is located next to the equalization basin and draws air off of the equalization basin, pump room, and grit cyclone room for treatment; however, with the clogging problems, odors are noticeable in the pump room and around the Septage Dump Station. Additionally, the grit cyclones discharge grit to a dumpster that is partially open to the atmosphere located outside the Septage Dump Station. Relocating septage dumping would remove a source of nuisance odors.

3.5.1.11.2 Headworks

The influent channels, screens, grit tanks, and Parshall flumes are all totally enclosed with removable solid cover plates. Air is drawn off near the Parshall flumes and the influent channel and sent to three Envirogen biofilters. Neither the belt conveyor nor the screenings and grit dumpster are covered or treated, so there are fugitive nuisance odors around these areas. An enclosure and odor treatment was provided at these in accordance with the recommendations of the System-Wide Odor Control Plan.

3.5.1.11.3 Primary Clarifiers

The six (6) operating 105 feet in diameter primary clarifiers are uncovered and open to the atmosphere. Under certain localized climatic conditions these tanks are a considerable contributor to offsite odors. In 2007 the primary clarifiers were fitted with high density polyethylene covers and an odor treatment system to capture and treat the odors emanating from the tank surface.

3.5.1.11.4 Biotowers

The biotowers are another contributor to offsite odors under certain localized climatic conditions. The biotowers are 265 feet in diameter and approximately 30 above grade. The biotowers have an open top and a series of vent ports near grade. Noticeable odors have been detected at each of these locations. PCRWRD has a plan in place to capture the odors emanating from the biotowers and treat the odors..

3.5.1.11.5 Gravity Thickeners

Gravity Thickeners No. 1 and No. 2 are each covered with a concrete cover to contain odors. Gravity Thickeners No. 1 and No. 2 each have three odor draw off points above the overflow troughs from which air is drawn to a Rosswood wet scrubber. Each tank has its own fan that discharges into a common duct to the scrubber inlet.

It was noted during the onsite assessment that the supply air to the gravity thickeners was around the perimeter of the tanks. It would be desirable to have fresh supply air introduced over the walkway where plant personnel must have access to the center drive mechanism for operations and maintenance duties.

Gravity Thickener No. 3 has a similar arrangement as Gravity Thickeners No. 1 and No. 2. A single fan draws air off of the tank above the overflow troughs at three locations and blows the air to a Paramount Fabrications packed tower scrubber. The scrubber is approximately 10 years old. The unit appears to be sized to treat air from a future gravity thickener, so is oversized for treating just Gravity Thickener No. 3. The cover on Gravity Thickener No. 3 is an aluminum dome, so the supply air handler is located on the ground adjacent to the thickener, unlike Gravity Thickeners No. 1 and No. 2 which have roof mounted units. A chemical building adjacent to Gravity Thickener No. 3 contains a Milton Roy Sodium Hypochlorite Metering Pump that pumps sodium hypochlorite from a drum to the odor unit for Gravity Thickener No. 3. At the time of the visit, there was no caustic being pumped to the odor control unit. This has since been corrected.

3.5.1.12 Electrical

The Roger Road WRF power distribution system consists of many electrical elements which contribute to the distribution of power on the plant site. The incoming utility electric service is provided at 2400 volts, 3-phase, 3-wire, delta ungrounded from Tucson Electric Power (TEP). The plant power generation system consists of three 400 kilowatt (kW) sludge gas fired engine generators, producing power at 480 volts, 3-phase, 3-wire delta ungrounded. The on-site generated power is distributed on site via underground duct banks to several motor control centers (MCC). The TEP 2400-volt power is distributed onsite via underground duct banks to seven Power Center transformers which step the power down to 480 volts, 3-phase, 3-wire delta ungrounded and 480/277 volts, 3-phase, 4-wire. Five of the transformers are delta-delta connected and two are delta-wye connected. The Power Center transformers are substation type with some having additional primary distribution sections and most having secondary power distribution panels or secondary breakers. The secondary power distribution panels or secondary breakers provide utility power to motor control centers and other utilization equipment. Some motor control centers are sub-fed from other motor control centers. The majority of the motor control centers are arranged with dual feed main breakers with key interlocks; one source being utility power and the other on-site generated power. The power distribution system has been expanded and upgraded over the course of the last forty years due to plant upgrades and systems improvements. Assessments of the power distribution systems major components as observed on site are provided below.

3.5.1.12.1 2400-Volt Plant Switchgear

A bank of three 500-kilo-volt ampere (kVA) pole mounted TEP transformers connected 13.8 kilovolt (kV)-2400 volts (V) provide 2400 volts, 3-phase, 3-wire, delta ungrounded overhead power to the 2400V Plant Switchgear. The switchgear is configured in a hot sequence arrangement with six fusible switch/contactor feeder units which distribute power throughout the site. The line-up initially consisted of three units installed in 1963 and expanded to six units in 1979. The six units were refurbished by an off-site service contractor approximately 3 years ago. The condition of the equipment is considered acceptable as the equipment has been maintained.

3.5.1.12.2 Power Center Transformers

There are seven power centers located across the plant site which distribute 480-volt power from their secondaries to motor control centers and other utilizing equipment.

Power Center No. 1 is located near the Flotation Thickener Building and is rated 500 kVA, 2300 – 480V, 3-phase, connected delta/delta with a 65 degrees C temperature rise. The primary section consists of a non walk-in aisle outdoor switchgear line-up with a main fusible switch, a fusible switch serving Power Center No. 1 and a fusible switch serving Power Center No. 4. The secondary compartment has a molded case circuit breaker. Data from plant records indicates the line-up to be 1955 vintage General Electric equipment. The primary switchgear doors were difficult to open and need to be lubricated. The mechanical condition of the fusible switch units were not assessed as the equipment was energized.

Power Center No. 2 is located near the Blower Building and is rated 500 kVA, 2300 – 480V, 3-phase, connected delta/delta with a 65 degrees Celsius temperature rise. The primary section is configured similar to Power Center No. 1. with a main fusible switch, a fusible switch serving Power Center No. 2 and space for another fusible switch. The secondary compartment had no visible overcurrent device visible. Data from plant records indicate the line-up to be 1965 vintage General Electric equipment. The mechanical condition of the fusible switch units was not assessed as the equipment was energized.

Power Center No. 3 is located near Pump Station No. 3 and is rated 500 kVA, 2300 – 480V, 3-phase, connected delta/delta with a 65 degrees Celsius temperature rise. There is no overcurrent protection or disconnecting means on the primary compartment. The secondary compartment has a distribution panel with molded case circuit breakers consisting of a main breaker and four feeder breakers. Data from plant records indicates the line-up to be 1945 vintage General Electric equipment.

Power Center No. 4 is located adjacent to Power Center No. 1 and is rated 750 kVA, 2300 – 480V, 3-phase, connected delta/wye with a 55 degrees Celsius temperature rise and provisions for future fan cooling. There is no overcurrent protection or disconnecting means on the primary compartment. The secondary compartment has a distribution panel with molded case circuit breakers consisting of a main breaker and three feeder breakers. Data from plant records indicate the line-up to be 1993 vintage General Electric equipment.

Power Center A is located near the Administration Building and is rated 500 kVA, 2300 – 480V, 3-phase, connected delta/delta with a 65 degrees Celsius temperature rise. There is no overcurrent protection or disconnecting means on the primary compartment. The secondary compartment has a molded case circuit breaker. Data from plant records indicate the line-up to be 1965 vintage General Electric equipment.

Power Center B is located near Pump Station No. 7 at the Bio Towers and is rated 750 kVA, 2300 – 480V, 3-phase, connected delta/wye with a 65 degrees Celsius temperature rise and provisions for future fan cooling. There is no overcurrent protection or disconnecting means on the primary compartment. Data from plant records indicate the line-up to be 1995 vintage General Electric equipment.

Power Center C is located near the Process Water Pump Station in the vicinity of the Chlorine Facility and is rated 500 kVA, 2300 – 480V, 3-phase, connected delta/delta with a 55/65 degrees Celsius temperature rise. There is no overcurrent protection or disconnecting means on the primary compartment. The secondary compartment has a distribution panel with molded case circuit breakers consisting of three feeder breakers. Surface corrosion was visible on parts of the assembly. Data from plant records indicate

the line-up to be 1979 vintage General Electric equipment. In general all power centers exterior finishes are faded and chalky due the heat and environmental conditions. Where enclosure ground connections were visible, cables were black, likely due to the present of H_2S corrosion. Aside from the deficiencies noted, all of the power centers were functional and no major malfunctions were noted.

3.5.1.12.3 On Site Power Generation Facilities

The engine generators and associated equipment are located in the Mechanical Building. The generators consists of three natural /methane gas dual fuel engine driven generators with each rated 400 kW at 480 volts, 3-phase, 3-wire delta ungrounded. Engine Generators EG-1 and 2 are 1982 vintage Waukesha units with 12 cylinder engines operating at 900 RPM. Engine Generator EG-3 is a 1995 vintage Waukesha unit with a 6 cylinder engine operating at 900 RPM. Each generator is connected to a Generator Distribution Center (GDC) identified as GDC No. 1, 2 and 3. The Generator Distribution Centers are interconnected with electrical operated tie circuit breakers. If generator sets are to be paralleled, this is accomplished with the use of a synchronizing scope and manual breaker control switches. It appears that the generators are normally operated isolated from each other. Physical space is provided for a fourth future generator. GDC No. 1, 2 and 3 are located in the same room as the generators. GDC No. 1, 2 and 3 distribute 480 volts, 3-phase, 3-wire delta ungrounded power to the plant motor control centers. GDC No. 1 is a 1982 vintage switchboard. GDC No. 2 and 3 is a continuous line-up of 1998 vintage switchboard. Though not confirmed, record drawings indicate that EG-1 and EG-2 may both have initially been connected to GDC No. 1 and perhaps split during the 1998 upgrade with EG-3. Main breakers for each of the generators are aligned in a continuous arrangement between GDC No. 1 and 2. Condition of the GDCs, generator main breakers and paralleling equipment shows average wear. Exteriors are dirty due to the environment in which they are located. Maintenance personnel advised that the overhead bus tie to GDC No. 1 from the associated generator main breaker has had a continuing problem with a loose connection as noted by a thermal graphically survey Aside from a loose connection, the equipment has functioned satisfactorily.

3.5.1.12.4 Motor Control Centers

There are two styles of motor control centers used throughout the plant and are located adjacent to and within the process structures. Outdoor motor control centers are provided in National Electrical Manufacturer's Association (NEMA) 3R enclosures with front access weatherproof doors. Doors are provided with filters in the ventilation slots to prevent the infiltration of dirt. Some enclosures have roof top mounted exhaust fans that are thermostatically controlled and others are not ventilated. Due to their physical location, most are dirty on the exterior.

The majority of all motor control centers are configured with two main breakers; one from the utility source and the other from the generator source. The breakers are key interlocked so that only one breaker can be closed at a time. The two equipment design vintages for all of the motor control centers on site are General Electric 7700 Line and General Electric 8000 Line. Some are provided with or retrofitted with transient voltage surge suppression (TVSS) and others have no protection. Protection has been provided in line-ups where loads served include sensitive or electronic equipment. MCC CA is an outdoor line-up located at the Effluent Pump Station. The line-up consists of early vintage variable frequency drives which no longer function satisfactorily. The line-up and associated Effluent Pumps are currently scheduled for replacement. MCC 2B is located at the Chlorine Feed and Storage Building. The line-up is NEMA 1 construction located outdoors in a covered area. As the associated building is not in service and

the remaining electrical load is minimal, replacement is not imperative at this time. **Table 3-2** provides a list of each motor control center.

3.5.1.12.5 Plant Grounding System

Plant maintenance personnel confirmed that there are problems with the existing plant grounding system. The system has been professionally examined and tested in the past with the results on file in the plant's maintenance library. This is an ongoing issue which will be addressed in forthcoming service upgrade alternatives being presented by another consultant under a separate contract agreement.

3.5.1.12.6 Electrical Feeders

There are no records to indicate that the medium voltage feeders have been tested since their original installation. Plant maintenance personnel did not indicate there being any feeder problems on the 2400 volt (V) system. Insulation resistance tests were performed in 2003 on the motor control center feeders by Electro Test an independent testing service. The results were published in Technical Memorandum 1 dated July 2003 by Kennedy/Jenks Consultants. The results of the tests recommended replacement of B and C phase feeder cables to MCC-C and B phase feeder cable to MCC-BC. It was not determined if these feeders had been replaced.

Table 3-2
Pima County Roger Road WRF – Motor Control Centers Assessment

EQUIPMENT TAG	LOCATION	MANUFACTURER	VOLTAGE	TYPE	BUS AMPS	YEAR BUILT	MAIN CIRCUIT BREAKER
MCC-1	FLOTATION THICKENER BUILDING (INDOOR)	GE 7700	480 V	3PH, 3W	600 A	1955	600 A
MCC-1B	DIGESTER NO. 3 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	1982	300 A
MCC-1C	PUMP STATION 1 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	2000	100 A
MCC-2	BLOWER BUILDING (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	600 A
MCC-2A	HEADWORKS (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1989	250 A
MCC-2B	CHLORINE BUILDING (OUTDOOR COVERED)	GE 7700	480 V	3PH, 3W	600 A	1982	150 A
MCC-2BE	CHLORINE BUILDING (OUTDOOR COVERED)	GE 8000	480 V	3PH, 3W	600 A	1995	
MCC-2C	PUMP STATION 9 (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1965	200 A
MCC-2D	PUMP STATION 12 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	200 A
MCC-3A	PUMP STATION 2 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	2002	100 A
MCC-3B	PUMP STATION 8 (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	200 A
MCC-3C	MECHANICAL BUILDING (INDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	200 A
MCC-3D	PUMP STATION 10 (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	200 A
MCC-3E	GRAVITY THICKENER NO. 3 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	200 A
MCC-4A	DIGESTER NO. 5 (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1982	200 A
MCC-4B	DIGESTER NO. 6 (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	200 A
MCC-AA	ADMINISTRATION BUILDING (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	1996	200 A
MCC-AB	PUMP STATION 14 (OUTDOOR)	GE 8000	480 V	3PH, 3W	600 A	1999	200 A
MCC-BC	PUMP STATION 4 (INDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	200 A
MCC-BF	PUMP STATION 7 (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	100 A
MCC-BG	DIGESTER NOS. 1 AND 2 (INDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	250 A
BRP-4BR (MCC-BH)	PUMP STATION 4 (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1993	800 A
MCC-C	PROCESS WATER PUMP STATION (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	600 A
MCC-CA	EFFLUENT PUMP STATION (OUTDOOR)	GE 7700	480 V	3PH, 3W	600 A	1982	400 A
MCC-CB	DECHLORINATION BUILDING (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	200 A
MCC-CBE	DECHLORINATION BUILDING (INDOOR)	GE 8000	480 V	3PH, 3W	600 A	1995	

3.5.1.12.7 Comments on Electrical System

There are numerous upgrade projects in the planning, design and implementation stages which may impact the existing electrical distribution system. The impact of the upgrades has not been factored in the evaluation of the existing equipment. The issues discussed herein before relate only to the condition assessment of the equipment as installed at the time of the onsite assessment. All electrical distribution equipment is thermal graphically inspected annually and problems corrected upon completion of the inspections. There is some electrical equipment which is probably more susceptible to problems or possible failure due to its age, but at present is functioning satisfactorily. Equipment falling into this category would be the 2400V Plant Switchgear, 7700 Line motor control centers and older 480V feeders. It is suggested that this equipment be considered for systematic replacement if the existing system is to remain viable. Also, a short circuit and coordination study is suggested as numerous electrical changes have been made over the years and the study would be beneficial in identifying problem areas in the plant electrical distribution system.

PCRWRD undertook an extensive evaluation of the electric system at Roger Road WRF in 2006 to address short and long term power issues. Numerous actions resulted from the evaluation. However, considering the long term fate of the existing electrical system at Roger Road WRF, PCRWRD was able to consider interim power/electrical measures in several areas and was able to save $6 million dollars in capital construction that would have not have had value in the future facilities. The interim electrical measures will provide adequate service over the life of the facility.

3.5.1.13 Instrumentation and Control

The process instrumentation at Roger Road WRF consists mainly of open channel flow meters, sludge flow meters, tank level transmitters, digester gas and air flow meters and chlorine residual and ORP instruments for disinfection. Most instruments are operational. The instruments are discussed below in their respective process areas.

3.5.1.13.1 SCADA System

The plant has a rudimentary SCADA backbone that is fully functional but is under-utilized. The backbone consists of a fiber optic trunk network that runs throughout the plant and connects a number of Allen-Bradley PLCs using a DH-Plus™ network protocol. The fiber optic PLC network interconnects the following facilities:

- Chlorination Facility
- Dechlorination Facility
- Digesters
- Generator (Maintenance) Facility
- Biotowers (Pump Station No. 4)
- Blower Building
- Headworks
- Administration Building

The entire plant has less than 600 monitored and computed parameters, many (~120) of which are from the abandoned chlorination and dechlorination facilities. The SCADA system has two computer workstations at the Administration Building running Rockwell RS-View™ HMI software that the operators use primarily to monitor real-time trends of various analog inputs and also equipment and process alarms using process graphic displays. The system is fully functional.

There is virtually no information monitored regarding equipment running status or the positions of the various valves and gates. While the PLCs have the capability of being programmed for remote control, that capability has not been implemented. There is presently no ability to remotely start or stop any equipment using the SCADA system. There is some automatic control being performed locally, but for the most part, the plant is operated completely manually.

In summary, there is a sound hardware foundation and network backbone to the SCADA system that has not been adequately developed to provide a useful real-time aid to Operations personnel. What was installed is adequate for as far as the system was developed. But the overall system is in need of a significant upgrade to fully utilize the system's capabilities. At the very least, the addition of remote control of equipment would serve the operations personnel well after a power interruptions by eliminating the need to go all over the plant to restart equipment.

3.5.1.13.2 Headworks

There are three Parshall flumes that measure the plant influent downstream from the screens and grit tanks. Two of the flumes are active and operate as parallel meters to measure influent flow. Flow is combined immediately downstream of the flumes and sent to the primary clarifiers. The third flume is provided to measure to the flow into the future plant interconnect with Ina Road WRF. That flume is not in use. The two active flumes are equipped with ultrasonic level transmitters which compute flow through each flume.

3.5.1.13.3 Primary Clarifiers

The only instrumentation associated with the clarifiers is the flow meters on the sludge lines to the gravity thickeners. Although some of the meters are quite old, they appear to be in good working condition and are installed properly with respect to upstream and downstream piping runs.

Scum pumps are manually controlled locally and scum discharge lines to the digesters are not metered.

Primary sludge pumps are controlled locally based on time cycles.

- Primary tanks Nos. 1-4, 9 and 10 are on a repeating cycle of 7 minutes running, 3 minutes off.
- Primary tanks Nos. 5-8 are on a repeating cycle of 9 minutes running, 1 minute off.

3.5.1.13.4 Biotowers and Biotower Pump Station

The biotower feed pumps all discharge into a common header which feeds the biotowers in two directions. Although there is manually operated butterfly valve at the feed point to each biotower, there is no way to determine the flow split to each tower. As a result, Operations personnel report having

observed instances where the biotower distribution arms were not moving in one of the biotowers at low flows. Because of piping arrangement, flowmeters would have to be added to the underground piping to measure the flow split, which could then be controlled by the manual butterfly valves.
The original control system which blended RAS back into the feed pump wet well based on wet well level is no longer in use. The original system was configured to run the pumps at a constant speed and maintain the wet well level by blending RAS back into the wet well to make up the difference between pumping rate and influent to the wet well from the primary tanks. This control system has been abandoned and the pumps are now manually adjusted in response to wet well level changes as measured by a pneumatic bubbler system. RAS is no longer returned to the biotowers.

The pump engines each have dedicated control panels with IDEC PLCs. Status and control signals are hardwired from each panel to a master panel (FID-BR) which contains an Allen-Bradley PLC acting as a data concentrator on the SCADA network. The system is operational and the bubbler system for the wet well is reportedly trouble-free.

3.5.1.13.5 Aeration Tanks

There is no way to measure or control the wastewater flow split to the various aeration tanks.

Aeration Tanks No. 1 and No. 2 have orifice plates installed to measure the flow of air to the diffusers. There is a flow control valve located only five feet upstream from each meter. This lack of sufficient straight upstream piping can distort the flow profile and makes the accuracy of these meters questionable. The orifice plates have no transmitters to allow remote monitoring of the flow. Instead, they have local differential pressure gauges calibrated to read in scfm. The gauges were pegged at maximum flow when observed. The indicators appear to be quite old.

Aeration Tanks Nos. 1 and 2 each have Hach LDO dissolved oxygen probes located at the end of each pass. These were newly installed meters. Each tank was reading between 3 and 3.3 mg/L dissolved oxygen (DO) when observed. These meters are state of the art and require significantly less maintenance than earlier generation DO meters.

Aeration Tanks Nos. 3 through 6 also have orifice plates installed to measure air flow to the diffusers. However, these meters have the proper unobstructed upstream piping runs. The flow control valves for these lines are located roughly four feet downstream from the meters. These meters also have no transmitters. They are equipped with old Foxboro differential pressure indicators. These flow meters should provide acceptable accuracy.

Aeration Tanks Nos. 3 through 6 also have newly installed Hach LDO dissolved oxygen meters. The probes are installed at the end of the second pass in each tank. The probe for Tank No. 3 was removed for repair during the onsite assessment. The remaining tanks had DO readings ranging from 2.41 to 3.05 mg/L when observed.

3.5.1.13.6 Blower Building

Each of the three engine driven blowers have a dedicated package control panel with an Allen-Bradley PLC. Blowers are controlled by modulating the inlet guide vanes with the engine driven blower running

at a constant speed. The blower panels are connected to the fiber optic SCADA network at master panel remote terminal unit (RTU)-BB which converts the copper interface signals from each panel's PLC to fiber optic signals.

The north and south air discharge headers from the blowers are isolated and separately metered. Air flow meters are thermal mass flow elements and are functioning properly and installed with the recommended straight upstream piping run. When observed, Blower 2 was serving the south feed to Aeration Tanks Nos. 1 and 2 and was reading 7,600 scfm. Blower 3 was serving the north feed to Aeration Tanks Nos. 3 through 6 and was reading 3,250 scfm.

3.5.1.13.7 Flow Split to Final Clarifiers

Each of the flow split structures have down-opening gates that act as flow control weirs. The gates are hand operated. With this arrangement there is no accurate way to control the flow split to the clarifiers. Plant I&C staff are in the process of equipping each gate mechanism with an ultrasonic level/flow transmitter to measure the flow over the movable control weir. This is considered to be a very good approach to achieving better flow distribution to the final clarifiers. Flow control weirs are not extremely accurate, however, as long as they are all configured the same way, they should be very repeatable. This approach should allow Operations personnel to more accurately control the hydraulic loading to the clarifiers.

Plant staff is also considering adding motor actuators to the weirs to be able to control the flow split in real-time.

3.5.1.13.8 Final Clarifier RAS and WAS Flow Metering

All return and waste activated sludge lines from the final clarifiers are well instrumented. All sludge lines are equipped with magnetic flowmeters. These meters all appear to be operating properly and are installed with the correct piping configuration upstream and downstream from the meter.

Scum pumps are manually controlled locally and scum discharge lines to the digesters are not metered.

3.5.1.13.9 Disinfection Facility

Disinfection is achieved by feeding sodium hypochlorite in response to chlorine residual at the contact tank. There are two U.S. Filter liquid chemical feeders located in the hypochlorite feed building that meter the hypochlorite under vacuum to the two U.S. Filter Water Champs in the common contact tank influent channel. A sample pump taking suction from the east contact basin a short distance downstream from the Water Champs conveys a sample to a chlorine residual analyzer in the old chlorination feed and storage building. When observed, this analyzer was reading 5.59 mg/L total chlorine. This was the analyzer being used to control the hypochlorite feed rate.

A second chlorine analyzer was assigned to monitor the residual of the process water which was pumped from the contact tanks effluent channel. This analyzer indicated 3.6 mg/L total chlorine when observed. The controls are configured with a selector switch to allow either of these two analyzers to control the hypochlorite chemical feeders.

Each contact tank has an ultrasonic level transmitter located in the first pass of the tank, well upstream from the effluent weirs, to compute flow. It is unclear why these transmitters were located so far away from the effluent weirs.

Dechlorination is achieved using a sodium bisulfite feed system which is identical to the hypochlorite liquid chemical feeders. The bisulfite feeders are located in a small dedicated structure adjacent to the day tank. Sodium bisulfite is fed to two Water Champs located just upstream from the two effluent Parshall flumes. Each flume has an ultrasonic level/flow transmitter. Chemical feeders are paced by the flume flow readings and control to an ORP probe reading immediately downstream from the flumes. There is an alternate ORP analyzer at the outfall sampler location which can also be used for control. The ORP transmitters are located in the old dechlorination feed facility. The flume outlet probe was reading 105-107 millivolts when observed. ORP control of dechlorination is becoming very common and is considered appropriate technology for accurate control.

3.5.1.13.10 Thickener Metering Building

Magnetic flowmeters are provided in the metering building for the measurement of makeup water, primary sludge and WAS to the gravity thickeners. All meters are functioning and installed properly.

3.5.1.13.11 Gravity Thickeners

Combustible gas detectors located inside the covered thickener reportedly foul rapidly due to sulfide contamination, requiring replacement every few months.

Thickener No 3 has two thickened sludge magnetic flowmeters, whereas Thickeners No. 1 and No. 2 have no thickened sludge metering.

3.5.1.13.12 Sludge Digesters

All digesters have thermal mass flowmeters which measure the flow of service gas and gas to the waste gas burners. These are appropriate meters for this application and functioning correctly.

Digesters No. 4 and No. 5 are secondary digesters and are equipped with liquid level transmitters and gas holder cover position transmitters. Although relatively old, these appear to be functioning properly.

3.5.1.13.13 Sludge Pumping Station

The sludge transfer pumps have a magnetic flowmeter to measure the flow of sludge transferred daily to the Ina Road WRF. This meter is installed in a pit and is functioning properly.

3.5.2 Ina Road WRF

3.5.2.1 System Description

The Ina Road WRF systems descriptions are organized into the following chapters:

- Emergency Overflow Basins
- Headworks
- High-Purity Oxygen Activated Sludge Process
  - Primary Clarifiers
  - Activated Sludge Reactors
  - Secondary Clarifiers
  - Sludge Thickeners
  - Chlorination Facilities
  - Digesters
  - Odor Control
- Biological Nutrient Removal Activated Sludge Process
  - Intermediate Pump Station
  - Primary Clarifiers
  - Anoxic/Aeration Basins
  - Secondary Clarifiers
  - Chlorination Facilities
  - Odor Control
- Centrifuge Building
- Covered Sludge Storage Basin
- Dechlorination
- Electrical
- Instrumentation and Control
- Laboratory Facilities

3.5.2.2 Emergency Overflow Basins

There are three concrete lined Emergency Overflow Basins at the Ina Road WRF. The three basins can hold approximately 19 million gallons of overflow. In case of an emergency, flow can be diverted from the Headworks to the overflow basins. Overflow Basin No. 1 will fill and then overflow a weir into Overflow Basin No. 2 which will fill and then overflow a weir into Overflow Basin No. 3. There is a drain that sends flow back from Basin No. 3 to Basin No. 2 then to Basin No. 1, which has a pump that pumps the overflow back to the Headworks. The Overflow Basins are used only a couple of times per year to hold overflow from the Headworks, usually during monsoon season.

In addition to holding plant overflow, the Emergency Overflow Basin No. 1 is used to store and dewater plant screenings that are too wet to be disposed of at a landfill, the contents of vactor trucks hauling from scum pits and sump pumps at the plant, and also the contents from vactor trucks that are cleaning out clogs in the collection system. From these sources grease, raw sludge, solids, and other highly odorous materials are dumped into the basins to dry. Once the materials have dried, front end loaders transfer the material to trucks which remove the material for landfill disposal. By doing this, the Emergency Overflow Basins have become a major source of offsite nuisance odors. There have been numerous odor complaints from patrons of a sports park that is located a couple of hundred feet from the basins. Since late 2006, some of the sports park complaints are attributed with the landfill operation adjacent to the Emergency Overflow Basins. Ina Road WRF personnel have begun a regiment of applying a sodium hypochlorite solution into the stored materials in the basins to curb odors.

3.5.2.3 Headworks

Influent flow is split through two U.S. Filter Rake Arm style Coarse Screens. There is room for a future third Coarse Screen. The Coarse Screens discharge onto a Serpentex style belt conveyor. The belt conveyor carries the coarse screenings to a coarse screenings hopper that stores the coarse screenings until disposal. When a disposal truck drives underneath the coarse screenings hopper a gate opens and the disposal truck is loaded for landfill. If the coarse screenings belt conveyor were to be out of service, plant personnel would use a bypass chute off the coarse screens into a manual dumpster.

The coarse screened wastewater is then pumped up approximately 20 feet in elevation by three Influent Screw Pumps capable of pumping 32 mgd each. There is room for a future fourth Influent Screw Pump. Usually one pump and sometime two pumps are running. The pumps are capable of running in Auto mode from SCADA but are generally run in local manual mode.

The pumped influent flows through three Parkson Aquaguard moving media Fine Screens. The Fine Screens discharge onto a belt conveyor which discharges onto a shorter reversible cross belt conveyor. If the fine screenings belt conveyor were to be out of service, plant personnel would use a bypass chute off the fine screens into a manual dumpster. One screen is always run continuously in Computer Manual mode. Manual operation does not interlock the screen with the conveyor. A second screen runs in Computer Auto mode (repeating timed cycle), which does interlock the screen with the conveyor. The screens are set to operate in this manner to prevent the conveyor, screenings washer/press and reversible cross conveyor from operating continuously when little amounts of screenings are being collected.

The reversible cross conveyor discharges the screenings into one of two Waterlink Hycor Screenings Washers. The Screenings Washers discharge the washed screenings into an associated Waterlink Hycor Screenings Press. The two Screenings Presses each discharge screenings into a fine screenings hopper. The fine screenings hopper works similar to the coarse screenings hopper.

The screened wastewater flows to three Aerated Grit tanks. The grit tanks have chain and flight collector mechanisms. Four blowers located in the blower room beneath the grit tanks are used to aerate the grit. Grit is then pumped by five Wemco Grit Pumps to three Wemco Hydrogritters Grit Washers where the grit is removed from the wastewater, washed and discharged to a grit hopper. The grit hopper is used in a similar capacity to the screenings hoppers.

The screened and degritted wastewater then flows through a single Parshall flume discharging to the conduit feeding the HPO system and BNRAS system. This flume measures the total influent flow to the treatment plant.

The influent channels, Influent Screw Pumps, Aerated Grit Tanks, Parshall flume, and grit tank effluent channels are all covered with solid cover plates and concrete. This is for odor control and will be discussed in greater detail under odor control below.. Rodney Hunt sluice gates are used to isolate screens, grit tanks, parshall flume, and flow to the rest of the plant. An Ingersoll Rand service air compressor was installed in the basement of the Headworks facilities underneath the stairwell. Plant personnel indicated that the compressor worked, but code will not allow for a compressor in the stairwell, so they will be relocating the compressor to another location in the Headworks.

Plant personnel have indicated that the Coarse Screens, belt conveyors, Influent Screw Pumps, Fine Screens, and gates all work well and are in good condition. The only problem experienced is that the coarse screen rake mechanism bounces excessively during travel. This has caused the metal support structure to suffer fatigue breaks on different occasions. Plant staff has been able to weld and reinforce the metal support frame. The Screenings Washer is experiencing problems with stones and rocks. Stones and rocks that are caught by the screens are wearing away at the brushes within the Screenings Washers. Consequently the Screenings Washers brushes need frequent replacement and the cycle times for the washing are longer. Plant personnel also mentioned that there are high levels of grease in the influent. The Screenings Presses would run and the grease would be extruded and dumped back into the Headworks. Consequently the grease levels would keep increasing since the grease would never leave the system. To solve this, plant personnel have removed the plate that the press would compress against, so now the press simply extrudes uncompressed screenings to the hopper. Because the screenings are not being pressed, the screenings are much wetter than is acceptable for land fill disposal. Occasionally a truck will have to dump the screenings into the Emergency Overflow Basin to dry, prior to being disposed of at a landfill. This practice has been discontinued. Another problem that occurred with the Screenings Presses is rock accumulation. As rocks build up within the press area, the press is unable to compact the rocks and the unit faults out on “incomplete press cycle”, resulting in the washer and screens faulting out due to interlocks with the press.

The grit and screenings hoppers drains are sloped the wrong way, so liquid does not drain away from the hoppers, resulting in a wet load for the disposal trucks that occasionally need to empty the hopper loads into the Emergency Overflow Basins to dewater. Plant personnel noted that the grit pumps send grit to the grit washers in two lines; however, there are three units. As a result, there is not enough flow capacity so that all three units could run at one time. It was also noted that the drains on the Grit Washers were all undersized, so if too much flow is sent to the Grit Washers, the room containing the grit washers, screenings washers, and screenings presses will flood.

3.5.2.4 High-Purity Oxygen Activated Sludge Process

The older portion of the Ina Road WRF treats wastewater flows up to 25 mgd using a HPO process. The facilities that are part of the HPO process are described below.

3.5.2.4.1 Primary Clarifiers

There are four concrete covered rectangular Primary Clarifiers that have two sections per clarifier. Each clarifier has plastic chain and flight collectors. Ten years ago, helical scum skimmers were installed at the effluent weirs of the clarifiers. Centrate from the Centrifuge Building was originally pumped to the Headworks, however, the centrate line became plugged by struvite. Centrate is now being pumped directly to the influent box of the Primary Clarifiers. The common influent channel also receives all other recycle flows. Six Wemco Primary Sludge Pumps are located in the tunnels beneath the Primary Clarifiers. There are four Muffin Monster grinders on the headers of the Primary Sludge Pumps. There is one Allis-Chalmers Dewatering Pump that can dewater the clarifiers.

Plant personnel indicated that the drives for the collector mechanisms have been rebuilt over the years and appear to be in good condition. The concrete tanks appear to be in good condition with only normal shrinkage cracking evident, based on external visual inspection. Severe corrosion was evident at the

scum skimmer building, to the point of making the doors difficult to open and close. The scum skimmings are often so thick that the two scum pits at the Primary Clarifiers can not be pumped out by the existing scum pumps. Either a vactor truck must vacuum the scum from the scum pits and then empty the scum in the Emergency Overflow Basins or plant personnel must spray a hose into the pit to dilute the scum enough to be pumped.

3.5.2.4.2 Activated Sludge Reactors

Flow from the Primary Clarifiers goes to the four Activated Sludge Reactors where high purity oxygen is introduced to the space above the liquid surface. The four Activated Sludge Reactors each have three stages. Each stage has a Lightning surface aerator to transfer the high purity oxygen into the mixed liquor. Sample ports and access manways are located by each surface aerator. A foam suppression system is provided at the discharge end of the reactors, but plant personnel stated that the system had never been used. In the tunnel beneath the Reactors, there is an Aurora Reactor Dewatering Pump that can be used to dewater the Reactors. Along the North side of the Activated Sludge Reactors is the Oxygen Production Facility which produces all on the oxygen that is introduced into the Activated Sludge Reactors. The oxygen facility equipment consists of three Pressure Swing Absorption (PSA) type HPO generators. Three Union Carbide PSA Oxygen Generators are located outside the blower building. Within the blower building, there are three Joy Manufacturing Co. Oxygen Generation Compressors, two Joy Manufacturing Co. Instrument Air Compressors, two Chilled Water Pumps, one Basco Inc. Air Cooler, and one Wilkerson Refrigerated Air Dryer. Also located outside the building are two liquid oxygen (LOX) storage tanks. The plant normally receives one delivery load of liquid oxygen per week.

The concrete top of the Reactors has normal shrinkage cracks, but in one location, a very large chunk of concrete has broken off the rest of the concrete top. Plant personnel advised that because of the concrete cover on top of the Reactors, no one is certain of the condition of the concrete beneath the tank cover.

3.5.2.4.3 Secondary Clarifiers

Flow from the Activated Sludge Reactors is distributed to four 115-foot diameter circular Secondary Clarifiers. The Secondary Clarifiers all have Dorr-Oliver collector mechanisms. Due to the hydraulics of the plant, the clarifiers are located approximately 5-feet below grade so that the wastewater stream may flow by gravity to the clarifiers. The RAS Pump Station is located between the four Secondary Clarifiers and contains five vertical centrifugal RAS pumps and five vertical centrifugal WAS pumps. The VFDs for the RAS Pumps and the WAS Pumps are located in the adjacent Vacuum Filtration Building. The Vacuum Filtration Building no longer is used for filtration; instead it is now used to house the VFDs, electrical gear, and a laboratory.

The clarifiers still have their original Dorr-Oliver collector drives, so some signs of wear are evident on the drive and bridge. The Plant personnel indicated no operational problems however. The concrete of the clarifiers, based on visual inspection only, appears to be in good condition. The RAS Pump Station had recently flooded and all the pumps were submerged. Plant personnel advised that the pumps have been sent to the manufacturer for cleaning and maintenance and have been reinstalled by staff.

3.5.2.4.4 Sludge Thickeners

Four 40-foot diameter Gravity Thickeners were constructed as part of the original construction at Ina Road WRF. In the 1980's Gravity Thickeners No. 2 and No. 4 were converted into DAF Thickeners. In the 1990's Gravity Thickener No. 1 was converted into a DAF Thickener. At present there are three DAF Thickeners, each with Eimco drives and one Gravity Thickener with a Westech drive. Between Tanks No. 1 and No. 3 there are two Peerless DAF Recirculation Pumps with a spot for a future third pump if Gravity Thickener No. 3 is converted to a DAF Thickener. There are also two Kaeser Air Compressors and one Westech Pressurization Tank. Between Tanks No. 2 and No. 4 there are three Peerless DAF Recirculation Pumps and two Pressurization Tanks. The basement of the Thickener Building contains six Carter Pump Thickened Sludge Pumps. These pumps were replaced in the late 1980's. At the top of the tanks is an influent splitter box. The sludge is split to either Tanks No. 1 and No. 3 or to Tanks No. 2 and No. 4. After this split, dedicated pipes to a particular tank feed each tanks influent feed box. Due to open hatches atop the tanks and open air splitter boxes and feed boxes, odors are very noticeable within the Thickening Building.

Plant personnel indicated that rehabilitation of the tanks has been performed within the last four years, so the tanks, based on visual inspection and the testimony of plant staff, appear to be in good condition. Thickener No. 1 has a new pump and accessories. All of the equipment between the remaining tanks is showing signs of excessive wear and tear. Between Tanks No. 2 and No. 4, new DAF Recirculation Pumps and a new Pressurization Tank are scheduled to be installed by in-house personnel to replace the existing equipment. This could be the result of the equipment being exposed to a corrosive environment. The tanks are closely placed to one another so not a lot of air flows between the tanks. Combine the open air splitter boxes and feed boxes with the lack of fresh air and a corrosive environment is created that can result in premature degradation of the equipment and higher than normal maintenance.

3.5.2.4.5 Chlorination Facilities

The Chlorination Facilities of the HPO system disinfect only the HPO system effluent. The BNRAS system has its own chlorination facility. Dechlorination of the combined effluent from both systems occurs together and will be discussed in a later chapter.

The HPO system has two Chlorine Contact Tanks. A Service Water Building is located upstream of the Chlorine Contact Tanks. The Service Water Building contains three Worthington Cooling Water Pumps, four Fairbanks Service Water Pumps, one Superchanger heat exchanger (providing cooling water for engines), two Chlorine Water Booster Pumps, a sodium hypochlorite flash mixer, and a sampler pump. The flash mixer injects sodium hypochlorite into the HPO plant effluent stream. The HPO plant effluent then is split to the two Chlorine Contact Tanks. After going through the Chlorine Contact Tanks, the HPO plant effluent travels through a parshall flume. The parshall flume is undersized for the current flow, so flow measurements are no longer accurate from this flume. Adjacent to the Service Water Building, two sodium hypochlorite storage tanks are located within a concrete containment area and two sodium bisulfite storage tanks are located within a separate concrete containment area.

3.5.2.4.6 Digesters

There are four anaerobic digesters, all presently being operated as primary digesters. Three Digesters have four external draft tube mixers (which are only used when the Digester are being fed) and one center mixer. The fourth digester has only an Enersave Fluid Mixers Inc. center mixer. Digesters No. 1 and No. 3 have fixed covers. Digesters No 2 and No. 4 have floating covers. The four Digesters share a waste gas burner. A Digester Control Building is located between the four Digesters and contains four National Welding and Manufacturing Co. Digester Gas Compressors, four EIMCO heat exchangers (two new and two originals), Varec sludge gas equipment, four Peerless Hot Water Pumps (for Heat Exchangers) two Peerless Service Water Pumps, four Wemco Heat Exchanger Pumps, and five Watson Marlow Sludge Pumps (two originals and three from the 1980's).

Based upon visual inspection, the digesters show signs of shrinkage cracks and some wear but generally appear to be in good condition. Plant personnel indicated there has been discussions regarding the replacement of the existing external draft tube mixers and center mixers on the three Digesters with an Enersave center mixer similar to what is on the fourth Digester.

3.5.2.4.7 Odor Control

The Ina Road WRF has not had a history of odor complaints from the surrounding community as it has primarily been isolated from the surrounding community. With construction of the sports park adjacent to the plant and community growth encroaching upon the facility, odor complaints are rising. Some facilities at Ina Road are uncovered tanks and the influent wastewater is high in hydrogen sulfides (H_2S) and other odor causing compounds. A comprehensive air sampling program gave a comprehensive look where nuisance odors are generated and what type of additional odor control is required. The odor control program undercovered several areas where odor containment and treatment could be improved. PCRWRD is undertaking a program to address the areas in need of additional odor control.

3.5.2.4.7.1 Headworks

The influent channels, screw pumps, aerated grit tanks, and parshall flume are all totally enclosed with concrete covers and provided with removable solid cover plates for access. Air is drawn off the influent channel, the coarse screen room, the influent screw pumps, fine screen room, grit tanks, grit tank effluent channels, and Parshall flume and sent to two Metpro Corp. chemical scrubbers. Each chemical scrubber has an inlet fan. Each chemical scrubber discharges to three carbon units (total of six carbon units).

Plant personnel indicated that the chemicals from the chemical scrubbers were causing a scummy buildup that was plugging the drain lines. Consequently the chemical scrubbers were taken out of service about 3 years ago. There is no bypass, so air still must flow through the chemical scrubbers on its way to the carbon units. The carbon units, based on external visual inspection, appear to be in good condition. Plant personnel advised that the carbon life was estimated to be five years. The carbon units have been running for longer than five years and the carbon has not experienced an odor breakthrough. In the screenings rooms there are noticeable odors.

Staff noted that there is no way to get inside the scrubber ducting to inspect it or clean it.

3.5.2.4.7.2 Primary Clarifiers

The primary clarifiers have a concrete cover over them to contain odors. Multiple odor draw off points located along the side of the clarifiers draw off air and send the air to a biological scrubber that is located adjacent to the clarifiers for treatment. The Primary Clarifier effluent weirs and skimmers are located in the Skimmer House. The Skimmer House originally had rolling overhead doors to bring equipment in and out of the Skimmer House. These doors have since corroded away and the openings have been boarded up. Also, the access doors are showing signs of heavy corrosion and will have to be replaced in the near future. The environment within the Skimming House is highly corrosive and odorous.

3.5.2.5 Biological Nutrient Removal Activated Sludge Process

The new portion of the Ina Road WRF treats wastewater flows uses a BNRAS process. This process was placed in service in late 2006. The different facilities that are part of the BNRAS process are described below.

3.5.2.5.1 Intermediate Pump Station

The screened and degritted wastewater that is not sent to the HPO System is sent to the BNRAS system for treatment. Four Fairbanks Morse vertical turbine submersible pumps are provided to pump the wastewater to the new Primary Clarifiers. Gates are provided to isolate the pumps. A jib crane is provided to remove the pumps when service or repair is needed.

At the time of the field inspection, the Influent Pump Station had not yet been placed into service for pumping sewage. During startup, while pumping water instead of wastewater, plant personnel indicated that they discovered that the influent magnetic flow meter measuring flow between the Pump Station and the Primary Clarifiers was oversized. As a result, low flow measurements taken by this magmeter may be inaccurate, a smaller magmeter should be installed in its place.

3.5.2.5.2 Primary Clarifiers

There are two new rectangular Primary Clarifiers with two sections in each tank. U.S. Filter chain and flight collector mechanisms are installed in each clarifier. Three Wemco Primary Sludge Pumps are located in the gallery beneath the Primary Clarifiers. Two scum pumps are installed at the effluent end of the Primary Clarifiers. Helical scum collectors, similar to the helical collectors on the Primary Clarifiers in the HPO process, perform the scum skimming.

3.5.2.5.3 Anoxic/Aeration Basins

Wastewater from the Primary Clarifiers flows by gravity to the Anoxic Basin Pre-Mixer Chamber. The Pre-Mixer Chamber contains two Chemineer mixers. From the Pre-Mix Chambers, the wastewater flows to the Anoxic Basin influent channel for distribution to the four Anoxic Basins. Gates are provided to isolate flow to each Anoxic Basin. Each Anoxic Basin has four Chemineer Anoxic mixers (sixteen total). After the wastewater flows through the Anoxic Basin it then flows through the Aeration Basins. There are five aeration basins that have five air header pipe drops per tank to provide air to fine pore diffusers. At the end of each Aeration Basins are two Chemineer Aeration Mixers (ten total). The aerated

wastewater then discharges to the effluent channel and to the Mixed Liquor Splitter Structure. Four Fairbanks Morse vertical turbine submersible Mixed Liquor Pumps are used to pump the wastewater to the new Secondary Clarifiers. There is room for three Mixed Liquor Pumps in the future. A jib crane is provided at the Mixed Liquor Splitter Structure to remove the Mixed Liquor Pumps for maintenance and repair. The new Blower Building contains four 600 hp Lamson Blowers to provide process air to the Aeration Basins. Each Blower has a filter. Two Xchanger Inc. Heat Exchangers are also located in the Blower Building to dissipate the heat in the process air from the blowers.

3.5.2.5.4 Secondary Clarifiers

The BNRAS plant has three 135-foot diameter circular Secondary Clarifiers with Walker Process drives and two rake arms per tank. The liquid level of the Secondary Clarifiers is approximately 12 feet below grade making it very difficult to clean the effluent weirs. To the North of the Secondary Clarifiers is the RAS/WAS Pump Station. The RAS/WAS Pump Station contains four Fairbanks RAS Pumps (with room for two future RAS pumps) for pumping RAS to either the Anoxic Basin or upstream of the Intermediate Pump Station. There are also four Fairbanks WAS Pumps (with room for one future pump) for pumping WAS to the Thickening Tanks. Two Gorman Rupp Scum Pumps are provided to pump Scum to the Thickening Tanks. The Tank Drain Sump contains two submersible pumps and a bubbler system that can be used to drain the Secondary Clarifiers and Chlorine Contact Tank back to upstream of the Influent Pump Station.

3.5.2.5.5 Chlorination Facilities

The Chlorination Facilities for the BNRAS system disinfect only the BNRAS system effluent. The HPO system has its own chlorination facility as discussed above. Dechlorination of both systems occurs together and will be discussed in a later chapter.

The BNRAS system has two Chlorine Contact Tanks. The BNRAS plant effluent splits to the two Chlorine Contact Tanks. Each tank uses a flash mixer to inject sodium hypochlorite into the BNRAS plant effluent stream. After flowing through the Chlorine Contact Tank the chlorinated BNRAS plant effluent comes back together and flows to the dechlorination equipment. Three Fairbanks Morse Service Water Pumps use the chlorinated plant effluent as service water for the plant. There is room for a future fourth Service Water Pump.

3.5.2.5.6 Odor Control

3.5.2.5.6.1 Influent Pump Station

A chemical scrubber is located adjacent to the Influent Pump Station to treat odors exhausted from the Influent Pump Station and influent channels.

3.5.2.5.6.2 Primary Clarifiers and BNRAS Tankage

Air is exhausted from the Primary Clarifiers, Skimmer Building and the BNRAS Anoxic Basins and is sent to a chemical scrubber located next to the Primary Clarifiers. Air is exhausted from the BNRAS Aeration Basins and is sent to a chemical scrubber located next to the BNRAS Primary Clarifiers.

3.5.2.6 Centrifuge Building

Sludge from Ina Road WRF and Roger Road WRF is handled within the Centrifuge Building. There are five Sludge Holding Tanks capable of storing 120,000 gallons each. Sludge Holding Tank No. 1A, 1B, and 1C hold Ina Road WRF and Roger Road WRF digested sludge separately. Sludge Holding Tank No. 2 holds centrate and dilution water from Roger Road WRF that is sent back to the primary clarifiers. Sludge Holding Tank No. 3 holds thickened sludge that is sent to the Sludge Storage Bladder. Two Moyno pumps are used to pump the thickened sludge from Sludge Holding Tank No. 3 to the Sludge Storage Bladder. Four Hydromatic pumps are used to pump sludge from Sludge Holding Tank No. 1A, No. 1B, No. 1C, and No. 2 to the associated locations.

Two Sharples centrifuges installed in the mid 1980's and one Alfa Laval centrifuge installed 2-1/2 years ago thicken the Ina Road WRF and Roger Road WRF sludge to about 8 percent solids. Normally one centrifuge is run at one time. Four Reeves Feed Pumps pump sludge to the centrifuges. Two Reeves Cake Pumps installed in the mid 1980's and one Schwing Cake Pump installed 2-1/2 years ago pump cake solids to Sludge Holding Tank No. 3. The Schwing Pump was installed in case the plant decides to go to dewatering with the centrifuges at some time. Three Reeves Polymer Feed Pumps installed in the mid 1980's and one Viking Polymer Feed Pump installed 2-1/2 years ago pump polymer from totes along the wall to the centrifuges.

On the roof of the Centrifuge Building is the pig receiving station in the sludge pipeline from Roger Road WRF. A splitter box with a bar screen receives the sludge pumped from Roger Road WRF. Plant personnel manually switch valves to direct the flow of sludge and dilution water to different holding tanks when a pig appears. They also rake the bar rack to remove rags and any other solids that are caught by the bar screen and dispose of them in chute to a dumpster along the north side of the Centrifuge Building.

At the time of the Greeley and Hansen site assessment, one of the Sharples centrifuges had been sent back to the shop for routine maintenance. The pumps, centrifuges, and polymer equipment, based on visual inspection and reports by plant personnel, all appear to be in good shape.

Before going onto the roof to look at the pig receiving station, a handheld gas detector was required to make sure that no gases were at hazardous levels on top of the roof. This is because odorous air escapes from the sludge holding tanks through the candy cane shaped intake vents located only a foot or so above the roof slab at many locations across the top of the roof. These vents allow escaped gas to collect along the slab below the roof parapet.

3.5.2.6.1 Centrifuge Building Odor Control

One small carbon unit adjacent to the East side of the Centrifuge Building and two large carbon units adjacent to the North side of the Centrifuge Building are used for odor control at the Centrifuge Building. Plant personnel indicated that the odor system was originally designed to treat odors eight hours per day; however the units are now treating odors twenty four hours per day and, in the opinion of plant personnel, are undersized for this application. Plant personnel have moved the chemical scrubber that was no longer in service at the Vacuum Filter Building to the North side of the Centrifuge Building. There have been discussions of connecting the chemical scrubber to the existing carbon odor control system at the Centrifuge Building to supplement the existing treatment capacity.

Odors are noticeable within, around, and on top of the Centrifuge Building. PCRWRD took action to improve odor capture and provide acceptable levels of odor treatment at the centrifuge building.

3.5.2.7 Covered Sludge Storage Bladder

Thickened Sludge is pumped from Sludge Holding Tank No. 3 in the Centrifuge Building to a rubber covered Sludge Storage Bladder located nearby within an earthen berm. The sludge is stored here for disposal trucks to remove and haul away. The disposal trucks are filled at a truck loading station that is adjacent to the storage bladder. The truck loading station pumps sludge out of the storage bladder to the disposal trucks.

Due to the age of the bladder (>25 years) the structural integrity is a concern . The bottom of the bladder is not visible for inspection. It is not possible to determine the condition of the bottom and interior of the bladder. Based upon visual observation, the top of the bladder appears to be in good condition. No leaks or tears are evident on the top of the bladder.

3.5.2.8 De-chlorination

Chlorinated plant effluent from the BRNAS system and the HPO system comes together in a large vault just to the west of the HPO Chlorine Contact Tanks. At this point, de-chlorination is achieved by feeding Sodium Bisulfite to this vault and injecting it into the combined flow. Just downstream of this vault is a sampling structure where effluent ORP is measured for control of the de-chlorination chemical feeder.

The combined plant effluent discharge flow meter structure is located northwest of the plant and along Ina Road north of the landfill. A 6-foot Parshall flume nested within a 10-foot parshall flume measures the effluent flow. Future flows require a 10-foot Parshall flume; however, current flows would not register accurately on such a large parshall flume. The 6-foot Parshall flume nested within the 10-foot parshall flume is able to measure current flows. In the future, when the flows increase to be in excess of the 6-foot parshall flume capacity, the 6-foot Parshall flume will be removed from the larger flume. At that point, the 10-foot Parshall flume will measure flow.

There is also a duplicate measurement of effluent ORP made at this metering structure.

These structures are all new, and based on visual inspection, concrete and equipment appear to be in good condition.

3.5.2.9 Electrical

The Ina Road WRF electrical power distribution system is served from utility sources and on site generators. The HPO plant constructed during the 1970's and the Centrifuge Building added in the 1980's are powered by the generators at the plant power generation facility. The current plant expansion is powered from three separate TEP incoming utility electric services.

The plant power generation system consists of seven 650 kW, 4160 volts, 3-phase generators connected in parallel to 4.16 kV Switchgear "A/B". Switchgear feeder breakers distribute power to six outdoor unit substations and three 400 horsepower Oxygen Compressors. The unit substations are connected delta-wye with their secondaries rated 480-volts, 3-phase. The secondary of each unit substation serves a close coupled walk-in aisle 480-volt switchboard with the exception of the two at the Centrifuge Building. The Centrifuge Building unit substations serves a motor control center directly from the secondaries of the substation transformers. Those configured with secondary switchboards distribute power to motor control centers and other utilization equipment.

The three TEP incoming utility electric services are located at the Headworks, New RAS/WAS Pump Station and the Blower Building. TEP provides incoming power at 13.8 kV, 3-phase that is stepped down at each location to the required utilization voltages using Plant owned transformers and unit substations. The utility electric services are autonomous from each other and are individually metered for billing. The power distribution system at each facility is further described in detail within this assessment.

3.5.2.9.1 Plant Power Generation System

The plant power generation system is housed in the Energy Recovery Facility which has been renamed to the Powerhouse. The engine generator units with heat recovery equipment are located on the ground level floor with associated 4.16 kV Switchgear "A/B" located on the upper level floor.

Each of the 650 kW, 4.16 kV, 3-phase plant generator units is driven by a 12 cylinder Waukesha engine capable of operating on methane, natural, or propane gas. The generators are by Electric Machinery Co. which they no longer manufacture. The plant is normally operated with five units generating power to the plant, one unit in the standby mode and one unit down for maintenance. Two units are normally operated on methane and three units on natural gas. The amount of methane gas currently produced by the plant determines the number of units operating on methane. Propane is provided as a back-up source for the natural gas pipeline. Each unit has been re-built four times since the initial installation which equates to approximately 7 years or 43,000 hours of operating time between overhauls. Presently, operating times have been extended to 45,000 hours. Removal of the units for major overhauls requires the use of "A" frames and fork lifts as there is no overhead crane in the building. Due to the limitations in the machining tolerances of the engine blocks and the subsequent operational failure of Unit #5, the blocks for Units #5, 6 and 7 have been replaced. A local outsource maintenance shop has been providing maintenance on the generators which has proven to be satisfactory. As part of the overall energy system, heat is scavenged off the engines for use in HVAC systems, production of chilled water, domestic hot water and heating sludge in the digesters. The heat recovery system is not addressed herein as the focus of this assessment is the electrical equipment and systems.

The 4.16 kV Switchgear "A/B" has line-up air magnetic circuit breakers and generator paralleling controls manufactured by Waukesha Engomatic Control. The air magnetic circuit breakers are manufactured by ITE which is no longer in business. A local outsource maintenance shop has been providing maintenance on the circuit breakers which has proven satisfactory. The bussing of 4.16 kV Switchgear "A/B" is arranged with two generators on the Section "A" bus, four generators on the Section "B" bus and a single generator on a third bus isolated by tie breakers connected to Sections "A" and "B ". The Section "A" bus primarily feeds the three 400 horsepower Oxygen Compressors with Section "B" serving the majority of the remaining plant loads. The original design intent was for Sections "A" and "B" to operate independently of each other with the single generator assigned to either Section "A "or Section "B". However, a subsequent upgrade to the lineup allows both tie breakers to be closed with all of the generators operating in parallel on a common bus. All paralleling operations are manually achieved using synch scopes on each line-up. Previously, there was a surging issue on the Section "A" bus due to the cycling of the Oxygen Compressors. The upgrade was made to better manage load sharing among all of the operating units. Additional upgrades to 4.16 kV Switchgear "A/B" include digital metering, electronic governor controls, updated excitation controls and two new feeder breaker sections added to each section for serving the Centrifuge Building.

The engine generators have been maintained since the initial installation. Replacing the remaining original engine blocks as the units come due for overhaul should continue as part of the ongoing maintenance. 4.16 kV Switchgear "A/B" has likewise been meticulously maintained. Despite the age of the line-up, the equipment appears to be in excellent condition. The conditioned environment of the Electrical Room has probably contributed to the switchgears overall condition and serviceability. The area of concern is the non-availability of ITE air magnetic circuit breakers. Vacuum circuit breakers are currently available from various manufacturers which would be suitable for use as replacements in the existing switchgear.

The location of the switchgear in the upper floor level Electrical Room of the Powerhouse presents physical limitations for removing equipment from the building for maintenance. The doorways and associated clearances allow for limited access. New vertical sections added to serve the Centrifuge Building were moved through the existing doorways one section at a time. If partial or full replacement of the switchgear were required, movement of equipment to and from the room would be slow and time consuming.

The unit substations discussed herein were provided as part of the original 1970's treatment plant and the 1980's addition of the Centrifuge Building. These unit substations distribute power throughout the plant site from 4.16 kV Switchgear "A/B".

Unit Substations Nos. 2, 3, and 4 have redundant feeds on the primary from 4.16 kV Switchgear "A/B". Each is configured with an outdoor substation type transformer with a secondary close coupled walk-in aisle 480V Switchboard. The primary for each has dual main circuit breakers which are key interlocked to allow only one source to be energized at a time. Unit Substations US-CEN1 and US-CEN2 are each fed on the primary from 4.16 kV Switchgear "A/B". The configuration of each consists of an outdoor substation type transformer with the 480V secondary connected directly to Motor Control Center MCC-CEN in the Centrifuge Building using bus duct.

Plant maintenance staff indicated that problems have been experienced with the secondary 480V switchboard breakers. Problems have been attributed to internal corrosion of the breaker mechanisms by the hydrogen sulfide in the plant's atmosphere. Events have included false trips and inability to close breakers. Described herein are the assessments of the individual unit substations associated with the plant generation power distribution system.

3.5.2.9.1.1 Unit Substation No. 1

Unit Substation No. 1 is located in an outdoor yard area enclosed with masonry walls adjacent to the Sludge Thickeners. The substation assembly was manufactured by Westinghouse. The transformer section is rated 2000 kVA, 65 degrees Celsius, 4.16 kV-480V, 3-phase, delta-wye. The 480V secondary switchboard provides individual redundant feeds to the secondary switchboards at Unit Substations No. 2, No. 3 and No. 4. Previously, it also provided a redundant 480V feed to Unit Substation No. 5 at the original plant Headworks. However, Unit Substation No. 5 was removed from service when the current plant expansion Headworks was constructed. The overall substation assembly is in poor condition with severe exterior corrosion. Door filters are missing from the exterior access doors and the interior aisle is extremely dusty. It appears that the unit substations physical location does not allow for sufficient circulation of air around the equipment as process equipment in the same vicinity shows similar signs of corrosion. This unit substation should be considered for replacement and possible relocation. An alternative to relocation would be to provide an indoor unit substation in a new building at the existing location with suitable filtered ventilation.

3.5.2.9.1.2 Unit Substation No. 2

Unit Substation No. 2 is located in an outdoor yard area enclosed with masonry walls adjacent to the Digester Tanks. The substation assembly was manufactured by Westinghouse. The transformer section is rated 2000 kVA, 65 degrees Celsius, 4.16 kV-480V, 3-phase, delta-wye. The 480V secondary switchboard provides power to the majority of the original plant process areas including the Vacuum Filters, Digesters, Thickeners, Service Water Pumps, Powerhouse and Training Building. The overall assembly is in acceptable condition. Some of the nameplates for the individual feeder breakers in the switchboard are missing. The transformer oil temperature gauge indicates that the transformer is operating at the upper temperature limit setting. This condition should be investigated to determine the cause and appropriate measures taken to rectify any potential problems.

3.5.2.9.1.3 Unit Substation No. 3

Unit Substation No. 3 is located in an outdoor yard area enclosed with masonry walls adjacent to the Oxygen Production Building. The substation assembly was manufactured by Westinghouse. The transformer section is rated 1500 kVA, 65 degrees Celsius, 4.16 kV-480V, 3-phase, delta-wye. The 480V secondary switchboard provides power to the Oxygen Production process. The overall assembly is in acceptable condition. Some of the nameplates for the individual feeder breakers in the switchboard are missing. A large industrial fan was being used to circulate air around the transformers cooling fins which would indicate that the transformer is operating at or above its nameplate rating. This condition, if left unchecked could contribute to the shortening of the transformers operational life. An accurate reading of the operating electrical load should be taken to determine if the transformer is a candidate for a permanent cooling fan upgrade or possible replacement with a larger unit.

3.5.2.9.1.4 Unit Substation No. 4

Unit Substation No. 4 is located in an outdoor yard area enclosed with masonry walls adjacent to the Warehouse Building. The assembly was manufactured by Westinghouse. The transformer section is rated 750 kVA, 65 degrees Celsius, 4.16 kV-480V, 3-phase, delta-wye. The 480V secondary switchboard provides power to the Warehouse Building and Administration/Lab Building.

3.5.2.9.1.5 Unit Substation US-CEN1 and US-CEN2

Unit Substation US-CEN1 and US-CEN2 are located in an outdoor yard area enclosed with masonry walls adjacent to the Centrifuge Building. Each assembly was manufactured by General Electric in the mid 1980's. The transformer section for each is rated 1500 kVA, 55 degrees Celsius, 4.16 kV-480V, 3-phase, OA, delta-wye. The substations are physically configured on the secondary to directly feed 480V motor control center MCC-CEN using metal enclosed bus duct. MCC-CEN is configured with key interlocked Main-Tie-Main breakers which allows any two breakers to be closed at the same time. It was not determined if secondary overcurrent protection was present at the transformers. The shortcomings of the present electrical configuration are as follows: There is some corrosion on the secondary transition bus duct connections. The bus duct feeders from the substation transformers to MCC-CEN may not be properly protected if overcurrent protection is not provided at the secondary of US-CEN1 and US-CEN2.

3.5.2.9.1.6 Comments on the Plant Power Generation System

Given the condition of the engine generators and associated switchgear, the system is capable of generating power for the foreseeable future. The comparative overall costs for generating power versus purchasing utility power has to be weighed when deciding whether to continue generating power on site. The cost of fuel is always an issue when generating power. Methane is obviously the preferred source. But with its limited availability and the volatility of natural gas prices, this is a factor which needs to be analyzed carefully. In addition to fuel cost, equipment maintenance and manpower costs need to be factored in for generating power.

The 1970's vintage unit substations with the exception of Unit Substation No. 1 are acceptable. The correction of the shortcomings noted for each and perhaps additional secondary breaker maintenance could increase their reliability. Unit Substation No. 1 should be replaced. The issue of replacement versus repair should be weighed in as the age of the equipment progresses. Regardless, the unit substations could be integrated into an overall utility powered distribution system if the county elected not to continue generating power autonomously. Electric service and rate options should be discussed with TEP exploring the possibility of utilizing the engine generators in a different role such as co-generation and peak shaving.

3.5.2.9.2 TEP Incoming Utility Electric Services

The utility electric services described herein were provided under the current plant expansion. All of the equipment is less than 5 years old unless otherwise noted. The following describes each in detail.

3.5.2.9.2.1 Headworks

The TEP 13.8 kV, 3-phase incoming power service cables are routed underground to the primary of a pad mount service transformer. It appears that the TEP overhead incoming power service cables enter the plant site from the southeast but, the transition point to underground could not be confirmed. The service transformer was provided by TEP but, purchased by the Plant. The associated utility metering CT's and revenue meter are located approximately forty feet away from the pad mount service transformer. The service transformer does not have a data nameplate but, it was determined that the voltage on the secondary was 4.16 kV, 3-phase. It was not apparent if the service transformer had primary or secondary overcurrent protection as the compartments were not accessible. The 4.16 kV, 3-phase secondary of the service transformer feeds two Outdoor Unit Substations US30-1 and US30-2 manufactured by Cutler-Hammer. The primary section consists of a primary line selector switch for selecting either the utility source (pad mount service transformer) or plant power generation system source. The transformer section is rated 2000/2340 kVA-2300/2576 kVA, 55/65 degrees Celsius, 4.16 kV-480/277V, 3-phase delta-wye with fan cooling. The secondary consists of a close coupled non walk-in aisle 480V Pow-R-Line Switchboard. How the 4.16 kV feed from the Plant power generation system was configured to serve both unit substations on the primary was not determined. The secondary 480V switchboard at each unit substation provides power to the motor control centers in the Headworks Electrical Room. The motor control centers are arranged with key interlocked dual main breakers with feeders from each of the unit substations 480V switchboards. All of the electrical equipment at the Headworks is in excellent condition. The shortcomings of the present electrical configuration are as follows: The feeders from the pad mount service transformer to Unit Substations US30-1 and US30-2 may not be properly protected if overcurrent protection is not provided at the secondary of the pad mount service transformer. The primary line selector switch on the unit substations must be manually transferred to the second source if the preferred source fails. All of the 480V loads could possibly be connected to one unit substation if the same main breaker source for each of the motor control centers was selected at the unit substation 480V switchboard. This would leave the second unit substation unloaded which is not beneficial to the transformer.

3.5.2.9.2.2 New RAS/WAS Pump Station

The TEP 13.8 kV, 3-phase incoming power service cables enter the plant site from the southeast and are routed overhead to a drop pole in the vicinity of the New RAS/WAS Pump Station. The overhead cables make a transition at the drop pole to underground and are routed to the primary of a substation service transformer. The transformer is a Westinghouse Insulated Unit Substation rated 1000 kVA, 65 degrees Celsius, 13.8 kV-480V, 3-phase delta-wye. It was not apparent if the transformer had primary or secondary overcurrent protection nor was the utility metering apparent. The transformer secondary feeds two motor control centers MCC37A and MCC37B located in the RAS/WAS Pump Station Electrical Room. The Electric Room is located below grade at a mezzanine level above the Pump Room. Each motor control center is arranged with key interlocked dual main breakers with a feed from the substation service transformer and the Plant power generation system. Where the 480V feed from the Plant power generation system is derived for each motor control center could not be determined. The substation service transformer was purchased used for the project and its age could not be determined. All of the electrical equipment appears to be in excellent condition. The shortcomings of the present electrical configuration are as follows: The feeders from the substation service transformer to MCC37A and MCC37B may not be properly protected if overcurrent protection is not provided at the secondary of the

substation service transformer. The main breakers on each of the motor control centers must be manually transferred to the second source if the preferred source fails. The Electrical Room is located below grade thus having the potential for flooding. The motor control centers were installed in the Electrical Room prior to the installation of the pump station roof. The catwalks and stairways for accessing the Electrical Room would prove extremely difficult to use for removing electrical equipment. In addition, the height of the doorways is not sufficient for removing a section of motor control center in the upright position.

3.5.2.9.2.3 Blower Building

The TEP 13.8 kV, 3-phase incoming power service cables enter the plant site from the east and are routed overhead to a drop pole in the vicinity of the Blower Building. The overhead cables make a transition at the drop pole to underground and are routed to the primary of a substation service transformer. The transformer is a General Electric Silicone Fluid Unit Substation rated 5000/7000 kVA, 65 degrees Celsius, 13.8 kV-4.16 kV, 3-phase delta-wye with provisions for future fans. It was not apparent if the transformer had primary or secondary overcurrent protection nor was the utility metering apparent. The service transformer secondary feeds Outdoor 4.16 kV Switchgear (SWGR-BB). The switchgear is a weatherproof line-up manufactured by S&C Electric consisting of four medium voltage fusible switches in a hot sequence arrangement. Two of the fusible switches feed 4.16 kV motor control centers MCC34C and MCC34D. Each of the motor control centers contains the starters for two of the process air blowers. The other two fusible switches each feed Outdoor Unit Substations US34-1 and US34-2. The unit substations are manufactured by Square D Company and configured similar to those used at the Headworks. The primary section differs in that a main fusible switch is provided between the primary line selector switch and the primary of the transformer. The transformer section is rated 1500/1680 kVA, 55/65 degrees Celsius, 4.16 kV-480/277V, 3-phase delta-wye with provisions for future fan cooling. When fan cooling is added, the transformer will be rated 1932 kVA. The secondary consists of a close coupled non walk-in aisle switchboard. How the 4.16 kV feed from the Plant power generation system was configured to serve both unit substations on the primary was not determined. The secondary 480V switchboard at each unit substation provides power to motor control centers MCC33A, MCC33B, MCC34, MCC35A and MCC35B. The 480V motor control centers are arranged with key interlocked dual main breakers fed from each of the unit substations 480V switchboards. The 4.16 kV and 480V motor control centers are located in the Electrical Room on the upper level floor of the Blower Building. The substation service transformer was purchased used for the project and its age was not determined. All of the electrical equipment appears to be in excellent condition. The shortcomings of the present electrical configuration are as follows: The feeder from the substation service transformer to the Outdoor 4.16 kV Switchgear (SWGR-BB) may not be properly protected if overcurrent protection is not provided at the secondary of the substation service transformer. The primary line selector switch on the unit substations must be manually transferred to the second source if the preferred source fails. The main breakers on each of the 480V motor control centers must be manually transferred to the second source if the preferred source fails. All of the 480V loads could possibly be connected to one unit substation if the same main breaker source for each of the motor control centers was selected at the unit substation 480V switchboard. This would leave the second unit substation unloaded which is not beneficial to the transformer. The 4.16 kV motor control centers do not have a redundant source of power. If the utility source fails, the Process Air Blowers will be off line. The location of the motor control centers in the upper floor level Electrical Room of the Blower Building presents physical limitations for removing equipment from the building for maintenance or replacement.

3.5.2.9.2.4 Comments on Utility Electric Services

The present service arrangement with three separate TEP incoming utility electric services is neither desirable nor beneficial to the overall operating scheme for the plant electrical system. The present arrangement does not allow the possibility for obtaining a more favorable rate from TEP as each service is independent from the others and billed separately for its energy usage. The three services are not configured to provide the flexibility needed for future plant expansion. Likewise, a common methodology for interfacing with the plant power generation system has not been established. It was not confirmed if the plant power generation system connections described for each of the electrical services are physically provided. The provisions may only have been made for future interfacing with the plant power generation system or other alternate power sources. Plant staff reported that an overall plant-wide electrical distribution system diagram has never been created. The present overall electrical distribution system needs to be properly documented with up-to-date one-line diagrams. These documents need to be provided to the electrical maintenance and power generation staff to ensure efficient and safe operation of the system.

3.5.2.9.3 Motor Control Centers

There are two styles of motor control centers used throughout the plant. They are located adjacent to and within the process structures. Outdoor motor control centers are provided in NEMA 3R and NEMA 4 stainless steel non walk-in enclosures with front access weatherproof doors. The NEMA 3R outdoor enclosures show some light surface corrosion. Some of the indoor motor control centers show corrosion on the face of the line-ups and the control devices. Motor control centers located indoors are NEMA 1 construction with the majority located in the same area as the process equipment. Due to their physical location, most are soiled on the exterior. The recent plant expansion provided Electrical Rooms within the structures to house the motor control centers. The majority of the motor control centers are arranged with key interlocked dual main circuit breakers which allow only one source to be closed at a time. Others are arranged main-tie-main with key interlocks which allow any two breakers to be closed. The power sources in either arrangement may be redundant generator feeds, redundant utility feeds or combinations of both. The breakers are key interlocked so that only one breaker can be closed at a time. Five equipment design vintages are present for all of the motor control centers on site. The five are Westinghouse Type W, Cutler-Hammer Series 2100, General Electric 8000 Line and Square D Models 4 and 6. Overall, the condition of the motor control centers falls in the range of acceptable to excellent with a few exceptions. **Table 3-3** provides a list of all the motor control centers.

3.5.2.9.4 Plant Grounding System

Plant maintenance personnel confirmed that plant grounding system is adequate and that there have not been any grounding related issues.

3.5.2.9.5 Electrical Feeders

Plant personnel did not indicate that there were any electrical feeder related issues.

3.5.2.9.6 Summary of Overall Assessments

The assessments made address the existing electrical equipment as it relates to the present plant electrical distribution system and its serviceability. Any upgrades or future expansions of the plant will impact the existing overall electrical distribution system as provisions for expansion have not been accounted for in the present systems. The impact of future expansions has not been factored into the assessments of the existing equipment. The issues previously discussed relate only to the conditional assessment of the equipment as presently installed.

All electrical distribution equipment is thermographically inspected annually and the problems corrected upon completion. There is some electrical equipment which is possibly more susceptible to problems or failure for various reasons but, at present, is functioning satisfactorily. This equipment has been identified herein. It is suggested that this equipment be considered for systematic replacement if the existing systems are to remain viable. A short circuit and coordination study is suggested as electrical changes have been made over the years and the study would be beneficial in verifying that the electrical equipment is proper coordination and provided with suitable interrupting ratings. In addition, the study would be useful for identifying potential problem areas in the plant electrical distribution system.

Table 3-3
Pima County Ina Road WRF – Motor Control Centers Assessment

EQUIPMENT TAG	LOCATION	MANUFACTURER	VOLTAGE	TYPE	BUS RATING	YEAR BUILT
MCC 05W1	OXYGEN PRODUCTION BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 05W2	OXYGEN PRODUCTION BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 08W1	SLUDGE THICKENERS CONTROL BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 08W2	SLUDGE THICKENERS CONTROL BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 08W3	SLUDGE THICKENERS CONTROL BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 08W4	CHLORINE BUILDING (OUTDOOR COVERED)	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 09W1	VACUUM FILTRATION BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 09W2	VACUUM FILTRATION BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 11W1	DIGESTER TANKS	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 11W2	DIGESTER TANKS	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 11W3	DIGESTER TANKS	WESTINGHOUSE 2100 LINE	480 V	3PH, 4W	600 A	1986
MCC 11W4	DIGESTER TANKS	WESTINGHOUSE 2100 LINE	480 V	3PH, 4W	600 A	1986
MCC 12W1	CHLORINATION BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 14W1	POWER HOUSE (ENERGY RECOVERY BUILDING)	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 14W2	POWER HOUSE (ENERGY RECOVERY BUILDING)	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 14W3	POWER HOUSE (ENERGY RECOVERY BUILDING)	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 17W1	SERVICE WATER BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC 17W2	SERVICE WATER BUILDING	WESTINGHOUSE TYPE W	480 V	3PH, 4W	600 A	1976
MCC A	SULFUR DIOXIDE BUILDING	SQUARE D MODEL 6	480 V	3PH, 4W	600 A	2002
MCC B	SULFUR DIOXIDE BUILDING	SQUARE D MODEL 6	480 V	3PH, 4W	600 A	2002
MCC-CEN	CENTRIFUGE BUILDING	GE 8000 LINE	480 V	3PH, 4W	600 A	1986
MCC-30A	HEADWORKS BUILDING	CUTLER-HAMMER SERIES 2100	480 V	3PH, 4W	600 A	2000
MCC-30B	HEADWORKS BUILDING	CUTLER-HAMMER SERIES 2100	480 V	3PH, 4W	600 A	2000
MCC 33A	BLOWER BUILDING	SQUARE D MODEL 6	480 V	3PH, 3W	600 A	2002
MCC 33B	BLOWER BUILDING	SQUARE D MODEL 6	480 V	3PH, 3W	600 A	2002
MCC 34	BLOWER BUILDING	SQUARE D MODEL 6	480 V	3PH, 3W	800 A	2002
MCC 34C	BLOWER BUILDING	SQUARE D ISO-FLEX MODEL 4	4160V	3PH, 3W	600A	2002
MCC 34D	BLOWER BUILDING	SQUARE D ISO-FLEX MODEL 4	4160V	3PH, 3W	600A	2002
MCC 35A	BLOWER BUILDING	SQUARE D MODEL 6	480 V	3PH, 3W	800 A	2002
MCC 35B	BLOWER BUILDING	SQUARE D MODEL 6	480 V	3PH, 3W	800 A	2002
MCC 37A	RAS/WAS PUMP STATION	SQUARE D MODEL 6	480 V	3PH, 4W	1200A	2002
MCC 37B	RAS/WAS PUMP STATION	SQUARE D MODEL 6	480 V	3PH, 4W	1200A	2002

3.5.2.10 Instrumentation and Control

The Ina Road plant is well instrumented. Process instrumentation includes open channel flow meters, sludge flow meters, aeration system analytical instruments, tank level transmitters, digester gas and air flow meters and chlorine residual and ORP instruments for disinfection. Most instruments in the older HPO train are operational. Instruments in the new BNRAS train are newly installed and some are operational, but there are a number of instruments that had not been fully commissioned at the time of our site assessment. Certain instruments are discussed below in the respective process chapters.

3.5.2.10.1 SCADA System

The plant SCADA system is very new, having been commissioned in 2002 and fully operational in 2004. The SCADA network backbone consists of an Ethernet fiber optic trunk running between the Administration Building and the Energy Recovery Building where the two main core switches and redundant SCADA servers are located. The two network core switches connect the following plant areas:

- Admin Building Server/Core Switch
  - Maintenance Building
  - Centrifuge Building 23
  - East-West Tunnel
  - BNRAS Train Building 34
  - HPO Oxygen Production Building 5

- Energy Building Server/Core Switch
  - Vacuum Filter Building 9
  - RAS/WAS Building 7
  - Thickener Building 8
  - Digester Building 11
  - Disinfection Building 12
  - BNRAS Train RAS/WAS Building 37
  - Training Building
  - Operations Trailer 29
  - Headworks Building 30

The Administration Building Information Technology (IT) Room houses the backup supervisor control and data acquisition (SCADA) server and the SCADA historian. The system is tied to the County network backbone through a firewall. The primary SCADA server is located at the Energy Building. Various view node workstations are located throughout the plant and communicate with the servers over the Ethernet network.

Numerous PLCs throughout the plant act as the input/output (I/O) connections to the process areas. Most PLCs are Allen-Bradley ControlLogix series with Ethernet ports to communicate with the SCADA servers. Package control systems generally include Allen-Bradley SLC-5/04 connected to the ControlLogix PLCs using DH-Plus data links. There are some other PLC models in the plant but all are

part of the Allen-Bradley product family. The system is easily expandable. Instrument technicians are able to troubleshoot and maintain the PLCs over the network backbone from the Maintenance Building. Local view nodes throughout the plant typically obtain their information form the primary SCADA server. These workstations have two backup modes. In the event the primary SCADA server fails, the view node will fail over to communicate with the backup server. In the event of a complete communication failure between the servers and view nodes, the view node will fail over to "Island Mode" where it turns into a local I/O server for just its facility. In this mode, the workstation still has monitoring and control capability for its own local process area, but can't see any data regarding other process facilities.

This SCADA system is functioning well and operators use it extensively. This type of configuration is considered state-of-the-art for today's wastewater treatment plants.

3.5.2.10.2 Headworks

Ultrasonic level transmitters are used extensively to monitor chamber levels, bin level, wet well levels and the plant influent parshall flume flow. Thermal mass flow meters are used to measure air flow to the aerated grit tanks. These are all functioning properly.

3.5.2.10.3 HPO Train Liquid Sewage and Sludge Meters

For the HPO process all sludge flow meters for closed pipe sewage and sludge located at the primary clarifiers, final clarifiers, thickeners, centrifuges and digesters are magnetic flow meters. Many of these meters are new technology, having been replaced in the 1990s. These are appropriate and are reported functioning properly.

3.5.2.10.4 HPO Aeration Tanks

The original dissolved oxygen meters have been replaced with ATI self-cleaning DO monitors. These probes are configured to go through a cleaning cycle every 20 minutes and reportedly work well.

The oxygen generation and oxygen distribution feed control system is automated through a local dedicated PLC which sequences the compressors and cycles the adsorption beds. The system requires periodic attention from the instrument staff but reportedly still functions well.

Control of return sludge to each of the aeration tanks is fully automated through the SCADA system and reportedly works well.

3.5.2.10.5 HPO Train Disinfection

Disinfection is now achieved using liquid sodium hypochlorite. U.S. Filter liquid chemical feeders control the rate of hypochlorite feed to the old injectors at the contact tanks. Plant staff is currently troubleshooting and fine tuning the automatic controls using a combination of flow pacing, chlorine residual and ORP analysis of the contact tank effluent. These parameters were being monitored by a

Great Lakes (now owned by Hach) chlorine analyzer and a Stantrol ORP probe. When observed, the chlorine residual was reading 5.8-6.3 mg/L total chlorine and the ORP was reading 450 millivolts.

3.5.2.10.6 Plant Effluent Dechlorination

Dechlorination is now being achieved using liquid sodium bisulfite. U.S. Filter liquid chemical feeders control the rate of hypochlorite feed to combined effluent vault just west of the HPO Train contact tanks. Similar to the disinfection system, plant staff is currently troubleshooting and fine tuning the automatic controls based on ORP analysis of the plant effluent just downstream from the point of bisulfite addition. When observed, the ORP was reading 90-100 millivolts. There is a second ORP probe located at the new plant effluent parshall flume metering station that was reading 80 millivolts when observed.

3.5.2.10.7 Sludge Digesters

Sludge gas flow is still measured using orifice plates and differential pressure transmitters. This technology is now outdated and would be better replaced with thermal mass flow meters which have better rangeability and accuracy.

3.5.2.10.8 New BNRAS Train Instrumentation

All instruments are new and have not yet been fully commissioned. As such, no evaluation is warranted except observation of installation practice. All instruments appeared to be installed in accordance with industry accepted guidelines.

3.5.2.10.9 Plant Effluent Flow Metering

The new plant effluent flow meter is a Parshall flume located well off the plant perimeter to the northwest of the plant site. This metering chamber is in a separately fenced area. It consists of an open channel meter entrance run and nested Parshall flume. The flume is a 6-foot parshall flume nested inside a 10-foot parshall flume. This is done to increase the sensitivity and accuracy of the flume at low initial flows while still being easily expandable for higher flows in the future. Since this is a flow measurement used for reporting, there are redundant level/flow transmitters installed. One transmitter is a Milltronics ultrasonic open channel level/flow transmitter. The backup level measurement is provided by a bubbler type level system mounted in the flume. The bubbler tube assembly appeared to be incorrectly located in the flume due to high velocities having bent the tube. The bubbler tube should be straightened and securely anchored to the flume wall. This flume installation is functioning properly.

3.5.2.10.10 Laboratory Facilities

The Laboratory Facilities were originally housed in a portion of the Administration Building at the Ina Road WRF which was specifically constructed (1977) to serve as laboratory space. Staff indicated that up until approximately ten years ago the Laboratory at the Ina Road WRF was providing process control and permit related analytical services for four facilities/permits. Currently, the Laboratory provides process analytical support for eight wastewater treatment/water reclamation facilities and permit compliance/reporting analyses for approximately 37 permits associated with the wastewater/water

reclamation, aquifer protection, and storm water programs. As the laboratory analytical requirements increased over the ensuing time, additional building space (Administration Building and Training Center) was converted to laboratory use.

Currently, laboratory facilities are located in three general areas at the Ina Road WRF. Sample receiving, microbiological, and organic analysis functions are conducted at the Administration Building. Inorganic and nutrient analyses and laboratory quality assurance and quality control (QA/QC) functions are located at the former Training Center. Laboratory management staff offices are located in a trailer adjacent to the Administration Building. In the past the Ina Road WRF laboratory facilities included the capability to perform whole effluent toxicity (WET) testing. This WET testing laboratory was located in the basement of the Vacuum Filtration Building. Currently, the Ina Road WRF laboratory has a staff of 30 (33 budgeted positions).

In fiscal year 2005/2006 the budget for outside laboratory services was $225,000 (expended $110,000). The majority of this budget was for WET testing services which the Department no longer conducts, as discussed above. Currently there are a very limited number of laboratories that have the proximity and capability to perform reliable WET testing for the PCRWRD. The Department needs to make certain that it has access to reliable WET testing capabilities, internal or contract laboratory, as it is anticipated that the volume of this testing will increase in the future.

Generally, laboratory equipment was in good condition. The Department has replaced/upgraded analytical instruments as a component of its annual operating budget. Over the years, as analytical sensitivity and reporting limits of detection have lowered, the number and sizes of analytical equipment have increased. This has resulted in the laboratory equipment (incubators, drying ovens, analytical, and others) competing for bench-top space with the chemists and technicians and the sample preparation, handling, functions required in the laboratory. Currently, the ability to consider enhancement of laboratory efficiency through automation of appropriate preparatory and analytical equipment is hindered due to the space constraints. Additionally, the space needed to adequately receive and store (refrigerated) samples has been exceeded.

The laboratory work areas were extremely cramped and the layout of the laboratory areas was not conducive to work flow. Narrow aisles, crowded bench-tops, limited data entry/desktop space, and storage space were not conducive to efficiency. The crowded conditions do not easily support the type of conditions needed to maintain appropriate laboratory QA/QC.

The support facilities associated with the laboratory areas were being stressed. Much of the space currently occupied by laboratory was not designed to address the specific electrical, heating, ventilation, and cooling (HVAC), plumbing, personnel, and specialty needs associated with an analytical laboratory. This condition was exacerbated as the volume and level of required accuracy of testing along with the sophistication of the analytical equipment all increased. Electrical power supply to most laboratory areas was close to capacity leading to instances of circuit overload.

HVAC systems were not generally able to maintain appropriate room temperature, humidity, and overall quality conditions. Particularly, most analytical testing protocols and instrumentation require very specific temperature conditions as a component of the QA/QC process. These temperature criteria cannot

be reliably accomplished with the existing HVAC systems. Fume hood space was inadequate leading to inadequate ventilated bench space. Further, most HVAC systems were not designed to accommodate the specialized air handling demands that fume hoods impose on a space. In some areas corrosion of equipment, instrumentation, and other fixtures was indicative of inadequacy of ventilation.

Plumbing systems serving the laboratory spaces were not arranged to support the work areas that have been arranged to address the increased workload demand. Deionized (DI) and ultra pure water required for analyses must be transported by hand cart to many areas of its use. Building temperature in the areas where the DI water systems are located results in production/distribution of water that exceeds the temperature (20 degrees Celsius) required for direct use in most analyses.

Personnel facilities related to the laboratory functions were limited. Desk space available for staff to accomplish data entry and related functions was not adequate. Locker/changing room space was limited and further complicated by the gender balance of the current workforce.

Other specialty systems associated with the laboratory areas include safety equipment (showers, eyewash stations, and fire blankets), walk-in refrigeration (current samples and sample retention for QA/QC purpose), chemical/supplies storage, and records storage. Safety systems were adequate but access is complicated due to the overall space/layout constraints. Refrigerated sample storage was not optimal for the purpose of prevention of sample cross-contamination during storage. Storage areas for chemicals, supplies, records, and other items was “full-to-the-brim” presenting a challenge whenever access to these items was required.

3.6 Summary

The Roger Road WRF is an older of the two major wastewater treatment plants and symptoms of aging are apparent. From an operational and maintenance point of view, there are several drawbacks in the existing facilities, including:

- Primary Clarifiers 5-8 are shallower (8-foot depth) than Primary Clarifiers 9-10 (12-foot depth). The shallower depth does not meet the current norm of design standard.
- The final clarifiers have various side water depths: 9-foot depth for clarifiers 1-2; 9-foot depth for clarifiers 3-4; 11-foot depth for clarifiers 5-6; and 12-foot depth for clarifiers 7-9. The 9-foot depth does not meet the current norm of design standard.
- Due to the inadequacies of several of the primary and secondary clarifiers and current flows and loading to the Roger Road WRF, individual tanks from primary clarifiers, final clarifiers or anaerobic digesters can not be taken out of service without jeopardizing the ability of the plant to meet permit effluent standards.

The BNRAS system at the Ina Road WRF is relatively new (operation started up in the fall of 2006) and is in excellent physical and operating condition. However, the HPO system is an older part of the plant and has some signs of aging in the structures and equipment, particularly the HPO Reactors.

To meet the future permit requirements, process modifications and changes will be required to lower ammonia, total nitrogen and phosphorus discharge levels. Rehabilitation is needed to repair process units,

replace equipment and structures that are beyond useful service life, address odor control and safety issues, and upgrade the facility to be compliant with environmental, regulatory and building code requirements. Laboratory facilities need to be expanded and upgraded with better integration of facilities. The potential need for added capacity and treatment capability at Roger Road WRF and Ina Road WRF is addressed in Chapter 4.

CHAPTER 4

Overall Treatment Strategy

Chapter 4 - Overall Treatment Strategy

4.1 Introduction

The Overall Treatment Strategy for the Pima County Regional Optimization Master Plan entails planning efforts to satisfy two primary issues:

1. System Configuration - how much flow is to be treated at the Roger Road WRF and how much flow is to be treated at the Ina Road WRF.

2. Process Selection - selection of the best process to meet current regulatory requirements as well as probable future regulatory requirements.

To address these two primary issues, this chapter provides description and detailed evaluations on the following subjects:

- Future wastewater flows and characteristics
- Treatment strategy alternatives with three flow-split options
- Reclaimed water program
- Biological nutrient removal (BNR) treatment alternatives
- Alternative evaluation criteria
- Evaluation of alternatives
- Selection of recommended alternative
- Preliminary sizing facilities

4.2 Future Wastewater Flows and Characteristics

4.2.1 Future Wastewater Flows

The flow projection for the Roger Road WRF and the Ina Road WRF was made based on information described in the Pima County Wastewater Management Department's 2006 Metropolitan Facility Plan Update (2006 Facilities Plan). According to the report, the future flow projection was based on the projected population growth in the planning area and projected wastewater flows of 85 gallons per capita per day (gpcd). The wastewater flow projections for year 2030, along with the current (year 2005), in the planning areas are summarized as shown in **Table 4-1**.

Table 4-1
Current and Projected 2030 Wastewater Flows from 2006 Facilities Plan

Plan Area	2030 Projected Flow	
	Current (2005)	Future (2030) (1)
Roger Road Service Area, mgd	44.27	59.72
Ina Road Service Area, mgd	16.90	22.33
Total Flow, mgd	61.17	82.05

(1) Randolph Park WRF capacity of 3.0 mgd is not included. The existing Randolph Park WRF, located within the Roger Road WRF drainage area, will be continuously used to treat approximately 3 mgd flow and the effluent will be a part of the Tucson Water reclaimed water system.

Based on the projected flows for year 2030 shown in the above table, several flow split options between the two major treatment facilities, Roger Road WRF and Ina Road WRF, were developed. The following options were selected for detailed evaluation of plant configurations, operational and economical aspects.

- Option 1 – Referred to as the "Existing Plan" and is the recommended plan by the 2006 Facilities Plan study. It is based on a flow split of 32 mgd and 50 mgd between Roger Road WRF and Ina Road WRF, respectively.
- Option 2 – Referred to as the "Transfer Some" plan and is based on some flow transfer from the Roger Road WRF to the Ina Road WRF to make a flow split of 20 mgd and 62 mgd, respectively,.
- Option 3 – Referred to as the "Transfer All" plan and is based on transferring all flow from the Roger Road WRF to the Ina Road WRF and therefore treatment of all 82 mgd at the Ina Road WRF.

For the purpose of estimating the wastewater characteristics, each of the flow split options was divided into current (assumes that plant interconnect pipeline is constructed) and future flows as shown in **Table 4-2.**

Table 4-2
Wastewater Flow Split Options Used for Plant Evaluations

Flow Split Options*	Flow to Roger Road, mgd			Flow to Ina Road WRF, mgd		
	Current**	Future	Total	Current**	Future	Total
Existing Plan	22.6	9.4	32.0	36.5	13.5	50.0
Transfer Some	14.1	5.9	20.0	45.0	17.0	62.0
Transfer All	0.0	0.0	0.0	59.1	22.9	82.0

* Randolph Park WRF with capacity 3.0 mgd remains in service
** Assumes plant interconnect pipeline exists

4.2.2 Future Wastewater Characteristics

Wastewater characteristics for current flows were developed based on the data presented in the Modeling 2005 document (Additional Modeling of Ina Road WRF and Roger Road WRF – Final, Hydromantis, Inc., February 9, 2005). The modeling used the plant operating data for the following periods:

- Roger Road WRF – January to March 2001 (winter)
  August to September 2001 (summer)
- Ina Road WRF – March 2003

The calibrated model generated the influent characteristics for Roger Road WRF, but calibration was not made for Ina Road WRF because there were no operating data available for the BNRAS portion of the plant at the time of the modeling. A review of historical data showed that the strength of wastewater characteristics was highest during the winter and the data used for this period was considered to be the maximum month wastewater characteristics. The model-generated winter wastewater characteristics were selected for evaluation of the Roger Road WRF. The March 2003 data were used for evaluation of the Ina Road WRF. These values established current maximum month wastewater characteristics.

The future wastewater characteristics were developed applying a lower water consumption and therefore higher strength wastewater in the new development areas. This lower water consumption is a trend in a number of newly developed communities. A lower wastewater flow of 65 gpcd was used for future flow instead of 85 gpcd that was used in the 2006 Facilities Plan document. The flow projected in the 2006 Facilities Plan document was retained and applied to the predicted higher strength characteristics, resulting in a higher and more conservative estimate of total loads.

As a part of the current facility planning, the biosolids treatment evaluation has progressed and recommendations have been made on the biosolids treatment and handling alternatives as described in Chapter 6. Based on this information, more accurate recycle stream flows and characteristics were determined and complete mass balances were made for both plants with the recycle streams. Major assumptions applied to the mass balances associated with biosolids treatment and handling include:

- Recycle from gravity thickening of Roger Road WRF primary sludge and WAS is treated at the Roger Road WRF.
- Recycle from gravity thickening of Ina Road WRF primary sludge and WAS and centrifuge thickening/dewatering of digested sludge from both plants is treated at the Ina Road WRF.
- Estimated Non-Metro area sludge contributions to each plant are: Avra Valley WRF (4.13 tons per day (tpd)) to Roger Road WRF; and Marana WRF (6.16 tpd), Corona WRF (3.7 tpd), Fairgrounds WRF (0.004 tpd) and Mt. Lemon WRF 0.018 tpd) to Ina Road WRF. (Randolph Park WRF sludge is included with Roger Road WRF. Green Valley WRF and Southlands WRF were assumed to have separate sludge facilities.) The sludge was applied as a part of the influent stream for both plants.
- Primary sludge at 1% solids concentration.
- Secondary sludge yield of 0.7 pound (lb) TSS/lbs BOD applied and WAS concentration of 7,000 mg/L.
- Gravity thickener solids capture of 90% at 4.5% solids concentration.
- Volatile suspended solids (VSS) destruction of 50% in anaerobic digestion.

- Centrifuge solids recovery of 95% at 8% cake solids concentration.

Biosolids processing, except for sludge thickening, will not be performed at the Roger Road WRF and the wastewater characteristics were developed with only recycle from the thickening operations. Complete biosolids processing as described above will be performed at the Ina Road WRF and the wastewater characteristics were developed with the recycle stream from raw sludge thickening and digested sludge thickening/dewatering operations. To account for the recycle stream contribution, a percentage increase to each wastewater characteristics component, selected from previous plant design experience, was used.

The estimated wastewater characteristics were developed combining the current and future loadings, and recycle stream contribution. The estimated wastewater characteristics for three flow split options are shown in
Table 4-3 and
Table 4-4 for Roger Road WRF and Ina Road WRF, respectively.

Table 4-3
Development of the Roger Road WRF Year 2030 Wastewater Characteristics Based on Complete Mass Balance

Parameter	Units	Total Raw Influent	Recycles	Primary Influent	Primary Effluent
Existing Plan					
Flow	mgd	32.1	1.1	33.2	32.6
COD[(1)]	mg/L	648	1011	659	443
BOD_5[(2)]	mg/L	294	506	301	214
$sBOD_5$[(3)]	mg/L	121	116	121	123
TSS	mg/L	286	1011	310	126
VSS	mg/L	225	791	243	104
TKN	mg/L	47	51	47	46
TP	mg/L	10	19	10	10
Transfer Some					
Flow	mgd	20.1	0.7	20.8	20.4
COD	mg/L	665	1014	677	455
BOD_5	mg/L	303	507	310	220
$sBOD_5$	mg/L	123	117	123	126
TSS	mg/L	304	1014	329	134
VSS	mg/L	239	794	258	110
TKN	mg/L	48	51	48	47
TP[(1)]	mg/L	10	19	10	10
Transfer All					
Flow	mgd	0	0	0	0
COD	mg/L	0	0	0	0
BOD_5	mg/L	0	0	0	0
$sBOD_5$	mg/L	0	0	0	0

Parameter	Units	Total Raw Influent	Recycles	Primary Influent	Primary Effluent
TSS	mg/L	0	0	0	0
VSS	mg/L	0	0	0	0
TKN	mg/L	0	0	0	0
TP	mg/L	0	0	0	0

(1) COD = Chemical Oxygen Demand (2) BOD_5 = 5-day Biochemical Oxygen Demand
(3) $sBOD_5$ = soluble 5-day Biochemical Oxygen Demand

Table 4-4
Development of the Ina Road WRF Year 2030 Wastewater Characteristics Based on Complete Mass Balance

Parameter	Units	Total Raw Influent	Recycles	Primary Influent	Primary Effluent
Existing Plan					
Flow	mgd	50.2	2.3	52.6	51.4
COD	mg/L	663	1265	689	456
BOD_5	mg/L	318	456	324	229
$sBOD_5$	mg/L	123	125	123	126
TSS	mg/L	319	1201	358	146
VSS	mg/L	254	881	282	123
TKN	mg/L	55	219	63	61
TP	mg/L	11	102	15	14
Transfer Some					
Flow	mgd	62.2	2.7	64.9	63.6
COD	mg/L	654	1230	678	441
BOD_5	mg/L	31	462	317	223
$sBOD_5$	mg/L	122	124	122	125
TSS	mg/L	307	1172	343	140
VSS	mg/L	244	873	270	116
TKN	mg/L	54	196	59	57
TP(1)	mg/L	11	90	14	13
Transfer All					
Flow	mgd	82.3	3.4	85.7	84.0
COD	mg/L	654	1184	675	452
BOD_5	mg/L	307	472	314	222

Parameter	Units	Total Raw Influent	Recycles	Primary Influent	Primary Effluent
$sBOD_5$	mg/L	121	122	121	123
TSS	mg/L	304	1140	337	138
VSS	mg/L	241	852	265	115
TKN	mg/L	52	165	56	54
TP	mg/L	10	75	13	12

After detailed evaluations were made on the flow split options between the Roger Road WRF and Ina Road WRF as discussed in Chapter 4.7, Option (1): 32 mgd for Roger Road WRF and 50 mgd for Ina Road WRF, was selected. The final values of the wastewater characteristics for the selected flow-split option are shown in
Table 4-5.

Table 4-5
Selected Year 2030 Wastewater Characteristics
Based on Complete Mass Balance

Parameter	Units	Roger Road WRF		Ina Road WRF	
		Primary Influent	Primary Effluent	Primary Influent	Primary Effluent
Flow	Mgd	33.2	32.6	52.6	51.4
COD	mg/L	659	443	689	456
BOD_5	mg/L	301	214	324	229
$sBOD_5$	mg/L	121	123	123	126
TSS	mg/L	310	126	358	146
VSS	mg/L	243	104	282	123
TKN	mg/L	47	46	63	61
TP	mg/L	10	10	15	14

The future peaking factors for the flows and concentrations were based upon the historical peaking factors as described in Chapter 3 and are as follows:.

- Monthly Peak Flow (MPF) – 1.1 times average daily flow
- Daily Peak Flow (DPF) – 1.4 times average daily flow
- Hourly Peak Flow (HPF) – 2.0 times average daily flow

4.3 Treatment Strategy Alternatives ("Existing Plan", "Transfer All", "Transfer Some")

4.3.1 Existing Plan

The existing plan is for plants at both Roger Road WRF and Ina Road WRF to continue operating, following the present long-range CIP project schedule to address the capacity and regulatory needs of both Roger Road WRF and Ina Road WRF. As identified in the 2006 Metropolitan Area Facility Plan Update, the current plan is to complete the necessary rehabilitation and process optimization at both plants, incorporate enhanced odor control facilities, transfer all biosolids to Ina Road WRF, via a modified sludge line, develop a centralized biosolids processing facility with a potential for future modification to produce a Class A biosolids, and add an interconnect pipeline between the two plants that can provide a flow transfer from the Roger Road WRF service area to Ina Road WRF via gravity. This plan represents the flow split Option "Existing Plan" as shown in **Table 4-2.**

4.3.2 Transfer Some Wastewater Flows to Ina Road WRF

The transfer some plan is to maintain a facility at the Roger Road WRF to continue to provide effluent to the adjacent Tucson Reclaimed Water Treatment Plant, and direct the remainder of the flows to Ina Road WRF. Based on the economics of building and operating future facilities, it may be desirable to maintain a smaller treatment facility at Roger Road WRF, while directing the majority of the flows to Ina Road WRF. Under this option some of the existing facilities could be modified to treat all or a portion of the flow required for the Tucson Reclaimed Water Treatment Plant, CEP, SAWRSA, and other effluent water owners. All solids, including primary sludge and WAS, along with the remainder of the flow in the service area will be directed to Ina Road WRF. This would allow shutdown of a large portion of the facilities currently located at Roger Road WRF, and optimize operations and maintenance at this facility. This plan represents the flow split Option "Transfer Some" as shown in **Table 4-2**.

4.3.3 Transfer All Wastewater Flows to Ina Road WRF

This plan is to transfer all wastewater flow from the Roger Road WRF service area to Ina Road WRF and the Roger Road WRF would be shutdown. All flows would be directed by gravity flow from the Roger Road WRF to the Ina Road WRF. The two facilities are about 5 miles apart, and the Roger Road WRF is located approximately 75 feet higher in elevation than the Ina Road WRF. The transfer of all flows would be accomplished with a gravity sewer, and a plant expansion and/or process modifications at Ina Road WRF to accommodate the additional flows. The existing rehabilitation projects and potential future processing to Class A biosolids would be incorporated into the plan. Consolidation of treatment facilities would centralize treatment with the goal of optimizing operations and maintenance. Under this plan, the flow required for Tucson Water Reclaimed Water System, CEP, SAWRSA, Pima County and other reclaimed water owners are identified and addressed and would involve transfer of treated effluent from Ina Road WRF to the Roger Road site. This plan represents the flow split Option "Transfer All" as shown in **Table 4-2**.

4.4 Reclaimed Water Program

Effluent water will be made available to Tucson Water for their reclaimed water service system at the future Roger Road WRF, Ina Road WRF and Randolph Park WRF. The plan allows for approximately 30 mgd at Roger Road WRF and approximately 20 mgd at Ina Road WRF based on allocated effluent water shares in the year 2030. The 3-mgd effluent from Randolph Park WRF is also available for reclaimed water use. Up to 7 mgd could be made available for discharge into the Santa Cruz River at the Roger Road WRF site. This requires that up to at least 5 mgd (existing plan) and as much as 37 mgd (transfer all plan) of the Ina Road WRF effluent be transferred to the Roger Road WRF site via a pumping station/force main system. The balance of the Ina Road WRF effluent beyond reuse needs provided directly from the Ina Road WRF will be discharged into the Santa Cruz River. Reclaimed water system alternatives are presented in **Appendix F.**

Based on the ADEQ regulatory requirements for future wastewater treatment, effluent from the Roger Road WRF and Ina Road WRF will be classified as either Class B+, or Class A+. If the effluent is Class A+, Tucson Water would be able to decommission its pressure filter treatment system at Roger Road WRF and feed effluent directly into the reclaimed water distribution system after chlorination to meet residual requirements. Tucson Water will construct the necessary filtration system (as required for Class B+), pump station, reservoir, pipeline and chlorine feed facility at Ina Road WRF to provide its reclaimed water needs.

4.5 Effluent Disinfection

Arizona Administrative Code (AAC) Title 18, Ch. 9 includes disinfection requirements for all sewage treatment facilities, including expansions of existing sewage treatment facilities that treat wastewater containing sewage. Article 2. Aquifer Protection Permits – Individual Permits, Part B. BADCT for Sewage Treatment Facilities, defines the requirements for Pathogen Removal (sic: Disinfection) as follows:

> *i. No fecal coliform organisms or no E. coli bacteria are detected in four of the wastewater samples collected during the week, based on a sampling frequency of seven daily samples per week;*
> *ii. The single sample maximum concentration of fecal coliform organisms in a wastewater sample is not greater than 23 cfu/100 ml or the single sample maximum concentration of E coli is not greater than 15 cfu/100 ml.*

During the master plan investigations it was concluded that the cost effective disinfection process that would meet the BADCT requirements was inconclusive. Disinfection processes likely to meet the "demonstrated" disinfection requirements of the ACC include:

- Enhanced Chlorination
- Enhanced Chlorination preceded by effluent filtration
- UV Irradiation preceded by effluent filtration

Studies to determine if enhanced chlorination disinfection processes are capable of achieving the AAC disinfection requirements are included of this planning effort. The studies have provided favorable results but further review and regulatory approval is recommended before finalizing the conclusion of the study. Meeting Notes and the study results of the Enhanced Chlorination/De-Chlorination Evaluation are included in **Appendix G**. However, in an effort to make the planning process as complete as possible, particularly for the PCRWRD CIP, the most costly (capital and O&M) process, UV radiation preceded by effluent filtration is included for cost purposes.

4.6 BNR Process Alternatives

4.6.1 Universe of BNR Process Alternatives

The Pima County Wastewater Regional Optimization Plan Study addressed the need to upgrade existing wastewater treatment facilities at the Roger Road WRF, Ina Road WRF and Randolph Park WRF for increased capacity and more stringent effluent requirements in terms of suspended solids, nitrogen, phosphorus, and disinfection. A Master Plan for the design year 2030 must consider such effluent requirements, water reuse opportunities, and expanded facilities to treat the requirements. Although the existing permit does not require nitrogen or phosphorus removal, future discharge permits for the Roger Road WRF and Ina Road WRF require each facility to address ammonia toxicity. The current trend of regulatory requirements in the region indicates that more stringent phosphorus and total nitrogen removal requirements may be imposed in the future. The treatment process alternatives were developed to meet the goal of future effluent limits for nutrients with the following criteria:

- Ammonia nitrogen concentration of 2 mg/L or less
- Total nitrogen concentration of 8 mg/L or less
- Total phosphorus concentration of 1 mg/L or less

In addition to the treatment goals as stated above, a high quality effluent with low suspended solids is required for reuse of the effluent.

A number of biological treatment processes are currently available for nitrogen and phosphorus removal to meet the stated effluent goal. While chemical phosphorus (Chem-P) removal is a very effective method for removing phosphorus, particularly when the extremely low effluent phosphorus limit, such as 0.5 mg/L or less, is required, biological phosphorus (Bio-P) removal methods are considered preferable because they generate less sludge and do not require chemical storage and chemical feed system and do not incur additional chemical costs. In many cases biological phosphorus removal can be added to a nitrogen removal process with a minimum investment of additional tankage and provides the additional benefit of improving sludge settleability. Additionally, due to the size and location of the process units, it is considered prudent that the Bio-P removal process needs be addressed in the beginning of the project rather than as an add-on at some future date. Chem-P removal process (if required to meet more stringent effluent P limits than can be attained by Bio-P alone) could be easily added in the future.

From an overview of the universe of BNR processes (performed by the Consultant Team, the Peer Review Group and PCRWRD), the nitrogen removal processes that are considered best suited for further

consideration for the Pima County Regional Optimization Master Plan are listed below. An anaerobic process could be combined with these processes to achieve Bio-P removal as well.

- Suspended Growth System
  - Modified Ludzack-Ettinger (MLE)
  - Bardenpho
  - Step feed activated sludge system for nitrification-denitrification (NdeN)

- Attached Growth System
  - Biological Aerated Filters (BAF) and Denitrifying Sand Filters
  - Moving bed (MBBRs)
  - Trickling Filter (Biotowers)

- Integrated System
  - Integrated fixed film activated sludge (IFAS)
  - Membrane in activated sludge system, membrane bioreactor (MBR)

4.6.2 Initial Screening of BNR Process Alternatives

The available BNR processes were reviewed for their potential applicability and compatibility with the existing facilities, several BNR processes were initially screened for evaluation. The initially screened processes and descriptions are as follows:

- *Modified Ludzack-Ettinger (MLE)* – Suspended growth activated sludge with an anoxic zone followed by an aeration zone and secondary clarification. Mixed liquor from the aerobic zone is recycled upstream to the anoxic zone at a recycle flow rate of 3-4 times the influent flow rate. An anaerobic zone can be added to the front of the process if phosphorus removal is also required.

- *Bardenpho* – Similar to the MLE process but a second set of anoxic and aerobic zones is added after the first aerobic zone to provide additional nitrogen removal.

- *Step-Feed Nitrification and Denitrification (NdeN)* – This process has been used in many places in the U.S. to retrofit existing step feed activated sludge systems for biological nitrogen removal. The designs typically have 4 passes with the influent feed distributed at different ratios to an anoxic zone in each pass, followed by an aerobic nitrifying zone. Biological phosphorus removal is difficult to incorporate into each basin due to the complexity of the piping and tank arrangements.

- *Integrated Fixed-film Activated Sludge (IFAS)* – This process is a combination of fixed film and suspended growth biological treatment. The process can be envisioned as a standard activated sludge process that adds attached growth to the aeration tank to increase the amount of active biomass. The aeration tanks are partially filled with suspended inert media that serve as a surface for the attached growth. The aeration tank incorporates screens or sieves to retain the media in the aeration tanks. The aeration tank is followed by a secondary clarifier for suspended solids removal. A portion of the suspended solids are returned to the aeration tank.

- *Membranes (MBR)* – This is an activated sludge process in which microfiltration through a synthetic membrane is used in place of secondary clarification. The microfiltration occurs in a separate, final stage activated sludge tank. Essentially all suspended solids and bacteria are retained in the aeration tank due to the small pore size of the separation membrane. The membrane provides both solids removal and filtration. Sludge is directly wasted from the aeration tank to maintain the desired Solids Retention Time. With membrane separation a much higher mixed liquor suspended solids (MLSS) concentration (7-15,000 mg/L) can be used in the activated sludge process, reducing tank volume requirements. The MLSS concentration that can be achieved is limited by the oxygen transfer capacity of the aeration system and the fouling properties of the membranes.

- *Biological Aerated Filters (BAF)* – BAFs are upflow attached growth fixed film processes. Normal flow is upward through a packed bed of media. For BOD removal and nitrification, air is added concurrent with the wastewater flow to supply oxygen to the biomass. The media serves as both an attachment surface for the biomass and as a filter media. As a result these process doe not require clarifiers. Attached biomass is wasted from the filters when the filters are backwashed. The media size is in the range of 2 to 4 mm and oxygen for the biological process is supplied through an air header piping system below the media aerobic bio-treatment zones. The Biostyr and Biofor processes are the two most prominent BAF processes. The Biostyr process contains a light, buoyant polystyrene bead material and the Biofor process contains a dense expanded clay media. These processes have been used for BOD removal, nitrification and denitrification. For denitrification, an anoxic zone if provided by eliminating the air except for backwashing.

- *Activated Sludge/ Nitrifying Trickling Filter (AS/NTF) with denitrification filters at Roger Road WRF* – This process uses a mixture of attached growth and suspended growth process, and is intended to take advantage of some of the existing infrastructure at the Roger Road WRF. This is applicable only to the Roger Road WRF with the existing biotowers to be used as trickling filters. In the first step, a low sludge retention time (SRT) suspended growth activated sludge process is used for BOD removal and biological phosphorus removal. The process has an anaerobic zone followed an aerobic zone and secondary clarification. The effluent from this step is nitrified in trickling filters, with methanol added to the trickling filter effluent prior to denitrification and filtration on a deep bed denitrifying filter. Modification of this process includes adding metal salts, such as alum or ferric chloride to the primary treatment step for phosphorus precipitation and additional BOD and TSS removal.

- *Biotowers/Nitrifying Activated Sludge (BT/NAS) with denitrification filters at Roger Road WRF* – This is applicable only to the Roger Road WRF utilizing the existing biotowers. The existing biotowers are essentially deep packed bed gravity fed trickling filters. The wastewater is first treated in the biotowers, with the biotowers effluent treated next in an aerobic nitrifying activated sludge process before secondary clarification. Alum or ferric chloride is added before the secondary clarifier for phosphorus removal. Nitrogen and additional TSS removal from the secondary effluent is accomplished in deep bed denitrifying filters with methanol addition.

- *Moving Bed Bioreactor (MBBR)* – This process is an attached growth only process that uses media similar to that used in the IFAS process as the attachment media. The aeration tanks tend to be

deep to maximize oxygen transfers and are equipped with sieves or screens to retain the media. Wasting of biomass occurs by sloughing of the biomass from the media, similar to what occurs with a trickling filter. Clarifiers may or may not be needed based upon the effluent limits and the amount of sludge production.

Each of these processes needs to be combined with anaerobic process for Bio-P removal or chemical addition for Chem-P removal.

4.6.3 BNR Processes Selected for Detailed Evaluation

The initially screened processes were analyzed further using pass/fail criteria that were jointly selected by the Consultant Team, the Peer Review Group and PCRWRD. A matrix of process versus pass/fail criteria was used for this initial screening process. The pass/fail criteria applied to the screening are:

1. Ability to achieve the effluent goal
2. Adaptability to remove emerging contaminants of concern
3. Is high dose of methanol required?
4. Can use existing Bio-towers at Roger Road WRF?
5. Is it flexible for Bio-P removal?
6. Are capital costs in the range of Bardenpho? (Initial comparative cost analysis showed the lowest life cycle cost with Bardenpho)
7. Can use existing tankage?
8. Can achieve turbidity less than 2 NTU?
9. Can be applied with high purity oxygen (HPO)? (Ina Road WRF has a HPO system)
10. Are O&M costs in the range of Bardenpho? (Initial comparative cost analysis showed the lowest life cycle cost with Bardenpho)
11. Has the process been used in biological nitrogen removal in the plant size of larger than 20 mgd for more than three years?

Criteria 2, 4, 8 and 9 were determined to be secondary in consideration for purposes of BNR process selection and the remaining criteria were determined to be primary considerations.

Cost estimates for the alternatives were made on a comparative cost basis and common costs to all processes such as site preparation, yard piping, and various architectural structures, etc., were not included. Present worth analysis was based on 20 years with 8 percent interest.

A matrix analysis was made based on the pass/fail criteria and comparative cost estimates with the input from Consultant Team, the Peer Review Group and PCRWRD. The results with majority answers from the review groups are summarized in **Table 4-6** and **Table 4-7** for Roger Road WRF and Ina Road WRF, respectively.

Table 4-6
Roger Road WRF Process Selection Matrix Analysis – Majority Answers

Criteria	MLE	Bardenpho	AS/NTF	BT/NAS	Step NdeN	Biostyr/ Biofor	IFAS	MBR	BT/NdeN	MBBR
Primary Considerations										
1	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	N	N	Y	Y	N	Y	N	N	Y	Y
5	Y	Y	Y	N	Y/N	N	Y	Y	N	Y/N
6	N	Y	Y	Y	Y	N	Y	N	DK	DK
7	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
10	N	Y	N	N	Y	N	Y	N	N	N
11	Y	Y	DK	DK	Y	Y	N	N	DK	DK
Secondary Considerations										
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4	N	N	Y	Y	N	N	N	N	Y	Y/N
8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: Y = Yes; N = No; DK = Do not know; NA = Not applicable

As shown in **Table 4-7**, AS/NTF, BT/NAS and BT/NdeN are not applicable to the Ina Road WRF because treatment with existing trickling filters is available only at the Roger Road WRF.

Table 4-7
Ina Road WRF Process Selection Matrix Analysis – Majority Answers

Criteria	MLE	Bardenpho	AS/NTF	BT/NAS	Step NdeN	Biostyr/ Biofor	IFAS	MBR	BT/NdeN	MBBR
Primary Considerations										
1	N	Y	NA	NA	Y	Y	Y	Y	NA	Y
3	N	N	NA	NA	N	Y	N	N	NA	Y
5	Y	Y	NA	NA	Y	N	Y	Y	NA	Y/N
6	N	Y	NA	NA	Y	N	Y	N	NA	DK
7	Y	Y	NA	NA	Y	N	Y	Y	NA	Y
10	N	Y	NA	NA	Y	N	Y	N	NA	N

Criteria	MLE	Bardenpho	AS/NTF	BT/NAS	Step NdeN	Biostyr/ Biofor	IFAS	MBR	BT/NdeN	MBBR
11	Y	Y	NA	NA	Y	Y	N	N	NA	DK
Secondary Considerations										
2	Y	Y	NA	NA	Y	Y	Y	Y	NA	Y
4	NA	NA	NA	NA	NA	NA	N	NA	NA	NA
8	Y	Y	NA	NA	Y	Y	Y	Y	NA	Y
9	N	N	NA	NA	N	N	NA	NN	NA	N

Notes: Y = Yes; N = No; DK = Do not know; NA = Not applicable; NN = Not usable

Based on the comparative cost estimates and matrix evaluations using the pass/fail criteria stated above, the failed processes that are not to be considered for further evaluation and the reasons are as follows:

- Step Feed NdeN
  - Difficulty in incorporating the Bio-P removal
  - May require high dose of methanol
- Biostyr/Biofor
  - Difficulty in incorporating the Bio-P removal
  - High capital and operation and maintenance costs
  - Can not use existing tankage

- AS/NTF
  - Difficulty in incorporation of Bio-P removal
  - High capital operation and maintenance costs
  - No track record of long period, large plant operation (>3 years and >20 mgd)
  - Only applicable to Roger Road WRF

- MBR
  - Very high capital operation and maintenance costs
  - No track record of long period, large plant operation (>3 years and >20 mgd)
  - May require high dose of methanol
  - Unknown life expectancy of membranes

- MBBR
  - High capital operation and maintenance costs
  - No track record of long period, large plant operation (>3 years and >20 mgd)
  - No high temperature (20-33°C) wastewater experiences

Among the remaining processes, the Bardenpho process received the highest ranking followed by IFAS and MLE. The BT/NAS process has essentially similar advantages and disadvantages to those of AS/NTF. However, it was determined that there was a merit to include an alternative utilizing the existing biotowers for Roger Road WRF. Therefore the following four alternatives were selected for detailed evaluation.

- Bardenpho
- MLE
- IFAS
- BT/NAS for Roger Road WRF and Bardenpho for Ina Road WRF

4.7 Alternative Evaluation Criteria

4.7.1 Technical Criteria

The purpose of alternative evaluation is two fold: to select the most viable process applicable to both treatment plants; and then to select the most favorable flow split options between the plants. Technical criteria used in the analysis to determine the most viable alternative were:

- Operability
- Proven process
- Life cycle cost
- Site compatibility
- Resource consumption
- Ease of operation and maintenance during construction

4.7.2 Financial Criteria

Financial criteria used in the evaluation of alternatives included:

- Capital costs
- Operation and maintenance (O&M) costs
- Present worth of capital and O&M costs

4.7.3 Non-Economic Factor Criteria

Non-economic Factor Criteria were also used in the final evaluation to determine optimal flow split between the Roger Road WRF and the Ina Road WRF. These criteria and the evaluation are described in detail in Chapter 4.8.3.

4.8 Evaluation of Alternatives

4.8.1 Technical Evaluation

Technical aspects pertinent to each alternative are described below. Each of the processes described below is a nitrogen removal process and is typically preceded by an anaerobic process for Bio-P removal.

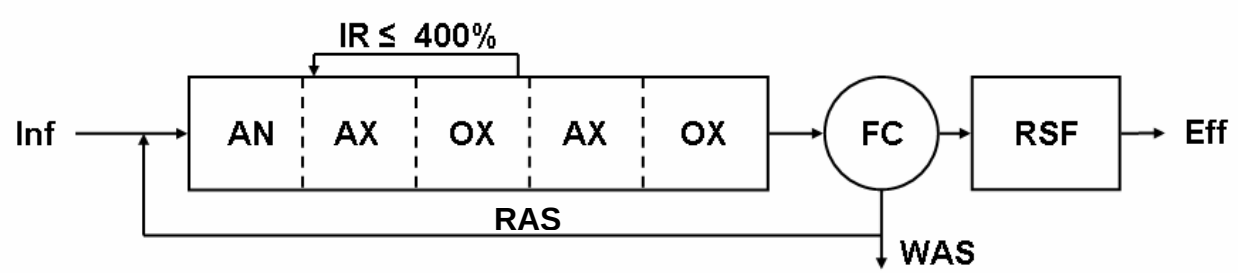
- *Bardenpho* – This process configuration consists of a series of four anoxic and aerobic zones with internal recycle of the mixed liquor from the last compartment of the first aerobic zone to the first anoxic zone at a rate of up to 400 percent of the average influent flow rate. This process is intended

to remove more nitrogen than the two-stage process such as MLE. Anaerobic zones for Bio-P process step are normally located ahead of the nitrogen removal process. Denitrification filters with methanol addition would not be required to achieve effluent limits for ammonia and nitrogen.

This process has at least 30 years of history in application and proven technology with a track record of small to plants > 100 mgd and wide range of influent characteristics while meeting effluent criteria more stringent than required for PCRWRD.

A typical process diagram for the Bardenpho process is shown on **Figure 4-1**.

Figure 4-1
Typical 5-Stage Bardenpho Process Diagram

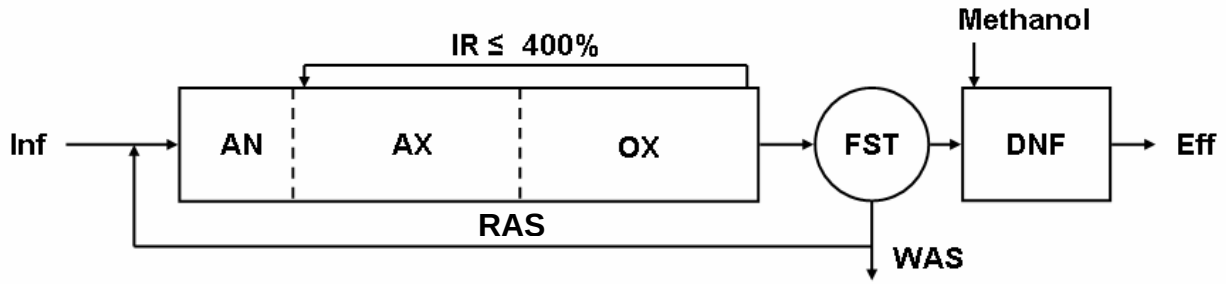


Inf – Influent
AX – Anoxic Chamber
RSF – Rapid Sand Filter
Eff – Effluent
AN – Anaerobic Chamber
IR – Internal Recycle
RAS – Return Activated Sludge
WAS – Waste Activated Sludge
OX – Oxic Chamber
FC – Final Clarifier

- *MLE* – This process consists of anoxic and aerobic zones with internal recycle of the mixed liquor from the aerobic zone to the anoxic zone at a rate up to 400% of the influent flow. The maximum percentage removal of nitrogen is less than the Bardenpho process. Denitrification filters with methanol addition would be required to achieve effluent limits for ammonia and nitrogen. Anaerobic zones for Bio-P process step are located ahead of the nitrogen removal step.

  A typical process diagram for the MLE process is shown on **Table 4-2.**

Figure 4-2
Typical MLE Process Diagram



Inf – Influent
AX – Anoxic Chamber
FST – Final Settling Tank
Eff – Effluent
AN – Anaerobic Chamber
IR – Internal Recycle
DNF – De-Nit Filter
WAS – Waste Activated Sludge
OX – Oxic Chamber
FC – Final Clarifier
RAS – Return Activated Sludge

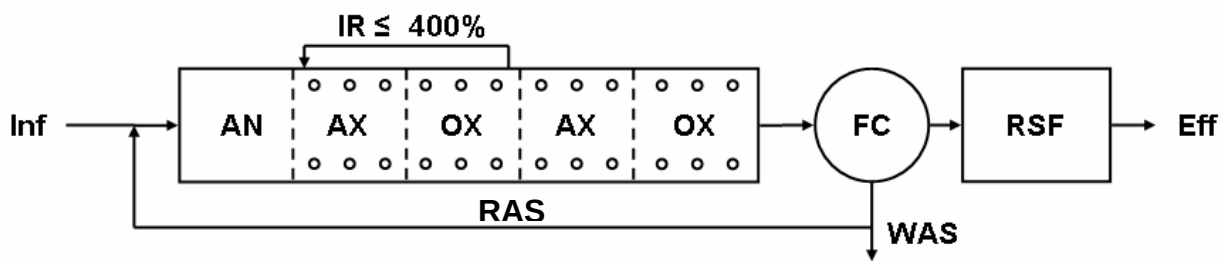
- *IFAS* – This process is a combination of fixed film and suspended growth biological treatment. The aeration tank configuration employs the same concept of MLE process with anoxic and anaerobic zones. Aeration tanks containing porous plastic media provide high surface area for attached biological growth. The media is separated from the aeration tank effluent with screens installed and retained in the aeration tanks. The attached growth enables the system to maintain an equivalent MLSS concentration of 4000-6000 mg/L without a high solids load to the clarifiers. Anaerobic zones for Bio-P process step are located ahead of the nitrogen removal process.

  This process is a relatively new, emerging technology and a few small scale applications with limited operational experience are available.

  Advantages of this process include a smaller foot print requirement to implement the process, increasing the capacity of the existing facilities by adding the media, good biomass control and high solids inventory in the aeration tanks. The attached growth nitrifiers are also less sensitive to potential washout then suspended growth. Disadvantages of this process include the cost of media, higher energy requirement for the aeration tanks with media, and no operational experience at high wastewater temperatures.

A typical process diagram for the IFAS process is shown on **Figure 4-3.**

Figure 4-3
Typical IFAS Process Diagram



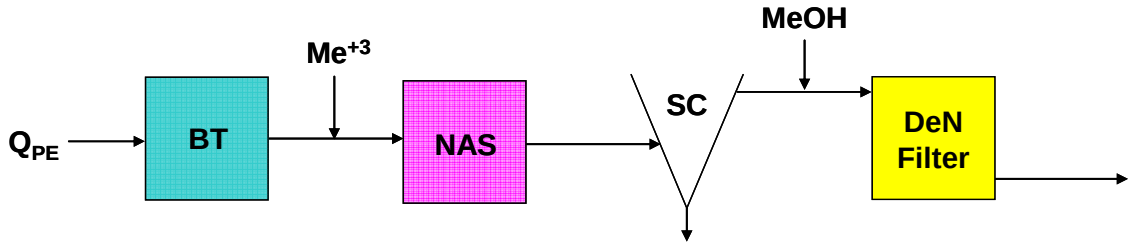
Inf – Influent
AX – Anoxic Chamber
RSF – Rapid Sand Filter
Eff – Effluent
o – Fixed Film
AN – Anaerobic Chamber
IR – Internal Recycle
RAS – Return Activated Sludge
WAS – Waste Activated Sludge
OX – Oxic Chamber
FC – Final Clarifier

- *BT/NAS for Roger Road WRF and Bardenpho for Ina Road WRF* – This process is intended to utilize the existing treatment facility and retrofit the required facilities treatment facilities at Roger Road WRF.

  The advantage of this process would be maximum utilization of existing facilities. The disadvantages would be difficulties of retrofitting the new process with the existing facilities, chemical requirement for phosphorus removal, requirement of denitrification filters with methanol addition and potentially high costs. In addition there would be no commonality of the processes at the two treatment plants which could require more operational training and a higher inventory of spare part.

  A typical process diagram for the BT/NAS process is shown on **Figure 4-4**.

Figure 4-4
Typical BT/NAS Process Diagram



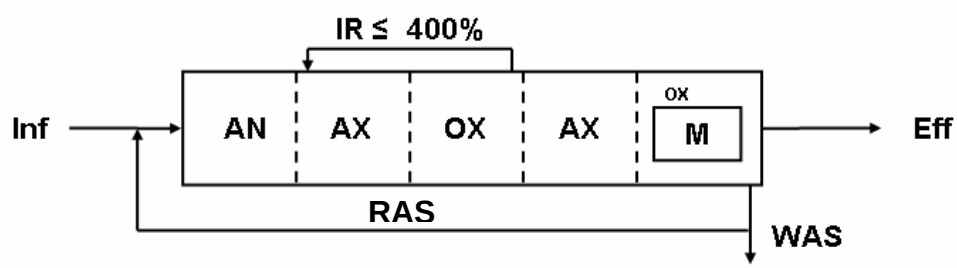
BT – Biotower
MeOH – Methanol
NAS – Nitrifying Activated Sludge
Me^{+3} – Metallic ion, Al or Fe
SC = Secondary Clarification

- *MBR* – This process combines an ultrafiltration membrane system for solids separation with an activated sludge reactor eliminating the need for separate clarification. Wastewater is screened before entering the biological treatment tank where aeration within this aerobic zone provides the oxygen required for biological respiration and maintains solids in suspension. MLSS in the bioreactor are maintained at high levels (1% - 3%) allowing high levels of organic loading to the reactor. All solids are retained within the reactor, thus requiring no return activated sludge system. The process runs at a high solids retention time and nitrifiers are easily maintained within the system. The process is capable of achieving low levels of effluent BOD, suspended solids, nitrogen, and phosphorus.

  A major advantage of this process is a smaller footprint and increased capacity for existing aeration tanks. The disadvantages would be high energy demand, high capital cost, and high costs associated with membrane maintenance. In addition there would be no commonality of the processes at the two treatment plants which could require more operational training and a higher inventory of spare parts.

  A typical process diagram for the MBR process is shown on **Figure 4-5**.

Figure 4-5
Typical MBR Process Diagram



Inf – Influent
AX – Anoxic Chamber
M – Membrane Bio-Reactor
WAS – Waste Activated Sludge
AN – Anaerobic Chamber
IR – Internal Recycle
RAS – Return Activated Sludge
OX – Oxic Chamber
Eff – Effluent

A matrix analysis was made with inputs from Consultant Team, the Peer Review Group and PCRWRD based on the technical evaluation parameters as stated above and the comparative cost estimates summarized in **Table 4-9**. The system evaluation matrix with evaluation criteria and completed scores for various flow split options are shown in **Table 4-8.**

Table 4-8
Summary of Technical and Financial Evaluation of Alternatives for Roger Road WRF

Criteria	Bardenpho RR/IR	MLE RR/IR	IFAS RR/IR	BT/NAS RR/IR	MBR RR/IR
Operability	0 / 0	0 / 0	0 / 0	0 / NA	
Proven process	+ / +	+ / +	0 / 0	0 / NA	
Life cycle costs	+ / +	- / -	- / -	- / NA	
Site compatibility	+ / +	- / -	+ / +	+ / NA	
Resource consumption	+ / +	- / -	- / -	- / NA	
Ease of maintaining treatment capacity during construction	+ / +	+ / +	+ / +	+ / NA	
Recommended process	Yes	No	No	No	

Notes: 0 means neutral; + means positive; – means negative;
NA means not applicable; RR = Roger Road WRF; IR = Ina Road WRF

Based on the results the Bardenpho process was determined to be the most viable technology for both plants for the given raw wastewater characteristics and effluent requirements.

4.8.2 Financial Evaluation

More detailed comparative cost estimates were made for the entire treatment facilities for Roger Road WRF and Ina Road WRF including interconnect pipelines, primary clarifiers, aeration tanks, final clarifiers, disinfection facility and odor control system. The costs were estimated in two sets: first, cost estimates were made for the four selected alternatives for the purpose of selection of the most viable alternative; second, the cost estimates were made for the Bardenpho process with the three flow split options for the purpose of selecting the most cost effective flow split between Roger Road WRF and Ina Road WRF. For each case capital and O&M costs were estimated and present worth (PW) costs were calculated based on a project period of 20 years at an interest rate of 8 percent. The major items of the capital costs included:

- Plant interconnect wastewater transmission pipelines
- Demolition and removal of existing obsolete facilities
- Construction of new facilities
- Reclaimed water return transmission lines
- Tucson Water booster pump station
- Tucson Water reservoir

The operation and maintenance (O&M) costs included:

- Labor
- Methanol
- Polymer for sludge thickening and dewatering
- Alum for phosphorus removal
- Power for wastewater treatment
- Power for reuse water pumping
- Interconnect line, pumps and mechanical maintenance

Comparative costs did not include items such as site work, paving, architecture, fencing, irrigation, administration, laboratory, and other elements common to all alternatives.

Capital and O& M costs were estimated using a computerized data base of costs for similar components at many other wastewater treatment plants (Water Cost model), recent experience of the consultant team with construction bids for similar facilities, and published (Means) data based on limited quantity take-offs and vendor quotes. Capital costs for major structures and facilities used in the comparative cost estimates were:

- New screening facility - $60,000/mgd
- New grit facility - $50,000/mgd
- Aeration Tank - $14/cubic feet (cf) of aeration tank volume
- Primary and secondary clarifiers - $350/square feet (sf) of surface area
- Denitrification filters - $3,000/sf surface area
- Rapid sand filters - $2,300/sf surface area
- In plant pump station - $60, 000/mgd
- UV disinfection facilities - $60,000/mgd
- Plant interconnect - $11/inch-foot
- IFAS media - $20/cf of media volume

Comparative costs for major O&M costs were:

- Power cost – 8.7 cents/kilowatthour (kWh)
- Methanol - $1.0/gallon
- Alum - $1.0/gallon
- Polymer - $2/pound
- Labor - $35/hour

Comparative capital costs and present worth (PW) costs are summarized in **Table 4-9**.

Table 4-9
Capital and Present Worth (PW) Costs of Alternatives (1) (2)

Process	Flow Split RR/IR = 32/50		Flow Split RR/IR = 20/62	
	PW	Capital	PW	Capital
Bardenpho at RR and IR	$431	$287	$464	$319
IFAS at RR and IR	$439	$295	-	-
MLE at RR and IR	$446	$300	-	-
BT/NAS at RR and Bardenpho at IR	-	-	$479	$327

(1) Physical limitations of existing trickling filters at Roger Road WRF limit the BT/NAS process application to the 20/62 mgd flow split.
(2) The costs are shown in million dollars.

The Bardenpho process offers the lowest cost treatment approach and is the most widely used process, Therefore, the costs for only the Bardenpho process were prepared to compare the relative costs of the three flow split alternatives.

The Roger Road WRF is aging and is difficult to retrofit with new facilities that are capable of meeting the effluent goals, while meeting all environmental requirements and odor control. The Roger Road WRF site has not sufficient available space to accommodate all new treatment facilities on the existing plant site. Therefore a new treatment plant on the available space referred to as the new Roger Road WRF option was considered as an alternative to the modification/expansion of the existing plant for Roger Road WRF. Major benefits of a new plant include:

- Eliminates risks associated with costs and schedule for rehabilitation
- Can be more flexible, reliable and operable
- Better integrates with reclaimed water system
- Provides least risk for regulatory non-compliance
- Maintains existing eco-system in Santa Cruz River
- Frees up the existing plant property for economic development

The results of the cost estimates for all options, including the new water reclamation campus (WRC) option adjacent to the existing operating facility are summarized in **Table 4-10.**

Table 4-10
Present Worth (PW) Costs for Bardenpho Process with Three Flow Split Options(1)

Flow Split	Capital Cost	PW Cost
RR WRF=32 mgd IR=50 mgd	$287	$431
RR WRF=20 mgd IR=62 mgd	$319	$464
RR WRF=0 mgd IR=82 mgd	$375	$514
New WRC=32 mgd IR=50 mgd	$320	$457
New WRC=20 mgd IR=62 mgd	$340	$480

(1) The costs are shown in million dollars.

The treatment of 32 mgd at Roger Road WRF and 50 mgd at Ina Road WRF is the lowest cost flow split alternative.

The comparative costs in **Table 4-10** for the rehabilitation of Roger Road WRF and the new Roger Road WRF options were based on costs without consideration of the potential costs of the risks inherent in rehabilitating the older Roger Road WRF. Exclusive of these risk-related costs, it would appear that there is a cost savings with the rehab option. However, there are extraordinary risks associated with the Roger Road WRF rehabilitation option that would not be found in the new Roger Road WRF option. The potential cost impacts of these risks are discussed in the following paragraphs.

Schedule – It will take longer to construct the rehabilitation project than to construct a new Roger Road WRF due to the added time needed to phase pieces of the construction to keep the existing plant in operation. There is also the risk of additional time associated with encountering unexpected conditions within the existing plant (piping in unexpected locations, unanticipated utility conflicts, poor underground structural conditions that take time to remedy, etc). There is the additional risk that it may take longer to gain public acceptance of the rehabilitation option than for the new Roger Road WRF option because of the history of odor problems and generally poor public perception of the existing Roger Road WRF. There would be added costs resulting from inflation and added field overhead if these risks materialize. In addition to the inflation, there has been extreme volatility and large cost increases for steel, concrete and copper experienced in the last year. Concrete costs are reported to have increased 15-18 percent from July 2005 to July 2006. Steel bar used to reinforce concrete is reported to have increased at least 50 percent. The net effect on construction costs has been reported to be an increase of 30 percent from July 2005 to July 2006. It is speculative whether or not these increases will continue but if they do, substantial additional costs would be incurred from schedule delays.

If the regulatory deadlines are missed because of delays, a fine for permit violations would likely result. Under Federal law, fines up to $35,000 per day can be imposed in Pima County for each such violation. There is also the potential that a building moratorium would be imposed until the permit violations cease creating added schedule-related costs. The costs and community impacts of such a moratorium would be enormous.

Constructability – Construction within the Roger Road WRF will be very difficult. Claims for changed conditions could be substantial. Existing "as-built" plans in older facilities are never complete or totally accurate. It is not possible to be knowledgeable about the condition of underground structures or the location of underground piping and utilities. These changed conditions could increase the cost of the rehab option.

System Operability – Once the plant is complete, owing to the fact that substantial portions of the plant retain older mechanical equipment and components, the resulting plant will be a patchwork of old and new facilities will cause the rehabilitation plant to be more cumbersome to operate than a new Roger Road WRF. This will require added operating/maintenance staff.

System Reliability – The rehab option which results in a plant that will be a mixture of old and new mechanical equipment that will be inherently less reliable than a new Roger Road WRF. There is a greater risk that a failure of older equipment could cause a violation of the discharge permit. There is a potential liability of $35,000 per day for each such violation.

Environmental Impacts – The rehab option will result in heavy construction occurring in the midst of an operating treatment plant. This increases the chances that a construction activity may disrupt the treatment process causing a violation of the discharge permit. There is a potential liability of $35,000 per day for each such violation. In the event that the disruption causes a severe failure of the treatment process, there could be substantial damage to the downstream environment and health risks with an associated liability.

The risk-related costs for the rehab option at the Roger Road WRF are estimated to be $50,000,000-$80,000,000 exclusive of the cost of a potential building moratorium. When the risk-related costs are considered, the cost difference between the rehabilitation and a new Roger Road WRF options for the Roger Road WRF shown in the above table disappear.

4.8.3 Non-Economic Factor Criteria

A set of non-economic factor criteria and weighting factors were used for a system analysis to determine the most viable and cost effective flow split configuration between the two plants. The evaluation criteria and weighting factors were selected with the input from the Consultant Team, the Peer Review Group and PCRWRD. The cost estimates as shown in the above table were used for the cost criterion. The selected non-economic factor criteria are included in the list shown below:

1. Cost (exclusive of risk-related costs involved in the rehab Roger Road WRF option)
2. Schedule
3. Constructability
4. Flexibility

5. System Reliability
6. System Operability
7. Environmental Impacts
8. Water/Waster System Optimization
9. Public Acceptance
10. Potential for Cost Sharing
11. Effect on Financing

The system evaluation matrix with evaluation parameters, weighting factors and total scores agreed upon by the Consultant Team, the Peer Review Group and PCRWRD in a workshop, are shown in **Table 4-11.**

Table 4-11
Non-Economic Factor Criteria Evaluation Matrix with Complete Scores
(Rating scale of 1-5 with a rating of 5 being most favorable)

Criteria	Weighting	Un-Weighted Score					Weighted Score				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
1	5	5	4	2	4	3	50	40	20	40	30
2	5	3	3	5	5	5	15	15	25	25	25
3	3	2	2	4	5	4	6	6	12	15	12
4	4	3	3	5	5	5	12	12	20	20	20
5	4	4	4	5	5	5	16	16	20	20	20
6	4	3	3	4	4	4	12	12	16	16	16
7	4	3	3	4	4	4	12	12	16	16	16
8	5	5	4	3	5	4	25	20	15	25	20
9	5	1	2	2	3	2	5	10	10	15	10
10	3	5	4	3	5	4	15	12	9	15	12
11	3	5	4	2	4	3	15	12	6	12	9
Total		39	36	39	49	43	183	167	169	219	190

This evaluation demonstrated that the flow split option of 32 mgd with a new Roger Roads WRF design for Roger Road WRF and 50 mgd with rehabilitation of existing facilities for Ina Road WRF employing the Bardenpho process provides the best option for the Regional Optimization Master Plan. The new Roger Road WRF option has a higher rating than the rehabilitation of Roger Road WRF options even without consideration of the risk-related costs involved in the rehab option. The new Roger Road WRF design option for Roger Road WRF was further reviewed to determine if there would be savings or other benefits of eliminating primary treatment in the new Roger Road WRF. Since all sludge produced at both plant sites would be processed at the Ina Road WRF, it would simplify operations if the primary treatment is eliminated at Roger Road WRF. Potential benefits of a new Roger Road WRF design without primary treatment include:

- Eliminates construction and operating costs of primary clarifiers at Roger Road WRF
- Eliminates primary sludge pumping to Ina Road WRF and processing it at Ina Road WRF
- Provides a carbon source necessary for Bio-P and nitrogen removal

A disadvantage is increased aeration tank size and aeration power at Ina Road WRF. However, comparative cost estimates concluded that the additional capital cost of larger aeration tanks is offset by the elimination of capital cost for primary clarifiers at Roger Road WRF. Considering the bulk of BOD removal is achieved through anaerobic and anoxic processes for Bio-P and nitrogen removal, the additional aeration power may be somewhat higher than with primary treatment. During start-up of the Ina Road WRF's BNRAS system, primary clarifiers have been bypassed and the new BNRAS plant has been operated with the raw wastewater resulting in an effluent total nitrogen concentration of 3.5 mg/L. This has been accomplished without appreciable additional aeration costs for air from the blower system. The other disadvantage is that without primary treatment, fine influent screening and good grit removal systems are essential to protect operating pumps and equipment. With these considerations, the new facility design without primary treatment is recommended.

4.8.4 Recommendation

As a result of the evaluations of the BNR process alternatives and flow-split options between Roger Road WRF and Ina Road WRF, the following recommendations are made:

- Use Bardenpho process at both plant locations
- Use a flow split of 32 mgd for Roger Road WRF and 50 mgd for Ina Road WRF
- Use the new facility design for Roger Road WRF plant and rehabilitation for the Ina Road WRF facilities
- Implement the new facility design at Roger Road WRF without primary treatment

4.8.5 Preliminary Sizing of Facilities

The facility for Roger Road WRF and Ina Road WRF was sized to adequately treat the future wastewater loads and to consistently meet the future effluent requirements meeting the treatment goals. The facilities were initially sized based on conventional design approach and confirmed by the GPS-X modeling.

The sizing of the aeration tank was based on the raw wastewater without primary treatment for the Roger Road WRF plant and with primary treatment for the Ina Road WRF. The flows and loading conditions used for the initial sizing are shown in
Table 4-5. The aeration tanks were configured with three-anaerobic bio-selector zones, five-anoxic zones, four-aerobic zones, one-anoxic zone and one-aerobic zone in series for a total of 14 zones. A typical internal recycle of 400 percent was used with the recycle flow from zone 12 to zone 4. This configuration utilizes zones 1-3 for anaerobic process for Bio-P removal and the rest of the zones for BOD removal, nitrification and denitrification.

The Roger Road WRF requires a new aeration capacity of 21 million gallons (MG) for the new facility design option without primary clarifiers. The Ina Road plant requires a total aeration tank capacity of 33

MG. The existing BNRAS aeration tanks provide 7.5 MG of capacity. The balance of 25.5 MG for new aeration tanks needs to be constructed.
Due to carbon limitation to achieve both biological phosphorus removal and denitrification, some chemical addition of ferric chloride (or alum) or methanol is required to remove additional N and/or P beyond the denitrification and Bio-P can achieve in order to meet the effluent requirements. Because of advantage of chemically binding of phosphorus in the biosolids treatment processes and reduced phosphorus in the recycle, additional chemical phosphorus removal, after optimal removal of phosphorus by Bio-P, is recommended. The ferric chloride can be added to the stream of aeration tank effluent ahead of the final clarifiers to clean-up the residual phosphorus to meet the future effluent limit for phosphorus.

The new WRC should be designed for a peak hourly flow of two times of the average daily flow. The peak hourly flows are 64 mgd for the new WRC adjacent to the existing Roger Road WRF and 100 mgd for Ina Road WRF.

Table 4-12
Peak Hourly Flows for Year 2030 at NEW WRC and Ina Road WRF

Item	Roger Road WRF New Facility Design without Primary	Ina Road WRF Existing Plus New Addition
Peak Hourly Flow, mgd		
Influent Pump Station	64	100
Grit Removal Facility	64	100
Primary Treatment	64	100
Aeration Tanks	64	100
Final Clarifiers	64	100
Rapid Sand Filters	64	100
UV Disinfection Facility	64	100
Preliminary Aeration Tank (AT) Size, MG		
Existing AT	0	7.5
New AT	21.0	25.5
Total AT	21.0	33.0

Preliminary site plans are shown on **Figure 4-6 and Figure 4-7** for the new WRC and Ina Road WRF, respectively.

Figure 4-6
32-mgd Water Reclamation Campus Preliminary Site Plan

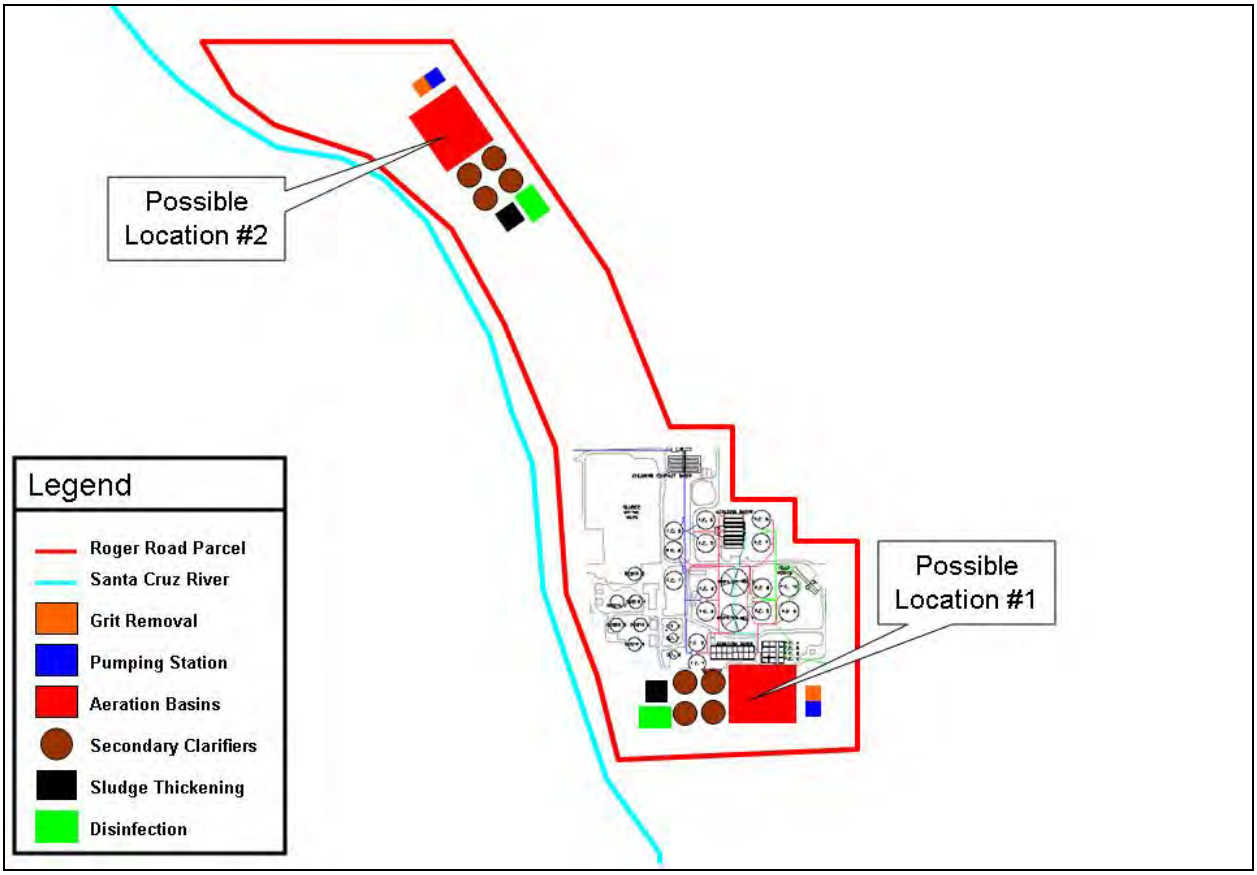
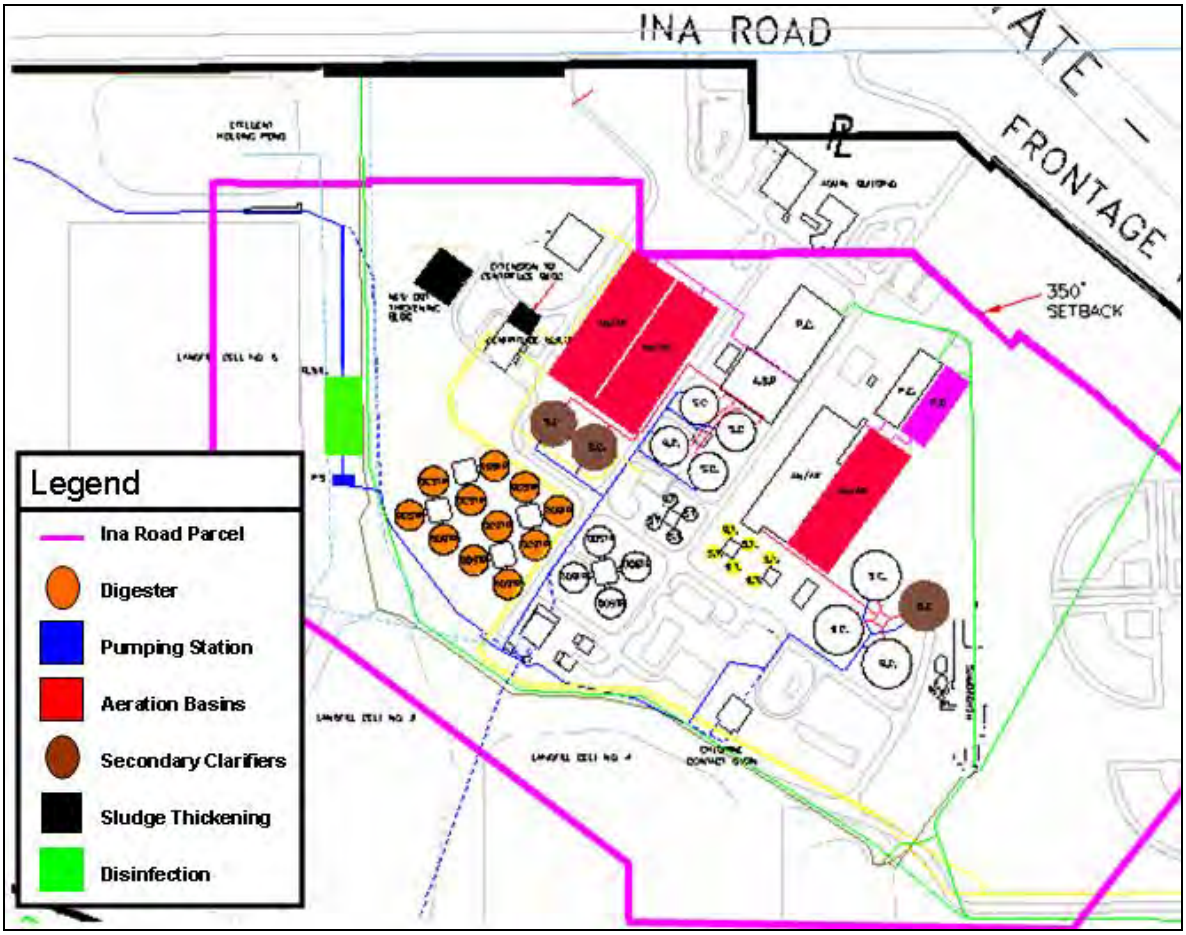


Figure 4-7
New 50-mgd Ina Road WRF Preliminary Site Plan



4.9 Summary

A detailed analysis on the wastewater treatment strategy was made and the results are summarized as follows:

- The year 2030 wastewater flows in the Roger Road WRF and Ina Road WRF service areas were estimated based on the population projections and flow estimates contained in the 2006 Facilities Plan document. The year 2030 total flow within the two service areas is approximately 82 mgd

- Wastewater characteristics were determined based on the information contained in the 2004-2005 GPS-X modeling, future loadings predicated on water conservation, and mass balance with recycle flows from expected future biosolids operation. Because of higher recycle contribution, the nutrient concentrations in the Ina Road WRF influent were substantially higher than the Roger Road WRF influent. Peaking factors were estimated based on operating data.

- Among a number of flow-split options reviewed, three flow-split options were selected for flow split between the treatment plants for further analysis and these include:
  - 32 mgd to Roger Road WRF and 50 mgd to Ina Road WRF
  - 20 mgd to Roger Road WRF and 62 mgd to Ina Road WRF
  - All 82 mgd to Ina Road WRF
- Due to expected stringent effluent requirements and effluent reuse requirements, a high degree of treatment would be required and the effluent goals were set at:
  - Ammonia nitrogen concentration of 2 mg/L or lower
  - Total nitrogen concentration of 8 mg/L or lower
  - Total phosphorus concentration of 1 mg/L or lower
  - Low turbidity

- To meet the effluent goals, a combination of biological nitrogen removal processes and biological phosphorus (Bio-P) removal was found to be the most cost effective.

- A review of BNR processes for nitrogen and phosphorus removal resulted in consideration of nine processes which were screened based on economic and non-economic criteria. As a result, four alternatives were selected for further evaluation:
  - Bardenpho
  - MLE
  - IFAS
  - BT/NAS (for treatment of 20 mgd at Roger Road WRF)

- Four BNR alternatives were further evaluated based on technical and economic criteria. The Bardenpho process was determined as the most reliable and cost effective process for both treatment plants.

- Using on the Bardenpho process, the flow split options were analyzed based of technical and economic criteria. The flow-split option of 32 mgd to Roger Road WRF and 50 mgd to Ina Road WRF was determined as the most reliable and cost effective option.

- The new facility option of replacing the existing Roger Road WRF with a new treatment plant at the Roger Road location was evaluated. Considering the cost uncertainties involved in rehabilitating and modifying the Roger Road WRF and considering non-economic factors, the new WRC option was determined to be the favorable option for the future Roger Road WRF.

Preliminary sizing was made for both treatment plants based on conventional design approach and was confirmed with GPS-X modeling. No chemical use is required for the new WRC, but some amount of alum (or ferric chloride) will be required at the Ina Road WRF when phosphorus removal becomes a requirement at some time in the future. This is due to relatively high nutrient concentration in the Ina Road WRF influent and insufficient carbon source to support for both denitrification and Bio-P. The chemical will remove additional amount of P, after Bio-P removal, to meet the effluent P requirement in the future.

CHAPTER 5

Biosolids

Chapter 5 - Biosolids

5.1 Introduction

Biosolids processing at wastewater treatment facilities is an integral and often costly part of the treatment plant operations. Incorporating sufficient facilities to remove solids from the wastewater stream, adequately stabilize these solids, and reliably dispose of the resultant product continues to challenge municipal agencies. Added to the more traditional needs of biosolids processing is the increasing pressure to provide higher level stabilization to the biosolids and continue to identify additional outlets for disposal and reuse. An evaluation of existing biosolids practices with respect to the Part 503 regulations has been made. Also, the drivers and alternative improvements required associated with achieving a Class A product will be discussed. The overall goal of these evaluations is to provide a road map for biosolids processing and handling that will allow the County to cost effectively process and dispose of biosolids now and through the 25-year planning period that can adapt to changes in the disposal markets. This chapter of the Regional Optimization Master Plan Report is arranged into the following topics:

- Discussion of existing Class B biosolids processing
- Estimated future biosolids production
- Class B and Class A requirements
- Discussion of available markets
- Process alternatives for Class A biosolids production
- Class B and Class A arrangements for the “existing plan”, “transfer all”, and “transfer some” options
- PCRWRD energy evaluation findings
- Biosolids processing recommendations
- Recommended biosolids management plan

5.2 Existing Class B Biosolids Processing

A condition assessment of all facilities at the Roger Road WRF and Ina Road WRF has been performed for this master planning effort and is summarized in this report. Thus, only a brief summary of existing facilities and the condition of these facilities will be provided in this chapter.

5.2.1 Roger Road WRF Biosolids Processing

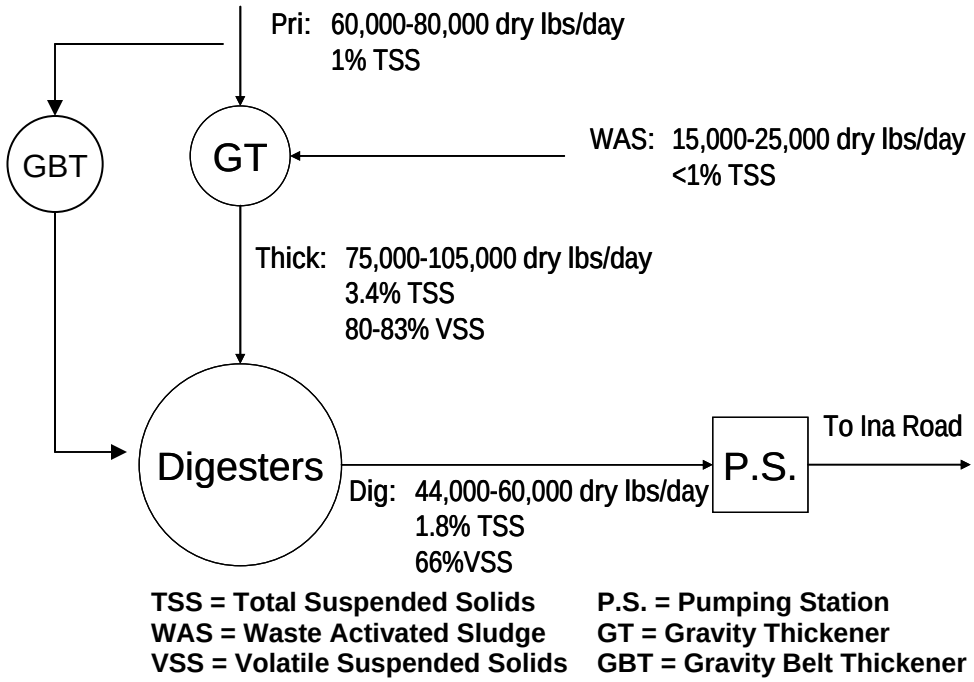
The existing Roger Road WRF biosolids processing facilities and a summary of the condition assessment results are provided in **Table 5-1**. The existing digestion facilities are designed to produce Class B biosolids through mesophilic anaerobic digestion. The design parameter for mesophilic anaerobic digestion to meet Class B 503 regulatory requirements is a 15 day hydraulic detention time to meet pathogen reduction requirements, which typically results in volatile solids destructions of approximately 45-55 percent. The digestion process must also attain at least 38 percent destruction of volatile solids to comply with the Part 503 requirements for Vector Attraction Reduction. Based on data provided by the County, the existing facilities are typically achieving volatile solids destructions of 50 to 54 percent. This reduction rate indicates good digestion operation at the plant, but as indicated in the table below, this

requires all four primary digesters to be in service and is at a plant influent flow of approximately 38 mgd (under existing plant capacity of 41 mgd). If the plant were at capacity, the existing digestion process could become stressed and volatile solids destructions could be reduced. The digested sludge is transported to the Ina Road WRF in a dedicated pipeline for further thickening/dewatering prior to land application. **Figure 5-1** summarizes existing biosolids facilities and mass transfers at the Roger Road WRF.

Table 5-1
Summary of Roger Road WRF Biosolids Facilities

Unit Process	Facilities	Condition
Solids Thickening (Primary Sludge and Waste Activated Sludge)	3 – Covered Gravity Thickeners	Uncertain structural stability and corrosive environment for equipment tankage
	2 – Dissolved Air Flotation Thickeners	Broken parts – currently not in use and not expected to be utilized due to labor intensity
	1 – Gravity Belt Thickener	Currently just beginning service for WAS thickening, excellent condition
Digestion	6 –Anaerobic Digesters (4 Primary and 2 Secondary)	No. 3 has gas leakage through roof, all un-inspected internally for 50 years, potential solids deposition in all, mixing issues with No. 6
Sludge Transfer to Ina Road WRF	Sludge Pumping Station and 5.3 mile 8-inch Force Main	Cavitation issues with pumping units, potential corrosion issues in force main, and single element redundancy issues

Figure 5-1
Existing Roger Road WRF Biosolids Diagram (at 38.3 mgd)



5.2.2 Ina Road WRF Biosolids Processing

The existing Ina Road WRF biosolids processing facilities and a summary of the condition assessment results are provided in **Table 5-2**. The existing digestion facilities are designed to produce Class B biosolids through mesophilic anaerobic digestion. Based on data provided by the County, the existing facilities are typically achieving volatile solids destructions of 55 percent. This reduction rate indicates good digestion operation at the plant. **Figure 5-2** summarizes existing biosolids facilities and mass transfers at the Ina Road WRF.

Stabilized Class B biosolids are currently thickened to approximately 8 percent solids using centrifuges and are disposed of through an existing contract for agricultural land application. This disposal option is preferred to thickened rather than dewatered solids as the water in the biosolids is beneficial in the region and the existing contractor's equipment is consistent with this product up to 10 percent solids.

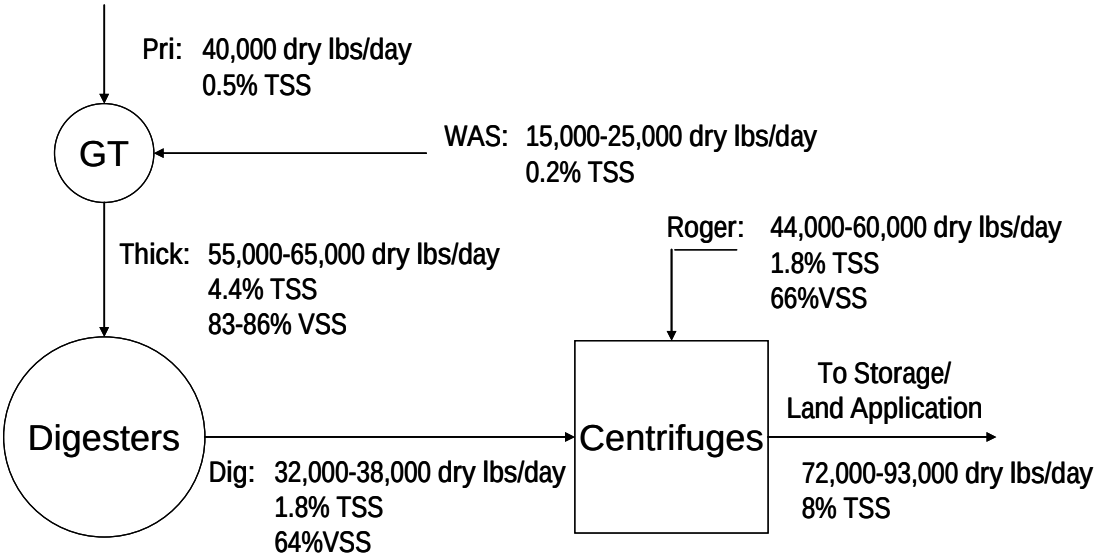
The current land application option has been successful for the County and provides a beneficial use of its biosolids. It is expected that land application will continue to be an option for biosolids disposal in the area in the future. However, some issues of concern with this disposal method have arisen. Currently, hauling distances for disposal are approximately 25 miles round trip and are through a single disposal contractor that controls the majority of available land in the area. It is expected that this hauling distance

could increase to 40 miles roundtrip at some point in the future as development pushes available land further out from the existing Ina Road WRF. Concerns over the quality of Class B biosolids have arisen in other parts of the U.S. If similar concerns arise in the area, disposal of Class B biosolids by land application could become difficult or unacceptable, requiring Class A processing. Also, the County wishes to have additional options for disposal.

Table 5-2
Summary of Ina Road WRF Biosolids Facilities

Unit Process	Facilities	Condition
Solids Thickening (Primary Sludge and Waste Activated Sludge)	1 –Gravity Thickener	Tankage in good condition, odor issues
	3 – Dissolved Air Flotation Thickeners	Tankage in good condition, wear on pumping and gas equipment, odor issues
Digestion	4 –Anaerobic Digesters (All Primary)	Fair condition, no major issues
Thickening/Dewatering	3 – Thickening/Dewatering Centrifuges	Centrate pumping capacity issues, struvite buildup problems, lack of cake pumping equipment, odor issues
Digested Sludge Storage and Transfer Station	1 – Bladder Storage Basin and Transfer Station	Inadequate and aging storage capacity; odor, safety and electrical system issues at transfer facility

Figure 5-2
Existing Ina Road WRF Biosolids Diagram (at 23.4 mgd)



5.2.3 Non-Metro Facilities

Pima County operates a number of wastewater treatment facilities besides the Roger Road WRF and Ina Road WRF termed the "Non-Metro Facilities". Biosolids processing at each of these facilities varies significantly from one facility to another and appears to have been based on size of facility, available land for evaporation, distance to existing sewers to Ina Road WRF and Roger Road WRF, etc. **Table 5-3** summarizes approximate solids production rates from these facilities and the type of processing and disposal used. Three of the plants, Marana WRF, Mt. Lemmon WRF, and Avra Valley WRF, have solids generated at the facility hauled to either Ina Road WRF or Roger Road WRF influent sewers. Thus, the sludge generated at these facilities become part of the treatment and disposal processes at Ina and Roger Road as well. For the purposes of evaluating treatment alternatives for the Ina Road WRF and Roger Road WRF during the planning period, it was assumed that these Non-Metro facilities would continue the current practice.

The Green Valley WRF, a 4.1-mgd facility, has the most significant biosolids processing facilities. This plant also has an alternative disposal method that has allowed Pima County to diversify its disposal options into a new market, mine reclamation. Dried solids (greater than 90 percent TSS) are transported to the ASARCO Mission Mine Facility for utilization to as a soil amendment for establishing vegetation on mine tailings. This disposal option is occurring through a research project associated with the University of Arizona. Results have been promising to date.

Table 5-3
Regional Facilities Current Biosolids Generation and Processing

Location	Current, dry tpd(1)	Processing, Disposal
Marana WRF	0.28	storage, hauled ⇒ Ina Road WRF
Rillito Vista WRF	0.014	dried, scraped, hauled to landfill
Avra Valley WRF	2.2	storage, hauled ⇒ Roger Road WRF
Green Valley WRF	5.7	GBTs, Aerobic Dig., Belt Filter Press (BFPs), Drying ⇒ Mine
Arivaca Junction WRF	0.09	dried, scraped, hauled to landfill
Corona de Tucson WRF	0.16	Evaporation, hauled to landfill when pond is cleaned
Pima Co. Fairgrounds WRF	0.004	Evaporation, hauled to landfill when pond is cleaned
Mt. Lemmon WRF	0.018	storage, hauled ⇒ Ina Road WRF
Randolph Park WRF	0.007	Conveyed by sewer to Roger Road WRF
Total	8.47	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

5.3 Estimated Future Biosolids Production

Through development of wastewater projections and treatment alternatives analysis associated with this project, future biosolids production rates have been estimated for the Roger Road WRF and Ina Road WRF for the three main arrangement alternatives – existing plan, transfer all, transfer some. The liquid stream treatment alternatives are impacted by recycles from the solids treatment processes, particularly from solids thickening and post stabilization thickening or dewatering. The type of solids stabilization utilized greatly impacts the constituents in the recycle streams, such as ammonia and phosphorus. Mass balances have been developed for the facilities to account for these recycle streams.

At the Biosolids Workshop (No. 7), it was agreed that Pima County will continue to utilize anaerobic digestion for solids stabilization of sludge streams from the Ina Road and Roger Road plants. Prior to this study, all three of the major system configuration alternatives considered (existing plan, transfer all, transfer some) included a central biosolids processing facility at Ina Road WRF and the digestion facilities at Roger Road WRF were to be decommissioned. Centralization of solids handling and treatment is cost effective, particularly if Class A biosolids are required. Thus, a centralized biosolids processing facility serves as the starting point for development of biosolids processing alternatives. Additionally, in the existing plan and transfer some alternatives, the scenario of a Roger Road WRF have been developed. In this scenario, Roger Road WRF solids would be handled as follows: primary sludge (if primary tanks are provided) would be transferred to Ina Road WRF in the influent sewer, and waste activated sludge would be thickened to 3 percent solids at Roger Road WRF and then pumped to digestion at Ina Road WRF.

5.3.1 Biosolids Production Assumptions

Major assumptions in developing biosolids production rates at the Roger Road and Ina Road plants are summarized below.

Non-Metro facility solids generation and contribution to Roger Road WRF or Ina Road WRF are determined for planning purposes**.** As these solids come into the plants with the influent, wastewater characteristics and concentrations were developed for these loads. **Table 5-4** summarizes the assumptions made for Non-Metro facility solids contributed to Roger Road WRF and Ina Road WRF.

Table 5-4
Non-Metro Facility Sludge Wastewater Characteristic Assumptions

Parameter	Assumption
Percent Solids	1%
TSS	**See estimates in Table 5-15 Non-Metro Facilities Future Biosolids Production**
BOD	0.5 *TSS
COD	2 * BOD

Parameter	Assumption
sBOD	0.23 * BOD
VSS	0.76 * TSS
TKN	0.05 * TSS
TP	0.02 * TSS

Primary treatment removals were estimated. The removal rates were established based on which treatment facility was being addressed and, for Ina Road WRF, the capacity being treated. Primary removal of BOD was estimated at approximately 31% and TSS removal at 60%.

Other major assumption for treatment to generate biosolids produced for the alternatives are summarized in **Table 5-5**.

Table 5-5
Additional Biosolids Generation Assumptions

Process	Parameter	Assumption
Secondary Treatment	Solids Yield with Primary Tanks	0.8 lb TSS/lb BOD applied
	Solids Yield without Primary Tanks	1.2 lb TSS/lb BOD applied
	WAS Concentration	7,000 mg/L
	TP Removal to Sludge	60% of Primary Effluent TP
	Sludge VSS	76% of Sludge TSS
Thickening	TSS	90% Removal
	Thickened Concentration	4.5%
Digestion	Minimum VSS Destruction	50%
Digested Sludge Thickening	Concentration	8%
Roger Road WRF Assumptions	Primary Sludge	Sent to Ina Road in Sewer
	WAS	Thicken to 3% and Pump to Ina Road WRF

Using the assumptions summarized above, biosolids quantities were developed for each of the major treatment alternatives.

5.3.1.1 Roger Road WRF

The treated flow at Roger Road WRF for each of the major system configurations (existing plan, transfer all, transfer some) is 32 mgd, 0 mgd, or 20 mgd, respectively. Also, the 32-mgd WRF alternative would have differing thickened sludge flows and recycles. **Table 5-6, Table 5-7, Table 5-8** and **Table 5-9** summarize sludge flows generated at the Roger Road WRF or the system configurations for 32 mgd, 32 mgd WRF (with primary tanks), 32-mgd WRF (no primary tanks), and 20 mgd.

Table 5-6
Roger Road WRF 32-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	0.62	1.0	51,900	39,400
Waste Activated Sludge	0.80	0.7	46,600	35,400
Thickened Sludge	0.24	4.5	88,700	67,400
Thickener Overflow	1.18	0.1	9,900	7,500

Table 5-7
Roger Road WRF 32-mgd Solids Streams (With Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge (to Ina Road WRF Influent)	0.58	1.0	48,700	37,000
Waste Activated Sludge	0.77	0.7	45,100	34,300
Thickened WAS (to Ina Road WRF Digestion)	0.24	2.0	40,600	30,900
Thickener Overflow	0.53	0.1	4,500	3,400

Table 5-8
Roger Road WRF 32-mgd Solids Streams (No Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Waste Activated Sludge	1.72	0.7	100,600	76,400
Thickened WAS (to Ina Road WRF Digestion)	0.36	3.0	90,500	68,800
Thickener Overflow	1.36	0.1	10,100	7,600

Table 5-9
Roger Road WRF 20-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	0.41	1.0	34,500	26,200
Waste Activated Sludge	0.52	0.7	30,100	22,900

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Thickened Sludge	0.16	4.5	58,100	44,200
Thickener Overflow	0.77	0.1	6,500	4,900

5.3.1.2 Ina Road WRF

The treated flow at Ina Road WRF for each of the major system configurations (existing plan, transfer all, transfer some) is 50 mgd, 82 mgd, or 62 mgd, respectively. Also, the 32-mgd Roger Road WRF alternative would result in differing sludge flows and recycles at Ina Road WRF as the Roger Road WRF solids handling will impact to the Ina Road WRF influent. **Table 5-10,** **Table** 5-11**, Table 5-12, Table 5-13** and **Table 5-14** summarize Ina Road WRF sludge flows for the major system configurations. Additional sludge from Roger Road WRF pumped to the plant via the 8-inch interconnect (loads shown in Subchapter 5.3.1.1) would be added to obtain total solids to digestion at Ina Road WRF. The following tables present only the solids generated from Ina Road WRF wastewater liquid stream processes.

Table 5-10
Roger Road WRF 50-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.14	1.0	95,200	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

Table 5-11
Ina Road WRF 50-mgd Solids Streams (Roger Road WRF, With Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.52	1.0	127,200	96,600
Waste Activated Sludge	1.60	0.7	93,700	71,200
Thickened Sludge (WAS + Primary)	0.53	4.5	198,700	151,000
Thickener Overflow	2.60	0.1	22,100	16,800

Table 5-12
Ina Road WRF 50-mgd Solids Streams (Roger Road WRF, No Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.15	1.0	95,300	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

Table 5-13
Ina Road WRF 82-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.75	1.0	145,900	110,900
Waste Activated Sludge	2.14	0.7	124,800	94,900
Thickened Sludge (WAS + Primary)	0.65	4.5	243,700	185,200
Thickener Overflow	3.24	0.1	27,100	20,600

Table 5-14
Ina Road WRF 62-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.35	1.0	112,600	85,600
Waste Activated Sludge	1.63	0.7	95,200	72,300
Thickened Sludge (WAS + Primary)	0.50	4.5	187,000	142,100
Thickener Overflow	2.48	0.1	20,800	15,800

5.3.1.3 Non-Metro Facilities

To estimate future production rates from the Non-Metro facilities, an assumed production rate of 2,800 dry lbs/day raw biosolids produced per mgd of flow treated was applied to the expected future capacities of the facilities. A new Non-Metro Southlands WRF has been proposed that would have a capacity of approximately 13.7 mgd. Solids generated at this future facility were assumed to have separate processing and disposal as currently provided at Green Valley WRF. **Table 5-15** summarizes the assumed future biosolids production rates for the Non-Metro facilities.

Table 5-15
Regional Facilities Future Biosolids Production (2030)

Location	Future, raw dry tpd(1)	Processing, Disposal
Arivaca Junction WRF	0.00	Facility decommissioned, flow transferred to Green Valley WRF
Avra Valley WRF	4.20	storage, hauled ⇒ Roger Road WRF
Corona de Tucson WRF	2.94	storage, hauled ⇒ Ina Road WRF
Green Valley WRF	6.16	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Marana WRF	6.16	storage, hauled ⇒ Ina Road WRF
Mt. Lemmon WRF	0.003	storage, hauled ⇒ Ina Road WRF
Pima Co. Fairgrounds WRF	0.00	Facility decommissioned, flow transferred to Southeast Interceptor (SEI)
Rillito Vista WRF	0.00	Facility decommissioned, flow transferred to Marana WRF
Randolph Park WRF	0.007	Conveyed by sewer to new WRC/Ina Road WRF
Southlands WRF (future)	14.70	Thicken/haul to interceptor for discharge
Total	**28.0**	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

5.4 Class B and Class A Biosolids Requirements

The 40 Code of Federal Register (CFR) Part 503 regulations set forth requirements for the stabilization and disposal of biosolids. The regulations are divided into sections by type of disposal method as well as general provisions and pathogen and vector attraction reduction requirements. A full summary of the regulations is not provided here as a number of other sources provide good descriptions of the requirements. The requirements associated with land application and specific Class A and Class B production is briefly reviewed in this chapter.

5.4.1 General Land Application Requirements

Based on the current regulations, bulk biosolids applied to land must meet pollutant ceiling concentrations and cumulative pollutant loading rates, Class B pathogen requirements, vector attraction reduction requirements, and management practices requirements. Vector attraction reduction can be accomplished in a number of ways listed in the regulations, such as digestion to achieve greater than 38 percent VSS reduction, alkaline stabilization, drying, injection, or incorporation. Management practices requirements apply to application of both Class A and Class B biosolids, but the restrictions associated with Class B products are considerably more stringent. If Class A pathogen reduction requirements are met, the biosolids can also be utilized for lawns and home garden applications.

5.4.2 Class B Requirements

The EPA Part 503 regulations provide three approaches to produce a Class B product. The first approach is to use a technology on the EPA list of PSRPs. The other two approaches require continuous monitoring for pathogens or submitting pathogens data to EPA to demonstrate that the process is equivalent to a PSRP process. The processes considered to meet the criterion for Class B biosolids associated with this study are all on the EPA PSRP list. **Table 5-16** summarizes the criteria for PSRPs process considered for this study.

Table 5-16
Class B Processes

Process	Requirements
Aerobic Digestion	MCRT of 40 days at 20°C or MCRT of 60 days at 15°C
Air Drying	Dry on beds for 3 months, with 2 months ≥ 0°C
Anaerobic Digestion	MCRT of 15 days at 35-55°C or MCRT of 60 days at 20°C
Composting	5 days at 40°C and 4 hours of the 5 days at 55°C
Lime Stabilization	Lime addition to pH 12 and maintained for 2 hours

5.4.3 Class A Requirements

The Part 503 regulations establish six alternatives to demonstrate meeting Class A requirements. As in the case of the Class B requirements, one approach is to use a technology that is on the list of PFRP. The other five alternatives prescribe a time-temperature requirement, a high pH-temperature requirement, continuous monitoring for pathogens to demonstrate compliance (alternatives 3 and 4) or obtaining a PFRP equivalency approval from EPA. Most of the process considered for Pima County for obtaining a Class A designation fall on the list of PSRP processes. **Table 5-17** summarizes the processes considered in this study to achieve Class A compliance.

Table 5-17
Class A Processes

Process	Requirements
Thermophilic Aerobic Digestion (1)	MCRT of 10 days at 55-60°C
Heat Drying (1)	Direct or Indirect Gas Drying to ≤ 10% moisture content and solids temperature of 80°C
Heat Treatment (1)	MCRT of 30 minutes at 180°C

Process	Requirements
Composting (1)	3 days at 55°C for in-vessel or static pile 15 days at 55°C for windrow
Pasteurization (1)	30 minutes at 70°C
Alkaline Stabilization (2)	pH 12 and maintained for 72 hours with biosolids ≥ 52°C for 12 hours, followed by air drying to 50% TS
Time/temperature (3)	Process meets detention time at temperature requirements by solids concentrations given in 503 regulations or has been given equivalency by U.S. EPA (temperature phased anaerobic digestion (TPAD) and batch thermophilic digestion for example)

(1) PSRP process (complies with Part 503 Alternative 5)
(2) Meets high pH-temperature requirement (complies with Part 503 Alternative 2)
(3) Meets Time-temperature requirement (complies with Part 503 Alternative 1)

5.5 Available Markets

5.5.1 Agricultural Land Application

Currently, Pima County is disposing of all biosolids from the Ina Road WRF and Roger Road WRF facilities through a land application contract for a liquid product at approximately 8 percent solids. As previously noted, concerns over having a single disposal option, future increased hauling distances, and potential pressure to provide Class A biosolids for land application have arisen. However, this current disposal method has been cost effective for Pima County and should be considered for future disposal. In a telephone interview with the current land application contractor, the potential need to produce Class A biosolids for land application and future loss of land sites for application were discussed. The Avragro Incorporated representative indicates that he sees no pressure to utilize Class A biosolids for land application. Also, the current contractor is capable of handling up to 10 percent solids with current application equipment. Thus, the Avragro representative's opinion is that land application, based on current haul distances of 25 miles and utilizing Class B biosolids, is viable for 20 to 25 years into the future even with increasing solids production from Pima County. Other land application contractors have bid on the Pima County contract in the past, thus competition does exist in the land application market. These other land application contractors may prefer a dewatered product. Thus, when considering land application with respect to processing alternatives, it is appropriate to have the capability to produce either a liquid or dewatered product.

5.5.2 Landfilling

Disposing of biosolids in a municipal solids waste landfill is not considered a beneficial use, but does represent a viable disposal option. A recent survey of biosolids management in Arizona indicated that a large number of municipalities rely on landfilling for biosolids disposal. Just as concerns have arisen about land applying Class B biosolids, there are some places where groups are concerned about land applying biosolids in general. Landfilling remains a viable and cost effective approach, especially as a backup or contingency plan. This disposal method can often be utilized without stabilization of solids as

long as the biosolids meet the EPA paint filter test (dewatered to 12-15 percent solids) and Toxicity Characteristics Leachate Procedure (TCLP). The paint filter test requires no free water and the TCLP test sets limits on the heavy metal content of water leached through a sample of the dewatered sludge. It is often advantageous to dewater biosolids to a greater degree (such as 25 percent) for landfilling to minimize disposal cost and to make the material easier to transport and place in the landfill. A past trial of disposing of biosolids at a Pima County landfill indicated that the solids were too wet and caused equipment problems at the landfill.

Landfill space is available in Arizona. Nearby landfills include: the Tangerine Road Landfill operated by Pima County, the Sahuarita Landfill operated by Pima County, and the Los Reales Landfill operated by the City of Tucson. The Tangerine Road landfill is expected to reach capacity in 2009. The Sahuarita Landfill is expected to have capacity for approximately 15 more years. The Los Reales Landfill is expected to have capacity for 60 years. Tipping fees at the Pima County landfills are approximately $100 per ton for non-standard waste. Tipping fees at the City of Tucson landfill is approximately $75 per ton for special handling rate. Given the tipping fees, minimizing the amount of water in the biosolids is advantageous. Thus, dewatering to approximately 25 percent solids would be recommended for this disposal option.

With the tipping fees and required hauling for landfilling it is likely that this disposal method will be more expensive than the current land disposal option. However, landfilling could provide a backup to other disposal options and reduce reliance on a single outlet.

5.5.3 Mine Tailings Reclamation

This disposal option has promise for Pima County. The current University of Arizona project utilizing Green Valley WRF biosolids has been successful. The dried biosolids from Green Valley WRF are taken to the ASARCO mine. The Dodge Phelps mine has also been identified as a possible reclamation site. Other mines within a 100 mile radius of Pima County exist and could be potential sites. This market requires a dewatered or dried product. Given the significant increase in biosolids for disposal if Ina Road WRF and Roger Road WRF sludge was added to the program, other disposal sites would have to be identified and utilized. Additionally, this market is dependent on mining conditions. Reclamation is performed when a site, or a portion of a site, is no longer being mined. There is a federal requirement that mines be reclaimed after they are closed. However, the amount of biosolids that can be dedicated to this market could be variable from year to year, depending upon mining operations.

This disposal option could be viable for Pima County in the future. It may be most applicable to the Non-Metro facilities as regionalization of these plants is considered. To further explore the potential of this option, a separate market study would be appropriate and expansion of the current project may be advisable to determine stability and actual costs for this alternative.

5.5.4 Dedicated Land Disposal

An alternative that may have future merit for Pima County is the development of a dedicated land disposal site. This alternative consists of acquiring a dedicated parcel of land to apply biosolids that is not accessible to the public. Biosolids would be applied to the site and incorporated into the soil. This

disposal option would not require solids stabilization, if the biosolids are covered on a daily basis. Otherwise, they would need to meet the Class B requirements. Vector attraction controls would be required either in the form of stabilization or by applying management practices such as daily incorporation into the soil. The primary requirements for dedicated land disposal is that the biosolids must meet the heavy metal limit, groundwater monitoring wells need to be installed and maintained, and surface runoff needs to be contained and monitored. There are restrictions on public access to the land and how the land can be used in the future. There are also reporting requirements that are prescribed in the Part 503 regulations. Dewatered solids could be trucked to the site or a solids pipeline could deliver solids to the site. If the solids are pumped to the site, an onsite dewatering facility may be beneficial. The alternative should be considered with a significant buffer zone around the site, such as a 1,000 foot setback to application areas. Other siting requirements are described in the Part 503 regulations.

This disposal method is being utilized effectively by the Dallas Water Utilities in Dallas, Texas. Based on experience in Dallas, an active area loading rate of approximately 0.1 dry ton per day per acre has been manageable. **Table 5-18** summarizes conceptual sizing information for this option.

Table 5-18
Dedicated Land Disposal Conceptual Sizing

Parameter	For Ina Road and Roger Road WRF Biosolids	For all County Biosolids
Application Rate, dry tons/day/acre active	0.1	0.1
Future Biosolids Production, dry tons/day	75	103
Required Active Site Area, acres	750	1,170
Active Site Parameter Sides (as square), feet	5,700	7,140
With 1,000 foot setback, parameter sides, feet	7,700	9,140
Total Required Area with Setback, acres	1,360	1,920

5.5.5 Other Land Application

Alternative land application options include use of biosolids on golf courses and other landscaping projects such as roadway improvements. Landscaping contractors could use biosolids for a variety of projects. These markets would require production of Class A biosolids. Additionally, dewatered or dried product would be required. The viability of these markets would require a detailed market analysis. A major issue to consider is stability of the market continually and long term given the high amount of solids to be disposed of. These markets may be more appropriate for some of the Non-Metro facilities with smaller and less frequent disposal needs.

5.5.6 Sale as Fertilizer

A few municipal agencies produce bagged fertilizer from biosolids. This market would require a dry, Class A product. Amendments to the biosolids to increase its value as fertilizer would likely be required. While this market has the highest public relations benefit potential, it requires significant capital and operations investment. Thus, such a market would require focused market research prior to investment.

5.5.7 Other Emerging Markets

Agencies around the U.S. continue to look for alternative markets for biosolids. One such market is waste to energy. Many of the energy markets utilize heat drying as a first step, and then further process the biosolids to produce a gas, liquid or solid fuel. It is expected that alternative markets will continue to grow over time. A way to handle such emerging markets, without the often high risk, is to utilize a design-build-operate contract for these disposal options. While analyzing emerging markets is beyond the scope of this project, the alternatives developed should allow for such future changes.

5.6 Process Alternatives for Class A Biosolids Production

In evaluating process alternatives to produce Class A biosolids, consideration should be given to the type of end product generated by the process and whether or not this type of product is marketable. For example, for the current land application arrangements in place at Pima County, the applicator prefers a liquid biosolids product with a solids concentration of approximately 8 percent. Thus, a heat dried product of more than 90 percent solids or alkaline stabilized product with total solids of 50 percent would not be consistent with this current market.

As noted in this chapter there are a number of PFRPs that by definition will result in Class A biosolids, such as heat drying, composting, pasteurization, and alkaline stabilization. Additionally, anaerobic digestion can be used to produce Class A biosolids if it meets the time temperature requirements. The currently accepted forms of Class A anaerobic digestion is a batch thermophilic process or a batch thermophilic process followed by a mesophilic process. As only anaerobic digestion with a batch process is given Class A status based on process design criteria, this study has limited the anaerobic digestion options to those with batch processing. Based on input from a U.S. EPA representative, it has been verified that continuous feed thermophilic digestion is not considered a Class A process without a batch step. Testing for equivalency may be occurring at some locations currently, but none have been given Class A status at this point in time.

The testing equivalency process requires significant data collection and obtaining results takes some time. If the biosolids do not meet the testing requirements, they can not be disposed of as Class A product. Thus, issues could result with disposal arrangements if the testing does not provide the verifications required.

For evaluating Class A biosolids production, the assumption that all biosolids stabilization would occur at the Ina Road WRF was made. As producing Class A biosolids will require significant capital investment and generally is more costly to operate than the current Class B production, it is logical that such facilities

would likely be most cost effective if centralized for the Ina Road WRF and Roger Road WRF sludge streams. This does not apply to major Non-Metro facilities such as Green Valley WRF and the future Southlands facility, both of which generate significant biosolids and do not have close proximity to the Ina Road WRF plant.

5.6.1 Class A Drivers

Significant drivers exist that require giving consideration to producing Class A biosolids. Regulations are subject to change. Public reaction to Class B biosolids land application and land application in general is increasingly negative is some areas of the U.S. Political pressure could result in state or national legislation that would require agencies to produce Class A biosolids. Finally, Pima County's commitment to achieving environmental management system (EMS) certification through the National Biosolids Partnership could drive production of Class A biosolids.

Participation in the National Biosolids Partnership requires of the County: utilization of a comprehensive EMS, demonstration of commitment to the community, and involving the community in defining performance improvements to the County's biosolids program. This community involvement could be a local trigger to future Class A biosolids processing.

5.6.2 Screening of Class A Processes

At Workshop No. 7 that dealt with biosolids, major Class A processes were screened. Digestion, alkaline stabilization, composting, heat drying, and advanced air drying were presented for consideration. This subchapter provides a summary of the major Class A processes considered and the results of that screening.

5.6.2.1 Digestion

The major digestion processes given screening consideration were: thermophilic aerobic digestion, temperature phased aerobic digestion, thermophilic anaerobic digestion, and temperature phased anaerobic digestion.

As both the Ina Road WRF and the Roger Road WRF currently utilize anaerobic digestion, conversion to aerobic digestion would require significant capital investment. Additionally, aerobic digestion does not produce methane gas. Thus, methane could not be beneficially used to heat the digestion process or for power production as currently utilized at the Ina Road WRF. Thus, thermophilic aerobic digestion and temperature phased aerobic digestion were not given further consideration.

Thermophilic anaerobic digestion utilizes digesters operating at 55°C. Thermophilic digestion is similar to the current practice of continuously feeding the anaerobic digesters except the digesters are operated at a higher temperature. Thermophilic anaerobic digestion is considered to achieve higher volatile solids destruction rates than mesophilic digestion thus reducing required volume. Also, some reports indicate improved dewaterability of solids and greater reductions in pathogen levels from thermophilic digestion over mesophilic digestion. Thermophilic digesters are more difficult and costly to operate than mesophilic digesters. Currently, thermophilic anaerobic digestion is classified as a Class B PSRP process

along with mesophilic digestion by the 503 regulations. In order to demonstrate compliance with Class A requirements, it would be necessary to continuously monitor pathogens or obtain approval as an equivalent PFRP process. Thus, continuous feed thermophilic digestion was prescreened from the digestion processes.

Temperature phased anaerobic digestion (TPAD) utilizes a batch thermophilic stage followed by a mesophilic stage. In this process solids are retained in a batch reactor for a sufficient period of time to demonstrate compliance with the EPA time-temperature criteria (Alternative Method 1). The process is therefore considered to produce a Class A equivalent sludge by USEPA. Higher volatile solids destructions and methane gas production are realized. Also, the quality of the methane gas is often better, odor generation associated with thermophilic digestion is reduced, and process stability is improved. Dewaterability of solids is reported to be better than with mesophilic digestion alone. Thus, this process was carried forward as the digestion process for screening.

The TPAD process is most consistent with the current facilities utilized at the Roger WRF and Ina Road WRF as mesophilic digestion is being utilized. This alternative would thus require addition of a thermophilic batch stage to the process. Typically, TPAD is designed with a 5 day batch detention time for the thermophilic stage and a 10 day detention time in the mesophilic stage. Resulting solids could continue to be thickened to 8 percent or dewatered to produce a cake.

5.6.2.2 Alkaline Stabilization

A number of alkaline stabilization processes are available. These include: N-Viro, Biofix, Leopold, Envesssel, Chemfix, and Bioset. The N-Viro process has the most installations (more than 50) with the Bioset process having the least (less than 5). Any of these processes could be utilized. They all utilize hydration as a source of heat and lime as one of the additives. Specific processes vary somewhat in additives use of other heat sources. For prescreening, the Bioset process, which is relatively new, was utilized.

Bioset requires the addition of lime and acid. This process uses less alkaline additives then the other processes, which may be an advantage because of the alkaline nature or Arizona soils. Heat is generated in hydration as well as in the acid reaction. This process requires dewatering biosolids to a minimum of 15 percent solids prior to processing. Digestion is not required. The process arrangement is relatively portable and compact. It produces a Class A, granular product. The product also has some value associated with the alkaline content that is beneficial for acidic soils. This benefit is not realized in the Southwest because most of the solids are alkaline in nature.

Major advantages of alkaline stabilization include a relatively small footprint, ability to be fully enclosed, moderate system complexity, and the ability to process raw or digested biosolids. Major disadvantages include increase in volume of solids due to lime addition, cost of chemicals, the potential for significant odor and dust generation, and potential ammonia recycle from odor scrubbers.

5.6.2.3 Composting

Composting biosolids can be performed as windrow, extended pile, or in-vessel. Both windrow and extended pile operations require significant space and thus are difficult to provide with odor control. Thus, composting was prescreened to the in-vessel process. In-vessel composting requires dewatering the biosolids to greater than 15 percent and requires the addition of a bulking agent. It does not require digestion to produce a quality product, although digesting the solids prior to composting significantly reduces the potential to produce odors during the composting process. Significant material handling is required in the process. Major advantages of this process include: high quality product, perception as a "green" process, and the ability to handle raw or digested solids. Major disadvantages include odor generation, complex material handling, and fire potential issues. The process also increases the volume of material that needs to be handled because of the added bulking agents.

One composting possibility that may have promise particularly for the Non-Metro facilities is a composting project being initiated at the Los Reales Landfill owned by the City of Tucson. Los Reales is performing pilot testing at this time on composting. One of the needs that they have is a good source of nitrogen for the composting process, which could be provided by biosolids. Composting at Los Reales is unlikely to require the significant volumes of biosolids that are generated at Ina Road WRF, but this outlet could be explored for biosolids from one of the Non-Metro facilities. An issue that would need to be evaluated is whether the biosolids provided can be essentially free of metal content, as this is one of the requirements for this composting operation.

5.6.2.4 Heat Drying

Heat drying systems can be broken down into three categories: direct, indirect, or combination direct/indirect. Direct drying systems bring the sludge into immediate contact with the drying medium. Indirect systems utilize an intermediate exchange surface to transfer the drying heat. Combination systems utilize both modes. The most prominent drying system with the largest number of installations is the rotary drum direct dryer. This type of system is manufactured by a number of companies. The process is enclosed, utilizes recirculation of gas to reduce energy consumption, and can be used to form very dry (90 percent solids) pellets. The process does not require digestion, but does require dewatering to approximately 15 percent solids. However, a higher quality and less odorous product is achieved if the biosolids are digested prior to heat drying. The digestion gas can also be used as a source of energy for the dryer. The product is high quality and marketable and can be used as low grade fuel. It has a small footprint and does not generate any recycle streams. Disadvantages include high energy consumption, complex equipment, and fire and explosion potential.

5.6.2.5 Accelerated Air Drying

This relatively new process utilizes a green house type of enclosure for solar drying of solids. A robotic turning machine accelerates the drying process. The process has low chemical and energy requirements, no nutrient recycle to the wastewater process, can process digested or raw solids, and produces approximately 75 percent solids. Disadvantages include a large system footprint, the need to establish

Class A equivalency to date, and limited experience to date. The process may have applicability at some of the Non-Metro plants that have been using air drying.

5.6.2.6 Screening Results

Screening criteria were utilized to reduce the number of Class A processes for further consideration. These criteria included: operability, proven process, expected present worth cost, marketability, resource consumption, ease of maintaining treatment during construction, and recycle impacts. Processes were graded with a +, 0, or -. The resultant matrix evaluation based on input during Workshop No. 7 is presented in **Table 5-19.**

Table 5-19
Screening Matrix Evaluation of Class A Processes

	Phased Anaerobic Digestion (TPAD)	Alkaline Stabilization	Composting	Heat Drying	Advanced Air Drying
Operability	+	0	–	–	0
Proven Process	+	+	+	+	–
Present Worth Cost, Capital + O&M	+	0	–	–	–
Marketability	–	–	+	+	–
Resource Consumption	+	–	–	–	+
Ease of Maintaining Treatment Capacity during Construction	0	+	0	+	0
Recycle Impacts	0	0	0	0	0
Recommended Processes	**Ina/Roger Road √**		**Non-Metro Sites √**	**Ina/Roger Road √**	**Non-Metro Sites √**

Based on the discussion in the workshop, it was determined that for the Ina Road WRF and Roger Road WRF biosolids, temperature phased anaerobic digestion and heat drying would be given further consideration. Additionally, the Cambi process was added at the workshop for consideration. For the Non-Metro facilities, advanced air drying or composting may be appropriate technologies.

It was also determined in the workshop that all Class A options would include anaerobic digestion. Thus, if heat drying were utilized, it would be added following mesophilic digestion.

5.6.2.7 Cambi Process

The Cambi process was developed in Norway in the early 1990s. The process utilizes a thickened sludge (15 to 20 percent solids), a hydrolization process, digestion, and final dewatering. The final stabilized product is typically dewatered to 35-40 percent solids. The hydrolization process uses steam and pressure to solublize organic compounds in the sludge. The hydrolysis step includes three tanks: a preheat tank, the steam and pressure reactor tank, and a flash tank. The pressure is released rapidly in a flash tank to rupture biomass cells. Heat is returned from the flash tank to the preheat tank. The solids are then sent on to mesophilic digestion. The manufacturer reports a 50 percent reduction in the required digestion volume, increased gas production, reduced foaming, and high VSS destructions (up to 60 percent). The process could be added on to the existing mesophilic digestion process much like TPAD can be. Disadvantages of this process include: no existing U.S. installations, it is currently not listed as a Class A process (although a USEPA representative has indicated that with the first stage heat treatment it is likely to meet the requirements), safety issues of handling high temperature steam and high pressure vessels, need for pre-thickening to 15 percent solids, complex system arrangement, and need to find stable market for the product. There is also some concern that the mixing system in the anaerobic digesters may need to be modified to mix a 15 percent solids material. However, there are some data that suggested that the changes in viscosity that result from the thermal conditioning may counteract the affect of the higher solids concentration. In addition, the process generates a high strength recycle stream which can be a source of odors. The final product will also be too dry to be applied with liquid application equipment. The process has many similarities with the Zimpro and Porteous processes that have largely been abandoned in the US because of odor issues.

Even with the noted issues, the process appears to have some potential to fit in with the existing mesophilic process at the Ina Road WRF and could in the future be considered as a Class A process. Thus, it appears to be valuable to keep this option open for future Class A biosolids production. At this time, with no existing U.S. experience and no approval by USEPA, implementation of this process for Class A in the immediate future could constitute a high risk. If the Cambi process is given significant consideration in the future, pilot testing is recommended as well as verification that sufficient markets exist to dispose of the drier product (35-40 percent solids).

5.7 Class B and Class A Arrangements for the "Existing Plan", "Transfer All", and "Transfer Some" Options

For both Class B and Class A plant arrangements, bases of design criteria for the alternatives needed to be determined at a master planning level. Often maximum month solids values are used in conjunction with the design criteria instead of annual average values, especially for Class B processing. This approach will be used for this master planning effort for producing Class B biosolids. Annual average values will be used for Class A processing alternatives. Based on previous analysis of wastewater characteristic performed for this master plan, a maximum month loading factor of 1.15 was established.

5.7.1 Class B Facility Arrangements

As the County currently produces a Class B product using mesophilic digestion, changing to an alternative Class B process for either the Ina Road WRF or Roger Road WRF facilities would require significant capital investment. Additionally, methane is produced in the anaerobic digestion process that is currently used at Ina Road WRF for electricity generation. If another Class B process, such as aerobic digestion was used, this energy source would be lost. Thus, the only process given consideration for the production of Class B biosolids in this master plan is anaerobic digestion. Typically, the main process design parameter used in determining mesophilic digestion volume is the SRT which equals the hydraulic retention time (HRT). For combined primary and secondary solids fed to the digesters, a design HRT is typically 15-20 days under average annual loading or a minimum of 15 days at maximum month loading.

5.7.1.1 Class B Existing Plan

The existing plan for this master plan provides for a 32 mgd capacity at Roger Road WRF and a 50-mgd capacity at Ina Road WRF. A sub-alternative to the existing plan is the Roger Road water reclamation option. In this option, the means for handling, transferring to Ina Road WRF, and thickening biosolids at Roger Road WRF differs. Thus, the resultant biosolids loads to digestion are significantly different than for the original existing plan. All biosolids stabilization would be at Ina Road WRF for Class B production in this alternative and sub-alternative. The Roger Road WRF digesters have structural and solids deposition issues that would require rehabilitation or expansion if they were utilized with a plant capacity of 32 mgd. This coupled with the desire to minimize facilities at Roger Road WRF, make digestion at Roger Road WRF unattractive at a 32-mgd capacity. **Table 5-20** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the existing plan alternatives. The water reclamation alternative associated with Roger Road WRF is shown for the plant having no primary tanks. In this arrangement, WAS is assumed to be thickened to 3 percent solids prior to pumping to Ina Road WRF. This concentration was chosen to balance head loss issues in the transfer line while still allowing for reasonable sizing of facilities. If a thinner WAS concentration is found to be necessary to reduce pumping head losses during further development of this master plan, it is recommended that additional thickening of the Roger Road WAS is performed at Ina Road WRF to allow the stabilization facilities to remain as currently sized.

Table 5-20
Summary of Class B Processing Existing Plan Bases of Design

Parameter	Existing Plan		Existing Plan WRF	
Plant	IR 50 mgd	RR 32 mgd	IR 50 mgd	RR 32 mgd
Thickening Facilities (24 hours / 7 days per week operation)				
Primary Sludge	6 GTs*	at Ina	4 GTs	None
WAS	3 GBTs	2 GBTs	3 GBTs	4 GBTs

Parameter	Existing Plan		Existing Plan WRF	
Total Max. Month Thickened Sludge, lb/day	180,100	102,000	180,100	104,100
Total Max. Month Thickened Sludge Flow, mgd	0.48	0.27	0.48	0.42
Total Solids to Digestion at Plant, lb/day	282,100	none	284,200	none
Total Solids Flow to Digestion at Plant, mgd	0.75	none	0.90	none
Minimum HRT, days	15	15	15	15
Required Volume, MG	11.3	none	13.5	none
Existing Digester Volume, each, MG	1.33	1.1	1.33	1.1
Existing Total Digester Volume, MG	5.3	4.4	5.3	4.4
Existing Number of Digesters	4	4	4	4
Total Number of Digesters Required	8.5 (9)	none	10.1 (10)	none
Additional Digesters Required	**5**	**None**	**6**	**None**
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 6 4	 None None	 6 4	 None None
Sludge Storage, minimum days	10		10	
Minimum Storage Capacity at 8% solids, MG	2.5	None	2.5	None

GT = gravity thickener

5.7.1.2 Class B Transfer All

If all wastewater is transferred from the Roger Road WRF to the Ina Road WRF so that the Roger Road WRF site is completely decommissioned, solids processing would all occur at the Ina Road WRF site. **Table 5-21** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the transfer all alternative at Ina Road WRF.

Table 5-21
Summary of Class B Processing Transfer All Bases of Design

Parameter	Transfer All Ina Road WRF
Thickening Facilities (24 hours / 7 days per week operation) Primary Sludge WAS	 6 GTs 4 GBTs
Total Max. Month Thickened Sludge, lb/day	280,300

Parameter	Transfer All Ina Road WRF
Total Max. Month Thickened Sludge Flow, mgd	0.75
Minimum HRT, days	15
Required Volume, MG	11.3
Existing Digester Volume, each, MG	1.33
Existing Total Digester Volume, MG	5.3
Existing Number of Digesters	4
Total Number of Digesters Required	8.5 (9)
Additional Digesters Required	**5**
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 6 4
Sludge Storage, minimum days	10
Minimum Storage Capacity at 8% solids, MG	2.5

5.7.1.3 Class B Transfer Some

In the transfer some alternative, 62 mgd would be treated at Ina Road WRF and 20 mgd would be treated at Roger Road WRF. Biosolids processing could be performed all at Ina Road WRF or digestion could occur at Roger Road WRF as well during Class B production. This would be applicable if the existing Roger Road WRF digester volume was sufficient to achieve stabilization while allowing at least one digester out of service to address current condition issues. **Table 5-22** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the transfer some alternative. Both all biosolids stabilization at Ina Road WRF and some stabilization at Roger Road WRF are shown in the table.

Table 5-22
Summary of Class B Processing Transfer Some Bases of Design

Parameter	All Processing at Ina Road WRF		With Digestion at Roger Road WRF and Ina Road WRF	
Plant	IR 62 mgd	RR 20 mgd	IR 62 mgd	RR 20 mgd
Thickening Facilities (24 hours / 7 days per week operation) Primary Sludge WAS	 6 GTs 4 GBTs	 @ Ina 2 GBTs	 5 GTs 4 GBTs	 2 GTs 2 GBTs

Parameter	All Processing at Ina Road WRF		With Digestion at Roger Road WRF and Ina Road WRF	
Total Max. Month Thickened Sludge, lb/day	215,100	66,800	215,100	66,800
Total Max. Month Thickened Sludge Flow, mgd	0.57	0.18	0.57	0.18
Total Solids to Digestion at Plant, lb/day	281,900	none	215,100	66,800
Total Solids Flow to Digestion at Plant, mgd	0.75	none	0.57	0.18
Minimum HRT, days	15	15	15	15
Required Volume, MG	11.3	none	8.6	2.7
Existing Digester Volume, each, MG	1.33	1.1	1.33	1.1
Existing Total Digester Volume, MG	5.3	4.4	5.3	4.4
Existing Number of Digesters	4	4	4	4
Total Number of Digesters Required	8.5 (9)	none	6.4 (7)	2.4 (3)
Additional Digesters Required	**5**	**None**	**3**	**None**
Dewatering Facilities				
Centrifuges (8/5 operation)	6	None	6	None
Centrifuges (24/7 operation)	4	None	4	None
Dewatered Sludge Storage, minimum days	10		10	
Minimum Storage Capacity at 8% solids, MG	2.5	None	2.5	None

5.7.2 Class A Facility Arrangements

To achieve a Class A product, two options were given development based on the Biosolids Workshop (No. 7) screening and further analysis, TPAD and mesophilic digestion followed by heat drying. As previously noted, the Cambi process may be an option for further consideration if Class A is implemented at a later date, but at this time, insufficient experience and the lack of Class A status make this alternative too high of a risk for development.

If the Cambi process were to be utilized in the future for the production of Class A biosolids, it would be added ahead of the mesophilic digesters. It would require addition of predewatering, typically performed via centrifuge or belt filter press technology, and patented Cambi hydrolysis chambers. These facilities would be provided instead of the thermophilic digestion shown in the alternatives. The mixing system in digesters would need to be evaluated to be sure it could handle the higher solids concentration.

For all Class A biosolids processing alternatives, the original assumption for this master planning effort – that all biosolids stabilization occurs at the Ina Road WRF - was employed. This approach will result in minimizing capital expenditure as well as providing consolidated facilities to efficiently operate and

maintain. Additionally, as the Roger Road WRF digesters are of questionable condition, this arrangement eliminates the need to investigate and renovate these facilities.

5.7.2.1 Class A Existing Plan

The existing plan alternatives for 50/32 mgd, either with Roger Road as a water reclamation facility option or with a rehabilitated existing Roger Road facility, would require additional mesophilic digestion at Ina Road WRF and either pre-thermophilic digestion or post heat drying. The Roger Road water reclamation alternative will result in a higher total solids mass and flow for processing due to the higher solids yield at Roger Road WRF in the secondary process without primary tanks and thickening Roger Road WAS to only 3 percent prior to pumping to Ina Road WRF. This concentration was chosen to balance head loss issues in the transfer line while still allowing for reasonable sizing of facilities. If a thinner WAS concentration is found to be necessary to reduce pumping head losses during further development of this master plan, it is recommended that additional thickening of the Roger Road WAS is performed at Ina Road WRF to allow the stabilization facilities to remain as currently sized. **Table 5-23** summarizes the annual average sludge loading rates and resultant required volumes for TPAD and heat drying for the existing plan alternatives.

Table 5-23
Summary of Class A Processing Existing Plan Bases of Design

Parameter	TPAD		Heat Drying	
Plant	Existing Plan	RR WRF	Existing Plan	RR WRF
Total Solids to Digestion at Ina Road WRF, lb/day	245,300	247,100	245,300	247,100
Total Solids Flow to Digestion at Ina Road WRF, mgd	0.66	0.78	0.66	0.78
Minimum Mesophilic HRT, days	10	10	15	15
Required Mesophilic Volume, MG	6.6	7.8	9.9	11.7
Existing Digester Volume, each, MG	1.33	1.33	1.33	1.33
Existing Total Digester Volume, MG	5.3	5.3	5.3	5.3
Existing Number of Digesters	4	4	4	4
Total Number of Mesophilic Digesters Required	4.9 (5)	5.8 (6)	7.4 (8)	8.8 (9)
Additional Mesophilic Digesters Required	**1**	**2**	**4**	**5**
Minimum Thermophilic HRT, days	5	5	–	–
Required Thermophilic Volume, MG	3.3	3.9	–	–
Number of Active Batch Thermophilic Digesters Required (same size as existing digesters)	2.5 (3)	2.9 (3)	–	–
Number of Fill/Draw Digesters (2*active digesters)	6	6	–	–

Parameter	TPAD		Heat Drying	
Total Number of Thermophilic Digesters	**9**	**9**	–	–
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 5 3	 6 4	 5 3	 6 4
Dewatered Sludge Storage, minimum days	10	10	3	3
Minimum Storage Capacity at 8% solids, MG	2.5	2.5	–	–
Minimum Storage Capacity at 20% solids, MG	–	–	0.25	0.25
Dewatered Cake to Drying, lbs/day tons/week	 – –	 – –	 145,000 510	 145,000 510
Drying Train Capacity, ton/day	–	–	20	20
Heat Drying Operation	–	–	24 hrs/5 day	24 hrs/5 day
Drying Trains Required	–	–	5.1 (6)	5.1 (6)

5.7.2.2 Class A Transfer All and Transfer Some

The transfer all and transfer some alternatives would require additional mesophilic digestion at Ina Road WRF and either pre-thermophilic digestion or post heat drying. As the total solids to digestion are approximately the same for these alternatives and all digestion was assumed to occur at Ina Road, WRF the required biosolids facilities for both alternatives are the same. **Table 5-24** summarizes the annual average sludge loading rates and resultant required volumes for TPAD and heat drying for the transfer all and transfer some alternatives.

Table 5-24
Summary of Class A Processing Transfer All/Some Bases of Design

Parameter	TPAD	Heat Drying
Total Solids to Digestion at Ina Road WRF, lbs/day	245,100	245,100
Total Solids Flow to Digestion at Ina Road WRF, mgd	0.66	0.66
Minimum Mesophilic HRT, days	10	15
Required Mesophilic Volume, MG	6.6	9.9
Existing Digester Volume, each, MG	1.33	1.33
Existing Total Digester Volume, MG	5.3	5.3
Existing Number of Digesters	4	4
Total Number of Mesophilic Digesters Required (Rounded Up)	4.9 (5)	7.4 (8)
Additional Mesophilic Digesters Required	**1**	**4**

Parameter	TPAD	Heat Drying
Minimum Thermophilic HRT, days	5	–
Required Thermophilic Volume, MG	3.3	–
Number of Active Batch Thermophilic Digesters Required (same size as existing digesters)	2.5 (3)	–
Number of Fill/Draw Digesters (2*active digesters)	6	–
Total Number of Thermophilic Digesters	**9**	–
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 5 3	 5 3
Dewatered Sludge Storage, minimum days	10	3
Minimum Storage Capacity at 8% solids, MG	2.5	–
Minimum Storage Capacity at 20% solids, MG	–	0.25
Dewatered Cake to Drying, lbs/day tons/week	 – –	 145,000 510
Drying Train Capacity, ton/day	–	20
Heat Drying Operation	–	24 hrs/5 day
Drying Trains Required	–	5.1 (6)

5.8 PCRWRD Energy Evaluation - Findings

5.8.1 Summary

The master plan recommends moving all biosolids handling and biogas production to Ina Road WRF by the year 2014. Further, it is recommended that mesophilic anaerobic digestion continue to be utilized with Class B or Class A stabilization. Thus, biogas will be produced at the Ina Road WRF throughout the planning period. This chapter of the master plan report presents preliminary findings and recommendations on how to best utilize the nearly 500 million cubic feet per year of biogas that will be produced in biosolids stabilization.

Options for evaluation of power supply facilities, listed in order of their current recommendation ranking, are:

A. *Continue the practice of biogas utilization for engine driven equipment and power generation onsite* (also referred to as Combined Heat & Power (CHP) in this chapter). Two alternatives are developed for this option: CHP1 matches system capacity to burn only the biogas that will be produced and CHP2 further increases system capacity to meet the total electric demand of the Ina Road facilities by burning supplemental natural gas to generate the additional electricity. The system could be operated by PCRWRD or an outside contractor.
B. *Sell all biogas to a third party for commercial use* (Third Party Use – TPU). Two alternatives are presented for this option: TPU1 contracts with an energy developer to transport the biogas offsite for energy recovery and under TPU2 the energy developer operates energy recovery systems onsite.

C. *Purchase power from a local utility and use biogas for heating and cooling functions* (Heating and Cooling Use – HCU). HCU1 decommissions the engines and replaces the lost thermal output capacity with boilers.

5.8.2 Ranking

The ranking of the options in order of economic potential is:

1. Combined Heat and Power (CHP1 and CHP2)
   - Internal combustion engine generators are the superior technology for both the CHP1 and CHP2 alternatives because they are a proven, familiar technology with maximum electrical output when compared to other system technologies like microturbines, fuel cells and Stirling engines.
   - High energy recovery system energy savings occur when they are limited to consuming only digester gas (CHP1), and the peak savings occur when the all the electricity and heat produced are put to beneficial use. Ina Road WRF, in the year 2014, will be close to this ideal match. The Ina Road WRF will consume all the biogas produced electricity and well over eighty percent of the engine thermal output at that point.
   - CHP2 is inferior to CHP1 economically because the cost of natural gas used to generate power above that which can be produced from biogas is roughly equal to the equivalent cost of utility electricity. There is also no projected use for the additional 'free' heat produced by the generator equipment during natural gas utilization to produce power.
2. Third Party Use (TPU1 and TPU2)
   - Pressure on utilities to generate greater portions of their power using renewable energy (e.g., the Arizona Corporation Commission's (ACC's) Environmental Portfolio Standard) will continue between now and 2014. This should increase the value of the renewable biogas. However, as of yet, sufficient credits are not available to provide the energy developer significant economic benefit.
   - TPU2 presumes an agreement could be reached with an energy developer to run the existing (on-site, upgraded) energy recovery facility. This alternative is cumbersome from a labor relations perspective as it is essentially CHP1 with the substitution of contract labor.
   - The off-site alternative (TPU1) requires energy recovery system modifications to replace the engine heat used to drive cooling, space heating and digester heating systems and loses the electrical reliability provided by the on-site engine-generators. PCRWRD would still have to incur the operating costs for the on-site heating and central cooling systems. Also, the energy developer will incur a considerable capital cost.
   - The economic viability of TPU2 is highly dependent upon whether an energy developer can significantly reduce maintenance and operating costs below those incurred by PCRWRD, without sacrificing reliability. The economic viability of TPU1 depends more upon what future incentives,

especially for investment, will be available to the energy developer. Additionally, the developer will need to find an end use for the biogas elsewhere that is superior to the already good 'match' at the Ina Road WRF.

3. Heating and Cooling Use – HCU1
   - This option would use boilers, which have nearly twice the heat output of engines per unit of biogas, to replace the thermal output of the engines.
   - This alternative has a far greater thermal output than is needed at the plant and would result in the loss of more than half of the beneficial biogas use.
   - The plant will have a far greater need for electricity than for heating and cooling.
   - A potential hybrid TPU-HCU option that would consume biogas for thermal loads on-site and sell the remainder to an energy developer may have merit.

5.8.3 Economic Comparison Summary of Options

The project cost ranges, savings and 20-year net present worth ranges of the options are shown in **Table 5-25**.

Table 5-25
Alternatives Economic Comparison

($ x 1,000)	CHP1	CHP2	TPU1 (off-site)	TPU2 (on-site)	HCU1
Project Cost	(5,500) to (12,000)	(25000) to (30,000)	(2,000) to (3,000)	(5,500) to (12,000)	(1,500) to (2,000)
Energy Savings/Yr	3,271	3,271	834*	3,271*	1,071
Energy Costs/Yr	(1,971)	(2,100)	(5,147)	(1,971)	(4,170)
Operating Costs/Yr	(1,475)	(1,977)	(400)	(1,844)*	(500)
Present Worth**	684 to (8,200)	(21,200) to (24,700)	(71,030) to (71,750)	(3,516) to (8,180)	(57,840) to (58,200)

* TPU1 Contract savings assumed to be same as CHP1, operating costs are those for CHP1 plus 25%.
** TPU2 Contract assumed to be 50% of the maximum utility replacement value of CHP electric and thermal energy of the gas less operating costs.
** 20 year net present worth: 8% discount rate, 6% energy escalation rate, 3% general and maintenance escalation rates, construction midpoint in 2013 and energy savings/costs commence in 2014.

5.8.4 Conclusions and Recommendations

CHP1 has the highest net present worth to PCRWRD. Its advantages include:

- The existing engine-generator capacity is a good match for the projected biogas production. The engines' thermal output is also a good match for the projected process and space thermal usages. This coincidence is one that produces maximum energy recovery and energy savings.
- Maintaining the existing engine capacities has air permitting advantages.
- Much of the energy recovery infrastructure is in place and serviceable. Even if field condition assessments recommend that the engine, generator and generator control equipment should be replaced, the costs are less than replicating the serviceable equipment already in place.
- The projected increase in plant electrical demand warrants that the utility service connections to Ina Road WRF be rationalized and that more redundant plant electrical distribution be included in the upgrade. Automatic generator synchronization is recommended as part of this work.

The economics of the energy developer alternatives, TPU1 and TPU2, are based upon reasonable assumptions but without any preliminary negotiation to assess a market value for the biogas.

5.8.5 Combined Heat & Power (CHP) Alternatives

5.8.5.1 Alternatives Listing

CHP alternatives selected for preliminary evaluation and the criteria used to compare them are shown in **Table 5-26**.

Table 5-26
Comparison of CHP Selection Criteria

Combined Heat & Power System					
Comparison Criteria	**IC Engine**	**Microturbine**	**Turbine**	**Fuel Cell**	**Stirling Eng**
Technology Status	Proven	Proven in Landfill Gas	Effective in large apps.	Emerging	Emerging
Mechanical Efficiency (% of input)	35%	26%	20-30%	>40%	25-30%
Heat Recovery Potential (% of input)	25% 45 or higher with exhaust heat recovery	40%	45% and higher	~30%	30%
Heating Temperature (hot water)	200-220 deg, steam with exhaust heat rec.	180-200	high temp hw, steam or both	160-200, emerging types higher	180-220
Emission Challenges	NOx, CO, VOCs	none	potential NOx	none	minor
Gas Pressure	<5 pounds per square inch (psig)	~50 psig	~200 psig	3-10 psig	<1 psig
Sulfur Dioxide Limits	<1000 parts per million (ppm)	75-100 ppm	varies greatly	<100 ppm	1000+
Siloxane Limits	~4000 parts per billion by volume (ppbv)	5-10 ppbv	~80 ppbv	50-100 ppbv	high tolerance
Capital Cost, $/kW	1000- 1600	1800-3000	900-2100	>4000	>2000
Hours Between Overhauls	20000- 40000	5000- 40000	30000- 40000	10000- 40000	10000- 20000
Gas Conditioning Cost	moderate	very high	high	very high	moderate
Overall Maintenance Cost, ¢/kWh	1.5, up to 4.0 with emissions control	1.5- 3.5	1.0- 2.0, higher with emissions	1.0- 1.5	2.0- 4.0
Startup Time	10-15 seconds	60 seconds	5-10 minutes	3 hours- 2 days	~5 minutes
Load Following	excellent	fair	fair	fair	fair

Combined Heat & Power System					
Comparison Criteria	IC Engine	Microturbine	Turbine	Fuel Cell	Stirling Eng
Motor Starting Capability	excellent	poor (synchronous utility translation system: good)	good	poor	fair

5.8.5.2 Alternatives Comparison Summary

Almost all the comparison criteria favor IC engine-generators at Ina Road WRF. Especially important criteria are the high mechanical efficiency, best gas impurity tolerance, personnel familiarity and lower capital cost.

Air emissions limits are a potential drawback to the use of IC engines. Engine replacement can include low NO_X machines and limiting sizing of the energy recovery systems, specifically engines, to digester gas production only the potential to stay within existing air permit criteria.

Good biogas conditioning is especially crucial to the effective operation of all these combined heat and power systems and especially so for the microturbines and fuel cells. They have an order of magnitude more stringent (and expensive) requirements. IC engines are tolerant of occasional lapses in gas treated gas quality. Of the systems listed, IC engines have the lowest biogas treatment energy costs.

Gas conditioning, especially for siloxanes, is still an emerging technology. The Ina Road WRF project has the advantage of enough lead time to better prove and establish good H_2S and siloxane treatment processes and systems.

5.8.6 Existing Ina Road WRF Energy Recovery Systems Overview

The heart of the systems are seven 650 kW engine generators that can operate on propane, biogas or natural gas. Heat is recovered from engine jacket water and exhaust. Jacket water leaving the engines is piped to ebullient (exhaust heat recovery) boilers that generate low-pressure steam. A boiler having three fuel input capability supplements engine steam generation.

Steam feeds four heat exchangers that generate domestic hot water, heating water and sludge heating water. The fourth heat exchanger transfers excess heat not used for heating to plant effluent water.

Steam also fires an absorption chiller that serves a majority of the cooling loads at the plant through a chilled water distribution system. Most of the plant heating loads are served by the energy recovery system through a hot water distribution system. **Table 5-27** lists the electric and thermal output and input capacities of major energy recovery equipment.

Table 5-27
Major Energy Recover Equipment Capacities

Equipment	MBH (1000 BTUs/hour)		Electric Output (kW)
	Input	Output	
Engine Generators	49000	17864	4550
Heat Rec Silencers		3200	
Steam Boiler		5300	
Domestic Hot Water Tank (HW) and Heat Exhaust (HEX)		2000	
HW HEX		8400	
Sludge HEXs		6500	
Heat Rej HEX		18000	
Adsorption Chiller	12000	600 (tons)	

Preliminary projections of the 2014 digester heating, space heating and space cooling loads reveal that these thermal systems have roughly the same demands as the system capacities listed above. Matching engine heat output with thermal loads greatly improves energy savings and return on investment.

5.9 Biosolids Processing Recommendations

Biosolids processing at wastewater treatment facilities is an integral and often costly part of the treatment plant operations. Incorporating sufficient facilities to remove solids from the wastewater stream, adequately stabilize these solids, and reliably dispose of the resultant product continues to be a challenge. The possibility that Class B biosolids could not be viable for traditional land application or other beneficial uses in the future requires attention and planning. The overall goal of these evaluations is to provide a road map for biosolids processing and handling that will allow the County to cost effectively process and dispose of biosolids now and through the 25-year planning period that can adapt to changes in the disposal markets. To that end, this chapter summarizes recommendations for consideration by the County in planning future biosolids processing at the wastewater treatment facilities.

5.9.1 Available Markets and Disposal Options

The County is currently utilizing land application through a local contractor to dispose of biosolids at approximately 8 percent solids to agricultural lands within an approximate 25 mile haul distance. This option appears to be viable through the planning period for Class B biosolids based on discussions with the existing contractor (see Chapter 2.5 for details). There is concern that most of the proximate agricultural lands are controlled by a single contractor, although other contractors have bid for disposal in the past. Alternative disposal options that could be promising even for Class B biosolids include: landfilling as a backup disposal method and investigation of dedicated land application.

Another market that shows promise in the area is mine reclamation. A number of mines are located in Arizona. The current University of Arizona project utilizing Green Valley WRF biosolids has been

successful. This market should be given further investigation. A dry, Class A product would be required. This disposal option may be most applicable to the Non-Metro facilities as regional biosolids disposal from these facilities is considered.

In an effort to provide PCRWRD with the optimal biosolids processing strategy, an extensive market study should be performed. The market assessment should address elements of a long-term biosolids management plan and include, at a minimum, the following items.

- Analysis of current biosolids program to establish baseline conditions
- Projected quantity and quality of biosolids and the effects of liquid treatment process changes
- Determine demand for a Class A and/or Class B product
- Identify multiple biosolids disposal options/outlets
- Determine appropriate liquid and/or dry forms
- Determine regulatory and social issues
  - Regulatory pressures
  - Public concerns
  - Increased urbanization
  - National trends
- Identify and screen process technologies
- Screen process technologies using economic and non-economic criteria
- Develop preliminary alternatives
- Evaluate shortlisted alternatives
- Examine possible design, build, operate options
- Determine if Ina Road WRF biosolids processing facility, a separate regional processing facility, or a combination of both are needed
- Conclude location of a regional solids processing facility if one is deemed necessary
- Recommend long-term plan
- Cost summary
- Implementation plan

A market assessment of this scale requires approximately 12 – 15 months to complete.

5.9.2 Recommended Level of Biosolids Stabilization

The County currently produces Class B biosolids at the Ina Road WRF and Roger Road WRF. This product is and is expected to remain consistent with land application into the future. The cost of producing Class A biosolids is considerably higher in capital investment as well as operation and maintenance costs regardless of the Class A process utilized. For example, TPAD will require significant additional digesters, heating equipment, and heat exchangers to meet the Class A requirements.

The need for Class A biosolids in the current regulatory and public environment is not clear. It is appropriate to have a plan in place such that future Class A facilities could be added on to the treatment trains. However, it does not appear to be in the County's best interest to make the considerable capital investment to produce Class A biosolids at this point in time when a direct need has not been identified. Additionally, in some areas of the country, land application of any biosolids has been seen as

unacceptable, regardless of whether it is a Class A product. If that future situation were to be encountered, the type of Class A product desired could be very different than envisioned at this time, which could require different processing.

Thus, it is recommended that the County continue to produce Class B biosolids using consolidated mesophilic digestion facilities at Ina Road WRF. This stabilization process will provide digester gas for use at the plant. Additionally, TPAD, heat drying, or possibly the Cambi process could be added in the future to produce Class A biosolids if necessary. An arrangement has been determined for the required Class A TPAD facilities on the Ina Road WRF site based on the conceptual sizing performed in this chapter. Finally, the centrifuges should be designed to operate in either a thickening or dewatering mode that will permit the use of landfilling as a backup or contingency plan for biosolids handling.

An alternative arrangement for consideration is to provide one thermophilic digester or arrange one of the mesophilic digesters to operate in thermophilic mode. This digester could be used to produce equivalent Class A biosolids. The County could then evaluate whether these solids could be disposed of at a lower cost than Class B biosolids and plant personnel could become familiar with its operation.

5.9.3 Recommended Biosolids Processing Improvements

In order to provide reliable biosolids processing and disposal through the planning period, the following biosolids processing improvements are recommended. The improvement recommendations are based on the Existing Plan WRF subalternative (50-mgd Ina Road WRF and 32-mgd Roger Road WRF without primary tanks).

Roger Road WRF

- Decommission existing gravity thickeners and dissolved air flotation thickeners
- Provide waste activated sludge gravity belt thickening facilities with 4 gravity belt thickeners to produce a minimum of 3 percent solids
- Decommission existing digesters
- Improve transfer pump station facilities to transfer 3 percent waste activated sludge to Ina Road WRF through the existing transfer force main
- Consider providing redundancy to the single sludge force main through construction of a parallel force main

Ina Road WRF

- Expand existing gravity thickening facilities for primary sludge at the same size as existing for a total of 4 gravity thickeners to produce 5 percent solids. (If no thickening is provided at Roger Road WRF, 6 gravity thickeners would be required.)
- Provide waste activated sludge gravity belt thickening facilities with 3 gravity belt thickeners to produce a minimum of 5 percent solids. (If no thickening is provided at Roger Road WRF, 6 gravity belt thickeners would be required.)
- Expand existing mesophilic digestion capacity with 6 additional digesters at the same size as existing

- Expand centrifuge facility to have 6 units (for 5 days per week operation) or 4 units (for 7 days per week operation) that can be operated to produce either thickened or dewatered solids
- Replace and expand centrate and cake pumping systems at the centrifuge facility
- Make provisions for struvite control in design of facilities with glass lined piping and possible chemical feed systems
- If 5 days per week operation is desired for dewatering, provide digested sludge storage upstream of centrifuges
- Provide thickened/dewatered solids storage with storage capacity to hold 10 days of solids production
- Replace existing solids transfer station
- Additional digesters may be required if the biosolids market study determines Southlands WRF biosolids be treated at Ina Road WRF's biosolids processing facility. The market study should determine the extent (number of digesters, dewatering process, etc.) processing improvement requirements are to be made

5.9.4 Recommended Biogas Utilization

It is recommended that the biogas be utilized for onsite power and thermal generation. The recommendation includes improving the gas cleaning process and the provision for new engine generator sets.

5.10 Recommended Biosolids Management Plan

The County is currently utilizing land application through a local contractor to dispose of biosolids. This approach is viable through the planning period for Class B biosolids, however, there is concern that most of the agricultural lands in close proximity of the plants are controlled by a single contractor, although other contractors have bid for biosolids disposal services in the past. Alternative disposal options for Class B biosolids include: landfilling, as a backup disposal method, and a dedicated land application.

Another market that shows promise is a dry Class A product for mine reclamation. A current University of Arizona project utilizing Green Valley WRF biosolids for reclamation on Asarco Mission Mine has been successful. This market should be given further investigation as there are a number of mines located in Arizona, many in the southern region of the County. This disposal option may be most applicable to the Non-Metro facilities.

An extensive market study is required to provide PCRWRD with the optimal biosolids processing strategy. The market assessment needs to address elements of a long-term biosolids management plan, most notably to determine the demand for a Class A, or Class B product or both; identify multiple biosolids disposal options and outlets; and determine if processing on a Metro or Non-Metro scale is required.

CHAPTER 6

Conveyance System Evaluation

Chapter 6 - Conveyance System Evaluation

6.1 Introduction

The conveyance system evaluation is a follow-up to the conveyance system analysis provided in the 2006 Facilities Plan. The purpose of this evaluation is to take a more comprehensive view of the recommendations laid out in the previous report and confirm, or add to the body of information related to, the capacity of the system to carry current and projected flows throughout the Roger Road WRF (includes Randolph Park WRF) and Ina Road WRF service areas.

Unless expanded, the Roger Road treatment plant will have insufficient capacity to accommodate the future flows generated by population growth. Therefore, a major component of this study is a more detailed analysis of an interconnecting pipeline to transfer flows from Roger Road WRF to Ina Road WRF. Four routing alternatives were given consideration and a recommended route identified.

To determine effective capacity to meet CMOM requirements, a need to quantify wet weather flows had to be developed. Current sewer design calls for leaving 15 percent of each pipe's capacity available for wet weather flows. An analysis of 12 months of flow monitoring data plus some additional wet weather flow data was performed to develop a wet weather factor based on observed wet weather flows. The wet weather flow analysis described herein is not without its limitations. A forthcoming hydrologic modeling project commissioned by Pima County Regional Wastewater Reclamation Department (PCRWRD) should improve upon the wet weather flow estimates provided in this evaluation of the conveyance system.

A hydraulic sewer model was developed in a modeling program called MOUSE for routing existing and proposed flows through the conveyance system. This model is based on a complete inventory of sewers 15 inches and larger and was the primary tool in which pipe capacities were analyzed. From the analysis of the conveyance system, other than the plant interconnect pipeline, relatively few trunk and interceptor sewer replacement projects are required to accommodate dry and wet weather flows through the year 2030.

6.2 Existing Conveyance System

6.2.1 Previous Studies – 2006 Metropolitan Area Facility Plan Update

The 2006 Facility Plan outlined the conveyance needs for the Roger Road WRF and Ina Road WRF service areas over a 25-year plan planning period. The goals of the facility plan were to evaluate how growth, regulatory requirements, and system rehabilitation needs affect the system, and to develop a CIP to effectively plan for these needs. Relying on population estimates developed by the Pima Association of Governments (PAG), this report estimated that the 2030 flow that must be handled by the system will equal 85-mgd ADWF based on a rate of 85 gpcd. The 85 gpcd was derived from a joint agreement between Tucson Water and PCRWRD on per capita flows used for planning. These same population data and per capita flow rates were used in this report.

In summary, the 2006 Facility Plan report listed the following recommendations with regard to the conveyance system:

- Continue closed circuit television (CCTV) and condition assessment for over 3,100 miles of sewer lines
- Implement approved comprehensive CMOM and asset management programs
- Rehabilitate 1,500+ manholes. (More recent manhole inspections will likely increase the number of manholes requiring rehabilitation to approximately 3,000.)
- Rehabilitate portions of the system with condition assessment grades of 4 "poor", or 5 "immediate attention required"
- Construct a plant interconnect from the Roger Road WRF to the Ina Road WRF to transfer flow between these facilities
- Perform engineering studies on interceptors identified as having potential capacity issues

The last two recommendations are evaluated further in this report.

6.2.2 Existing Capacity / Condition Issues

As part of the 2006 Facility Plan, 230 miles of the interceptor system were televised in 2005. All Class 4 pipe in the interceptor system was inspected in 2006. This analysis identified several reaches of interceptor sewer in poor condition and recommends rehabilitation as soon as possible. Approximately 3,000 miles of sewer remain to be inspected and evaluated. The initial manhole condition assessment evaluation has identified 1,500 and further inspection has identified up to 3,000 manholes in need of repair.

The Facility Plan identified the Northwest Outfall (NWO) sewer to be flowing at or above 85 percent capacity and in need of immediate attention. However, this assessment may have been based on local pipes' Manning's capacities, which does not reflect the true capacity of this interceptor. An analysis of 12 months of flow monitoring data revealed that the water level in this pipe is not likely to exceed 65 percent of its diameter once every 10 years. However, as population growth within the service area continues, the portion of this pipe's capacity available for wet weather will be reduced. This will be addressed in more detail in later in this chapter.

In an effort to develop a more comprehensive understanding of the system-wide conveyance system, PCRWRD has commissioned the development of a functional and highly calibrated, hydrology based hydraulic model. The advanced model will be integrated into the conveyance system Geographic Information System (GIS) platform and will be an extension of previous modeling developments used by PCRWRD. The advanced model will afford PCRWRD with many engineering and planning tools, the three most important are: 1) ability to identify current capacity issues, 2) ability to effectively plan for anticipated growth, and 3) enables planning for inflow/infiltration improvements. The project deliverable will be a completely calibrated and validated model of one basin within the conveyance system, as well as, less detailed but calibrated and validated models of the rest of the conveyance system using InfoWorks CS model. Less detailed basins will be fully developed by PCRWRD staff after the delivery of conveyance model and receipt of training.

6.2.3 Peak / Wet Weather Flows

6.2.3.1 Objectives

Objectives of the wet weather analysis are:

- Identify the parts of the existing conveyance system that are impacted by wet-weather flows
- Estimate the peak flow rates and/or water depths at various parts of the existing conveyance system that corresponds to a hypothetical 10-year storm event (CMOM requirement).
- Develop a strategy for accounting for future wet weather flows as population and conveyance system expand.

6.2.3.2 Approach

Ideally, the system response to actual wet weather events would be evaluated via an extensive review of rainfall and flow monitoring data. Correlations between rainfall intensities / volumes and system flows would be developed, and hydrologic models prepared and calibrated to these actual events. These models are used to predict the system response to hypothetical design storms for existing and future system configurations.

For this study, a simpler approach based exclusively on flow monitoring data was utilized. This was done for several reasons. First, the isolated nature of rainfall events in the Southwest makes it challenging to derive correlations between rainfall and flow for large sewersheds. Second, it was beyond the scope of this study to perform a comprehensive wet weather analysis. Finally, the high volume (one year) of continuous flow monitoring data that is available makes the probabilistic method described below a suitable approach to make an assessment of current and previous conveyance system work.

6.2.3.2.1 Probabilistic Method

Historical (one-year) flow rates and water depth monitoring data, recorded every minute, at 27 locations in the conveyance system were analyzed using the probabilistic method described below.

- 15-minute average values of water depth and flow rate at each site were calculated from the 1-minute monitoring data. The daily peak 15-min values of water depth and flow rate at each site were tabulated.

- Frequency analyses were conducted to each site's daily peak values. The resultant distribution is a means of estimating the likelihood that a particular flow rate/depth might be exceeded on any given day. This method provided a basis for determining whether a site is impacted by wet weather flow during this one-year observation period.

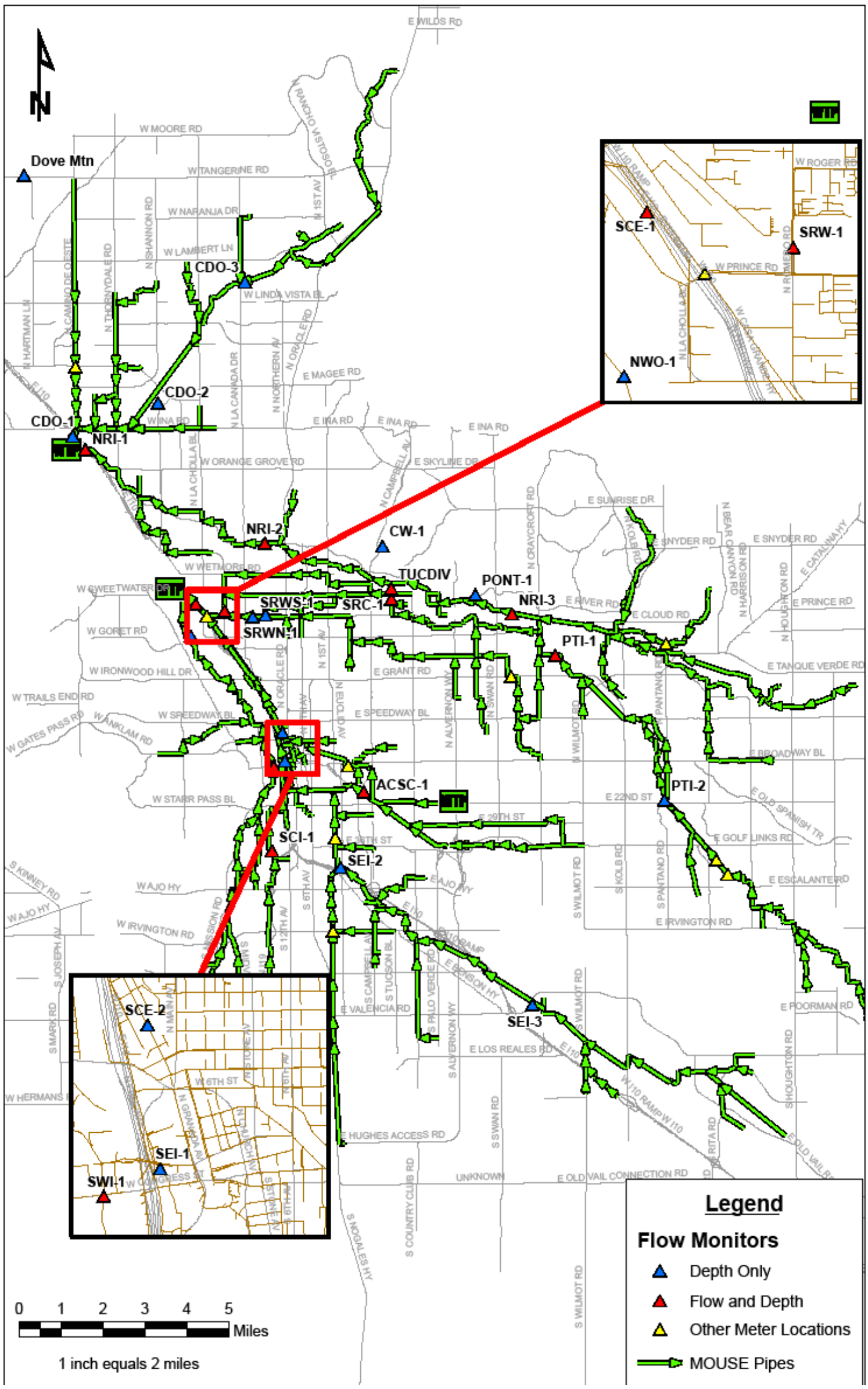
- The frequency analysis data at each site, presented as flow rate/water depth versus recurrence interval, were numerically fit using non-linear regression models. The best fit models were extrapolated to estimate the peak flow rates/water depths at a 10-year recurrence interval. The 10-year frequency is consistent with the regulatory requirements for wet weather flows. The outcome provides a basis for site-specific peaking factors which incorporate the peak 10-year flows.

6.2.3.2.2 Flow Data Summary

The data set used in this analysis was provided by PCRWRD and covers the period from July 1, 2005 to June 30, 2006. The data include depth readings at all 27 monitoring sites. Thirteen sites also recorded flow rates. Flow rates are calculated values derived from measured estimates of flow velocity and water depth, and therefore should not be considered true measurements, because of errors and inaccuracies resulting from the limitations of flow monitoring equipment. Locations of these monitoring sites are shown on **Figure 6-1**, which indicates a fairly good coverage of the existing conveyance system.

Data readings were logged at one-minute intervals resulting in more than 14 million of water depth data points and more than 6 million flow rate data points. During the analysis, abnormal data points were checked and questionable data points were excluded. Questionable data is documented.

Figure 6-1
Flow Monitoring Locations



6.2.3.3 Results

Results summarized at each site include:

- *1-year 10, 50, 90 and 100 Percentile Flow Rates*– The 10-percentile value means that 10 percent of the recorded flow rates are equal to or less than that value. The 100-percentile value is the maximum flow rate ever observed during the one-year period.

- *Calculated 10-year Flow Rate*– Values extrapolated from regression models. These values are considered to be the peak 15-min flow rates / depths likely to occur once every 10 years.

- *Design Capacity at Each Site* – Values taken from the previous study and included in this table as a reference. However, these values are merely the Manning's capacities derived from local pipe size and slope, and do not necessarily represent the pipes' true carrying capacities. More accurate design capacities should be those based on the hydraulic model developed in the course of this study

- *Wet weather Flow Rate* – Values calculated as the difference between the 10-year flow rates and the 50-percentile, or median, flow rates.

- *Wet Weather Peaking Factor* – Values calculated as the ratio of the 10-year peak flow rate to the 50-percentile peak flow rate, multiplied by a factor of 1.4. The factor was derived from an evaluation of flow monitoring data in which the typical peak dry weather flow is approximately 1.4 times the average daily dry weather flow (Q_{ADF}). Development of the factor is as follows:

$Q_{50\%}$ = Median Peak Daily Flow
PF_{DW} = Dry Weather Peaking Factor
PF_{WW} = Wet Weather Peaking Factor
From flow monitoring data, typical PF_{DW} = 1.4, so,

$$PF_{DW} = 1.4 = \frac{Q_{50\%}}{Q_{ADF}}$$

Therefore, $Q_{ADF} = 0.71 Q_{50\%}$

So, $$\boxed{PF_{WW} = \frac{Q_{10-yr}}{Q_{ADF}} = \frac{Q_{10-year}}{0.71 Q_{50\%}} = 1.4 \frac{Q_{10-yr}}{Q_{50\%}}}$$

- *12-month 10, 50, 90 and 100 Percentile Water Depths* – Presented as water depth to pipe diameter ratios at each site

- *Calculated 10-year Water Depth* – Presented as water depth to pipe diameter ratio at each site

Summaries of the results and observations for each site are discussed in the remainder of this chapter. Flow and depth figures can be found in **Appendix H**.

The 10-year wet weather peaking factors indicated in **Table 6-1** were plotted against the standard sewer design peaking factor curve (**Figure 6-2**). For the upstream sites (those with flows less than 10 mgd), there is a strong correlation that produces a curve similar in shape to the design standard, but with an increased peaking factor. Sites further downstream, North Rillito Interceptor (NRI)-2, South Rillito Interceptor-Central (SRC)-1, NRI-1, Santa Cruz-East Interceptor (SCE)-1, are on older parts of the system and are unique cases necessitating different techniques for estimating future wet weather flows. However, for those sites with Q_{ADF} less than 10 mgd, the revised curve would seem to be a viable method for evaluating system capacity to convey peak wet weather flows.

Table 6-1
Historical and Calculated Flow Rates and Water Depths

Site	Flow Rate, mgd					Design Capacity(2), mgd	Wet Weather Flow(3)	PF(4)	Water Depth/Pipe Diameter					Pipe Diameter (inch)
	Historical(1)				Calculated				Historical(1)				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
ACSC-1	2.69	3.56	4.60	8.77	10.19	19.2	6.63	4.00	0.22	0.26	0.29	0.42	0.51	42
AV-1	1.10	1.45	1.87	3.28	3.93	9.1	2.48	3.80	0.30	0.34	0.38	0.53	0.57	24
CDO-1	-	-	-	-	-	94.8	-	-	0.29	0.32	0.36	0.39	0.43	48
CDO-2	-	-	-	-	-	31.1	-	-	0.24	0.25	0.28	0.33	0.38	36
CDO-3	-	-	-	-	-	-	-	-	0.27	0.31	0.33	0.48	0.49	24
CW-1	-	-	-	-	-	-	-	-	0.19	0.20	0.21	0.31	0.25	12
Dove Mtn	-	-	-	-	-	-	-	-	0.16	0.17	0.20	0.21	0.22	15
GV-1	1.26	1.69	2.34	2.82	3.21	-	1.52	2.66	0.34	0.39	0.46	0.51	0.50	21
NRI-1	16.96	19.40	25.54	30.82	30.56	38.3	11.16	2.21	0.54	0.56	0.66	0.74	0.76	42
NRI-2	12.82	15.32	20.04	32.40	33.29	-	17.97	3.04	0.45	0.50	0.56	0.68	0.73	39
NRI-3	8.19	9.49	10.10	11.93	11.78	20.1	2.29	1.74	0.33	0.36	0.37	0.41	0.46	33
NWO-1	-	-	-	-	-	28.7	-	-	0.48	0.52	0.55	0.60	0.63	48
PONT-1	-	-	-	-	-	16.18	-	-	0.27	0.31	0.33	0.44	0.35	12
PTI-1	9.37	10.57	11.66	14.44	12.87	29.8	2.30	1.71	0.36	0.38	0.40	0.44	0.46	36

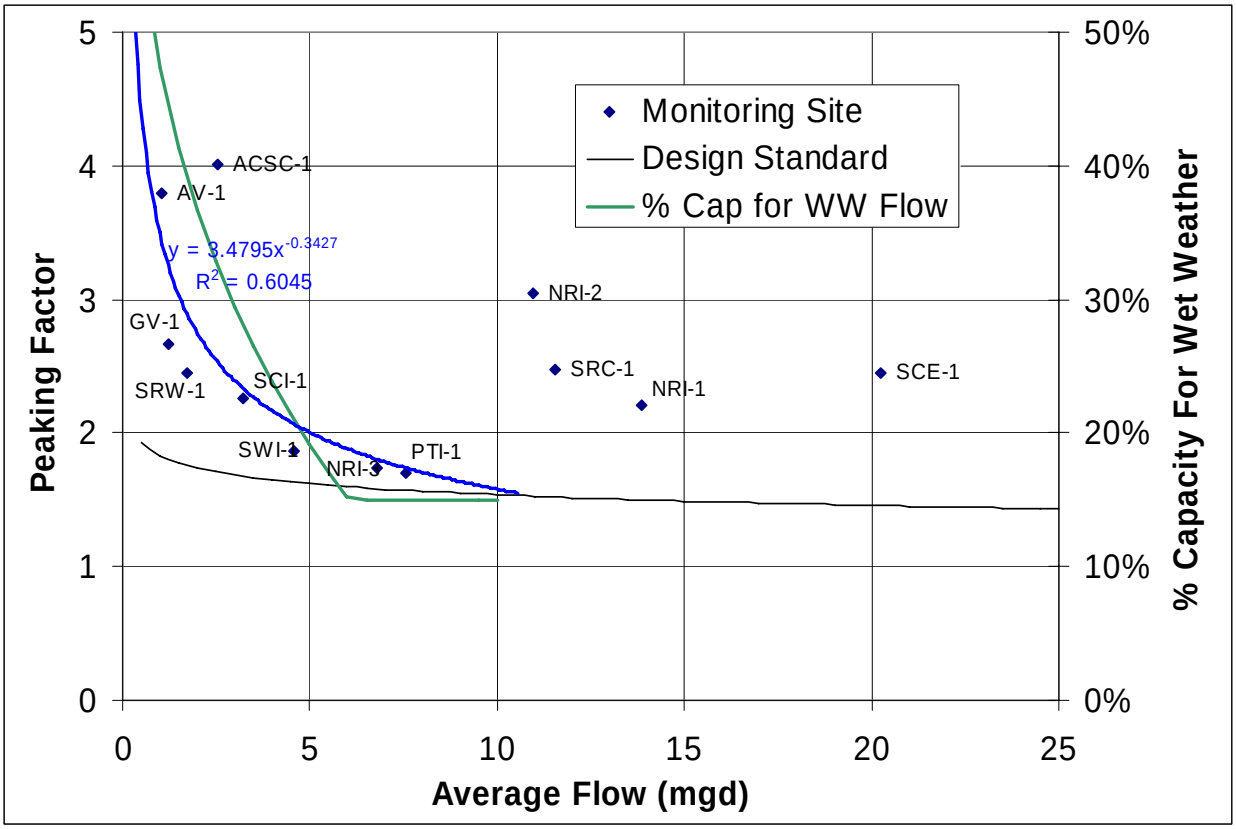
(1) Based on data recorded from July 1, 2005 to June 30, 2006
(2) From previous study: 2006 Metropolitan Area Facility Plan Update. Included here for reference only
(3) Wet weather flow, estimated as the difference between the calculated 10-year flow and historical 50-percentile flow
(4) PF: Peaking factor, estimated as 1.4 x (calculated 10-year flow/ historical 50-percentile flow)
ACSC = Aviation Corridor to Santa Cruz Interceptor; AV = Aviation Corridor; CDO = Canada Del Oro; CW = Campbell Wash; Dove Mtn = Dove Mountain; GV = Green Valley WRF; NRI = North Rillito Interceptor; NOW = Northwest Outfall; PONT = Pontatoc Wash; PTI = Pantano Interceptor

Table 6-1 (Continued)
Historical and Calculated Flow Rates and Water Depths

Site	Flow Rate, mgd					Design Capacity[2], mgd	Wet Weather Flow[3]	PF[4]	Water Depth/Pipe Diameter					Pipe Diameter (inch)
	Historical[1]				Calculated				Historical[1]				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
PTI-2	-	-	-	-	-	13.5	-	-	0.35	0.38	0.41	0.45	0.48	30
SCE-1	25.23	28.33	34.05	44.32	49.52	148.1	21.19	2.45	0.28	0.30	0.31	0.37	0.36	78
SCE-2	-	-	-	-	-	7.8	-	-	0.30	0.38	0.42	0.62	0.58	30
SCI-1	4.19	4.51	4.97	8.34	7.29	12.1	2.78	2.26	0.38	0.40	0.42	0.62	0.57	30
SEI-1	-	-	-	-	-	92.8	-	-	0.36	0.37	0.38	0.46	0.47	60
SEI-2	-	-	-	-	-	-	-	-	0.30	0.31	0.33	0.98	0.52	36
SEI-3	-	-	-	-	-	21.4	-	-	0.33	0.36	0.39	0.57	0.53	30
SRC-1	14.93	16.17	18.03	26.26	28.53	11.8	12.36	2.47	0.35	0.37	0.38	0.45	0.48	54
SRW-1	2.22	2.42	2.69	3.90	4.23	7.8	1.81	2.45	0.30	0.32	0.33	0.51	0.51	30
SRWN-1	-	-	-	-	-	127.9	-	-	0.20	0.24	0.25	0.28	0.28	66
SRWS-1	-	-	-	-	-	9.7	-	-	0.48	0.50	0.53	0.71	0.77	27
SWI-1	5.48	6.39	7.10	9.46	8.52	43.9	2.13	1.87	0.28	0.31	0.33	0.89	0.35	33
TUCDIV	1.37	3.13	7.61	11.98	14.92	30.2	11.79	6.67	0.20	0.30	0.40	0.96	0.70	33

(1) Based on data recorded from July 1, 2005 to June 30, 2006
(2) From previous study: 2006 Metropolitan Area Facility Plan Update. Included here for reference only
(3) Wet weather flow, estimated as the difference between the calculated 10-year flow and historical 50-percentile flow
(4) PF: Peaking factor, estimated as 1.4 x (calculated 10-year flow/ historical 50-percentile flow)
SCE = Santa Cruz-East Interceptor; SEI = Southeast Interceptor; SRC = South Rillito Interceptor-Central;
SRW = South Rillito Interceptor-West; SRWN = South Rillito Interceptor-West, North Line; SRWS = South Rillito Interceptor-West, South Line;
SWI = Southwest Interceptor; TUCDIV = Tucson Boulevard Diversion

Figure 6-2
Revised Peaking Factor Curve



6.2.3.4 Details of Flow Data Analysis

Flow data for each of the existing 27 monitoring sites was evaluated and interpreted for use in the conveyance system capacity analysis. The specific details by interceptor are included in **Appendix H.** It also details any suspect data that was excluded from the analysis.

6.2.3.5 July 2006 Flow Analysis

During the course of this analysis it was observed that the flow monitoring period selected for analysis was relatively dry and might result in underestimating the magnitude of peak wet weather flows. It was also noted that a series of significant events occurred near the end of July 2006 that might assist in verifying the probabilistic approach. Of these storms, the one that occurred on July 29 was found to have caused the greatest system flows and was selected for additional statistical analyses.

As **Figure 6-3** indicates, rainfall volumes varied greatly throughout the service area. Therefore individual rain gauge data were grouped into three regions (Canada, Tucson, and Tanque) and consolidated into "composite" rainfall hyetographs. A statistical analysis of this event determined its recurrence interval ranged from 1 to 10 years depending on location and duration (see **Figure 6-4**).

Figure 6-3
July 29, 2006 Rainfall Totals

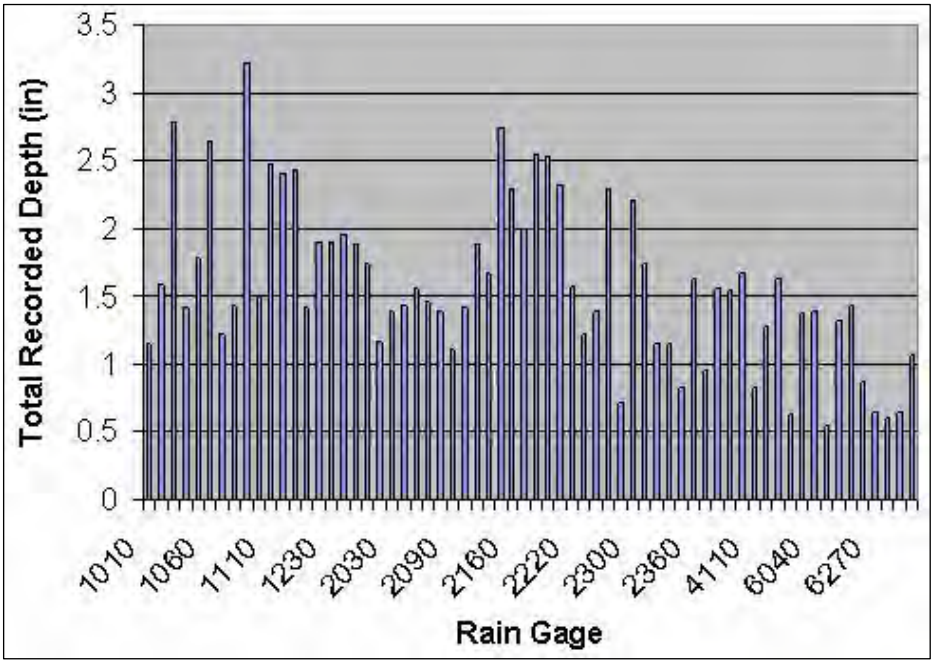
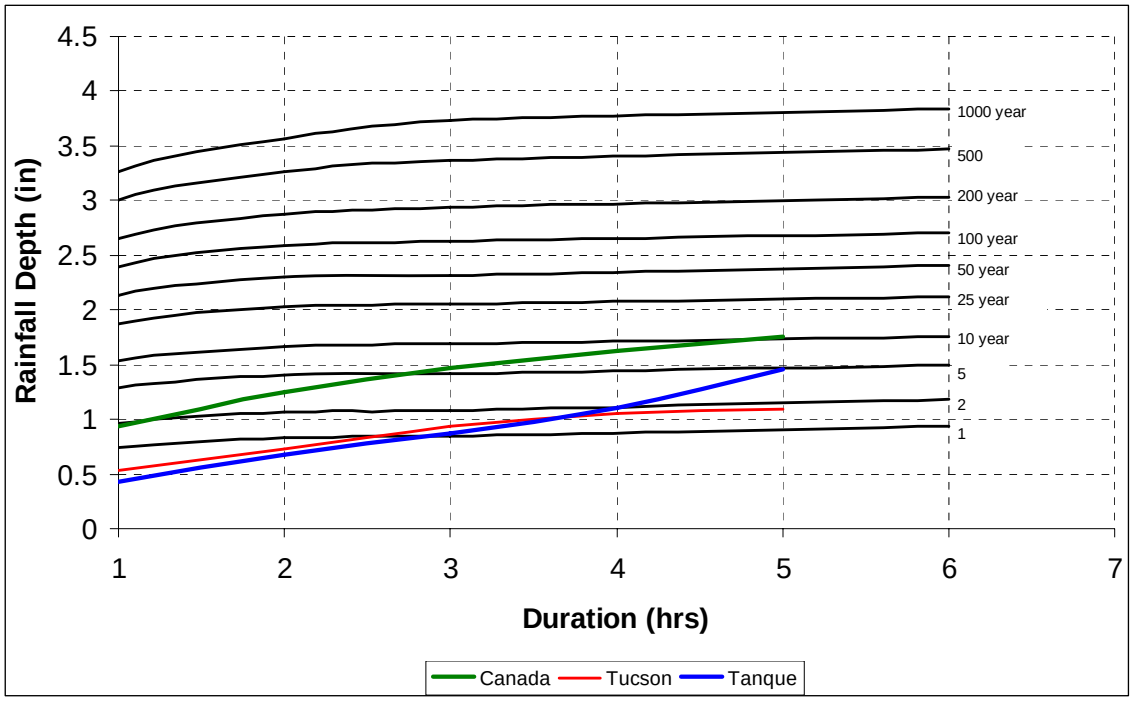


Figure 6-4
July 29th Rainfall Statistical Analysis



At each monitoring site that recorded both depth and flow a new data point for this particular event was added to the flow frequency distributions. Figures indicating where these points fell relative to the flow frequency distributions have been included in **Appendix H**. The majority of the data points fall relatively close to the frequency curves which would seem to validate the approach. However, there are a few exceptions where the data points fall off the curves. This is likely in large part due to the fact that the spatial variability of the rainfall makes the development of correlations between individual events and system flows challenging. This difficulty was a major factor in the decision to utilize the probabilistic method to approximate wet weather flows. It eliminates the need to derive such correlations as it is based exclusively on the frequency of flow without attempting to correlate such flows to rainfall.

6.2.3.6 Summary and Conclusions

While the Pima County conveyance system does experience an increase in flow in response to wet weather events, flow data indicate it has adequate excess capacity to convey these flows in accordance with CMOM criteria. On the other hand, as the service area population grows, excess system capacity will be reduced and the ability for the system to reliably convey peak wet weather flows will subsequently be reduced. There are some portions of the system that will most likely need to be augmented in the future in order to maintain adequate excess capacity for wet weather flows. The method detailed in Chapter 6.4.4 was used to account for wet weather flows when evaluating system hydraulics.

There are some notable limitations to the probabilistic method. First, this technique presumes that one year of flow data is sufficient to project the flows and depths that are likely to occur once every 10 years. Second, this technique makes no attempt to associate measured flows with rainfall. Finally, this technique estimates flows, not volumes. Therefore, while it may be a reasonable means of estimating wet weather flows, it has no means of estimating what sort of detention volumes might be employed as an alternative to increased conveyance capacity.

While this study has clearly shown that there are some significant wet weather impacts, a more comprehensive wet weather study is warranted and has been commissioned by PCRWRD. It is recommended that this study evaluate the correlation between measured rainfall and flows. These measurements should then be used to assist in the calibration of a hydrologic model capable of simulating the response of the collection system to actual and hypothetical rainfall events. This model could be used to validate the recommendations of this report, and could also be used to evaluate alternatives to increased conveyance, such as detention and flow equalization.

6.3 Future Conveyance System Capacity Requirements

6.3.1 Population / Flow Estimates

Model loads were derived largely from population estimates. The same traffic analysis zone (TAZ) population data that had been developed by PAG and was used for the 2006 Facility Plan was also used as the basis for estimating inflows into the MOUSE model described in Chapter 6.5. In general, a per capita wastewater flow rate of 85 gpcd was applied to the population estimates to determine model inflows. In some areas these population values were adjusted to account for customers on septic systems.

6.3.2 Previous Studies – 2006 Metropolitan Area Facility Plan Update

The same population estimates used in the 2006 Facility Plan were used for this study. The table below consolidates these estimates into a single table. For future flow scenarios it was assumed that all properties currently on septic would be served by the collection system.

6.4 Conveyance System Evaluation Criteria

6.4.1 Design Standards

Majority of the standards that were used to evaluate the system and develop the CIP have been established via State legislation. These are discussed in Chapter 6.4.2.

6.4.2 Regulatory Issues

Any Master Planning project must be done with existing and anticipated relevant rules and regulations in mind. A review of the Arizona Administrative Register[1] revealed several anticipated rules that impact this project. While this document is not yet policy, it is anticipated that it will be adopted as policy by 2008. Those proposed rules that affect master planning pertain primarily to the State's recommendation that a regulated CMOM standard be applied. Those proposed rule changes found to be most relevant to this master planning effort are:

- **R18-9-C305 2.05 General Permit**: Capacity, Management, Operation, and Maintenance of a Sewage Collection System – Specifically, this general permit will allow an operator to operate and maintain a collection system under the terms of a CMOM Plan. This permit applies to existing facilities. The CMOM plan must include:
  - Operation and maintenance of ability of system so as to maintain capacity to convey peak dry and wet weather flows, prevent SSOs, and respond to and report releases.
  - Capital improvement plan.
  - How to maintain adequate capacity to base flows and peak wet weather flows of a 10-year-24-hour storm event for all parts of the conveyance system.
  - Identification of conveyance system components that do not meet preceding criteria, and develop a CIP such that these components will be compliant within 10 years.

- PCRWRD received "notice of recording" from ADEQ from the type 205 General Aquifer Protection Permit on November 27, 2006.

- **R18-9-E301 4.01 General Permit**: Sewage Collection Systems – This permit pertains to newly constructed sewage collection systems.
  - Sewage collection system must be designed and operated such that it:
    - Provides adequate wastewater flow capacity for the planned service area;
    - Maintains proper flow velocities so as to minimize sedimentation;
    - Prevents SSOs via proper sizing and I/I reduction measures;
    - Minimizes exfiltration losses;
    - Provides for adequate inspection, maintenance, and testing;
    - Maintains structural integrity; and
    - Minimizes septic conditions in the collection system.
  - Design Requirements
    - Apply appropriate dry weather peaking factor and add wet weather I/I rate;
    - Maximum d/D of 0.75 during dry weather;
    - All collection system appurtenances should be designed such that any part of the system, when flowing full, can accommodate a peak wet weather flow calculated by

[1] Secretary of State, Arizona Administrative Register Notices of Proposed Rulemaking, Volume 11, Issue 2, January 7, 2005.

multiplying the sum of the upstream dry weather flows by a dry weather peaking factor based on upstream population and adding a wet weather I/I rate based on either a percentage of peak dry weather flow or a gallons per acre rate of flow;

- Minimum radius of curvature = 200 feet;
- Minimum depth of cover = 3 feet[1];
- Minimum velocity = 2 feet per second[2]
- Maximum velocity = 10 feet per second[3]
- Maximum manhole spacing according to **Table 6-2**:

Table 6-2
Manhole Spacing

Sewer Pipe Diameter (inches)	Max. Manhole Spacing (feet)
Less than 8	400
8 to less than 18	500
18 to less than 36	600
36 to less than 60	800
60 or greater	1300

6.4.3 Diurnal Flows / Peaking Factors / Flow Equalization

Dry weather peaking factors (PFs) established in the Arizona State Register are shown in **Table 6-3**:

Table 6-3
Dry Weather Peaking Factors

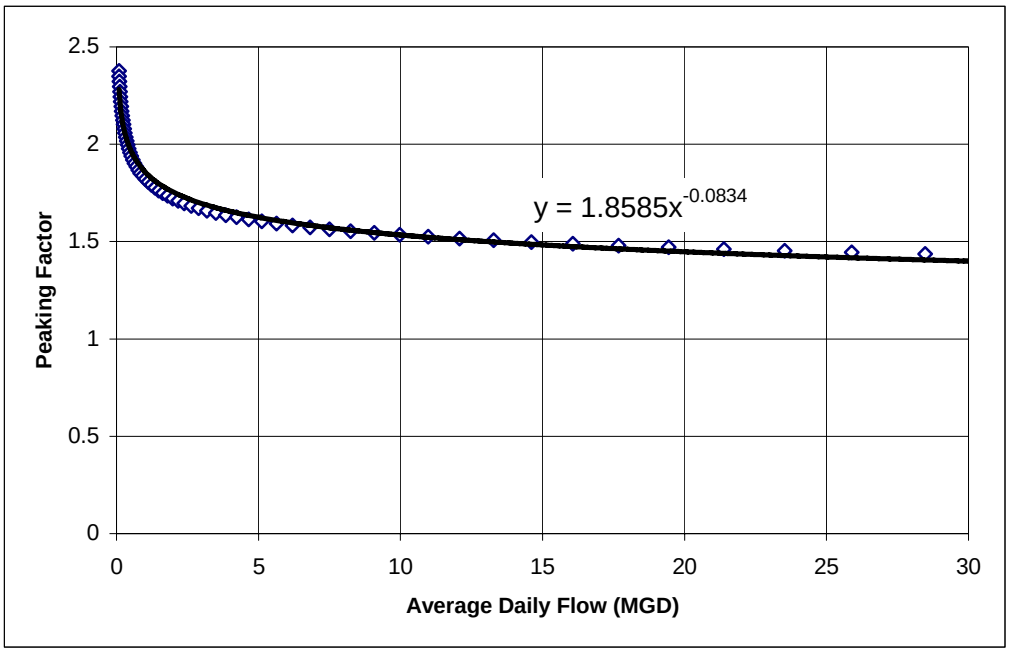
Upstream Population	Dry Weather Peaking Factor
1,001 – 10,000	$PF = (6.330 * p^{-0.231}) + 1.094$
10,001 – 100,000	$PF = (6.177 * p^{-0.233}) + 1.128$
More than 100,000	$PF = (4.500 * p^{-0.174}) + 0.945$

[1] Unless ductile iron or pipe or other design of equivalent or greater tensile and compressive strength is used.
[2] When flowing full, assuming Manning's formula and roughness coefficient of 0.013 are used.
[3] Unless ductile iron, or material of equivalent erosion resistance is used.

These three equations were consolidated to a single equation by assuming a per capita flow rate of 85 gpcd, plotting the results, and using regression analyses. The resultant curve fit and equation are indicated on **Figure 6-5**.

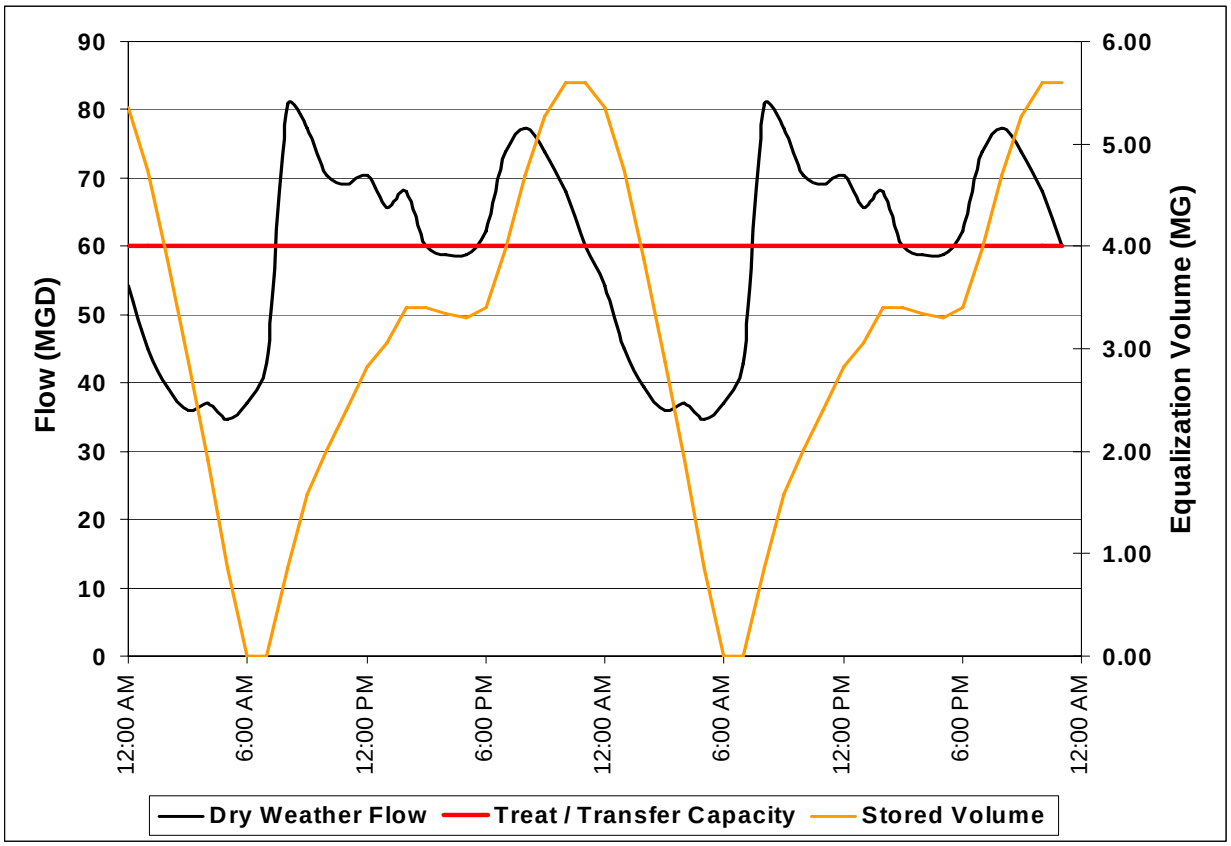
Peaking factor is of particular concern with regard to the evaluation of the plant interconnect pipeline. This is because this 5-mile large diameter sewer must be designed to convey peak flows, not just average daily flows. **Figure 6-6** represents the typical dry weather diurnal flow that is expected to reach the Roger Road WRF in the year 2030.

Figure 6-5
Consolidated Dry Weather Peaking Factor Curve



Peaking factor is of particular concern with regard to the evaluation of the plant interconnect pipeline. This is because this 5-mile large diameter sewer must be designed to convey peak flows, not just average daily flows. **Figure 6-6** represents the typical dry weather diurnal flow that is expected to reach the Roger Road WRF in the year 2030.

Figure 6-6
Diurnal Flow Equalization



6.4.4 Wet Weather Flow Allowance

The State Standards are somewhat vague in specifying how communities should design conveyance systems to accommodate peak wet weather flows. This is due to the site specific nature of wet weather events, which makes it difficult to develop a standardized approach to accommodate wet weather flows in a manner that would be appropriate for all conveyance systems. The standards state only that new collection system appurtenances should be designed to convey the 10-year event and that existing facilities should be able to do so within 10 years (See Chapter 6.4.2.). However, the standards also recommend allowing for wet weather flow as a percentage of peak dry weather flow or on a gpd/acre basis. Both techniques are applied to this analysis.

Referring to **Figure 6-2**, statistical flows data analyses seem to indicate that flows less than 10 mgd trend along a revised peaking factor curve that provides for sufficient capacity for system appurtenances to convey the peak 10-year flow without surcharging. The percentage of pipe capacity that remains for wet weather flows is also indicated.

However, for pipes with average dry weather flows over 10 mgd (those in more downstream reaches of the system as indicated by monitoring sites NRI-1, NRI-2, SRC-1, and SCE-1) the revised peaking factor curve is not applicable, most likely due to the unique nature of I/I in these downstream portions of the system. One possible explanation for the relatively high I/I recorded is that some of the older interceptors were constructed in the storm water washes, which can permit storm water flow to enter the sanitary system through manhole covers. Therefore, pipes with dry weather flows greater than 10 mgd the weighted average per acre wet weather flow rates from measured flows as indicated in **Table 6-4** were applied when evaluating pipe capacities. Peak flows in the portion of the system tributary to Roger Road were substantially higher than those to the Ina Road tributary area, therefore different peaking factors were used for their conveyance systems.

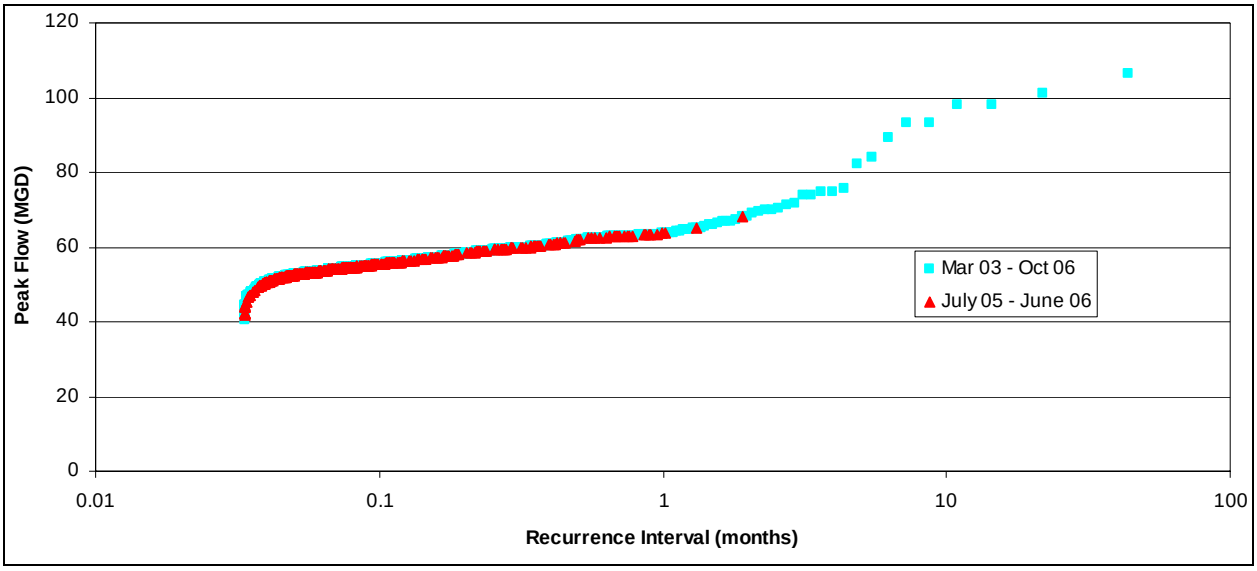
Table 6-4
Per Acre 10-Year Wet Weather Flow Rates

Meter Site	Service Area (acres)	10-Year Wet Weather Flow (mgd)	gpd/acre
NRI-1	110,190	11.16	101
NRI-2	101,249	17.97	177
Ina Road Service Area Weighted Average			**138**
SRC-1 (Roger Road WRF)	41,880	12.36	295

6.4.4.1 3-Year Roger Road WRF Flow Analysis

During the course of the development of the wet weather flows, it was noted that the 12-month flow monitoring period of July 2005 through June 2006 was relatively dry and might underestimate wet weather flows. Since the design of the plant interconnect pipeline is of particular concern, an analysis of 3.5 years of Roger Road WRF flows was performed to determine whether the 295 GPD/acre value is sufficiently conservative. The results of this analysis, utilizing plant flow data from March 2003 through October 2006, are presented on **Figure 6-7**. This frequency distribution of the peak flows into Roger Road WRF results in a 10-year peak wet weather flow to the plant of 110 mgd. Subtracting the median peak dry weather flow of 56 mgd results in a peak 10-year wet weather flow of 54 mgd or 264 gpd/acre (based on a service area of ~200,000 acres), approximately 10 percent less than what had been determined in the preceding analysis. The more accurate value was presumed to be 264 gpd/acre as it was based on a longer data period and has been used in subsequent pipe capacity analyses.

Figure 6-7
Roger Road WRF Peak Flow Frequency Distribution



6.4.5 Effluent Reuse

Effluent use for reclaimed water service does not impact the service area wastewater conveyance systems upstream of the wastewater treatment facilities at either Roger Road WRF or Ina Road WRF. The reclaimed water uses treated wastewater downstream of these facilities.

6.4.6 Odor Control / Conveyance Time

Odor generation, largely a function of conveyance time, was not evaluated as part of this study. A separate odor control model is being utilized for this purpose. However, the odor control model is based largely upon the hydraulic model used for this study. The pipe network and average daily flows generated by the hydraulic model described in the next chapter were used as input into a model that simulates odor generation. Odor control within the conveyance system is covered in a separate report on system-wide odor controls under development at the time of this report.

6.5 Evaluation of Conveyance System

A detailed engineering analysis of the capacity of the skeletal conveyance network to convey both dry and wet weather flows was performed. This analysis relied heavily on a hydraulic model to evaluate system performance under a variety of flow and system configurations.

6.5.1 Hydraulic Model Development

The 2006 Facility Plan utilized a "BASIN" model which relied on TAZ population data and subcatchment delineations to estimate inflows into the conveyance system. Wastewater flows were routed through the branched network by summing flows as they accumulated towards the treatment plants. This model evaluated the adequacy of conveyance system capacity by comparing estimated flows to the pipes' Manning's capacities, which are the theoretical full pipe capacities based on size, slope, and roughness. While a good base level tool, the BASIN model approach does not have the robust hydraulic computational ability to accurately evaluate system capacity.

In particular, this approach assumes that the Manning's capacity at a single location is representative of the pipe's overall capacity. However, in reality pipe slopes are not uniform, and if the segment used to calculate the Manning's capacity had a relatively flat slope in comparison to the upstream and downstream segments, the pipe might be able to carry far more flow than the initial Manning's capacity would indicate.

> *"Thus, individual sewer reaches within a sewer system can carry more than their calculated design capacity with no adverse consequences, while individual sewers within the sewer system can backup, overflow, and/or flood even while carrying flows well within their calculated design capacity. Consequently, it is necessary to define a system capacity independent of the calculated design capacity of the individual reaches of sewer."*[1]

The 2006 Facility Plan highlighted interceptors as orange and red if their capacities were found to be deficient. "The Orange classification identifies sections of the interceptor with potential capacity problems and suggesting only an engineering study to determine the severity of the problem." Further the report states, "The pipe capacity of the interceptor in the identified basin requires an engineering evaluation before being certified as being deficient." In addition, this model could not adequately predict the behavior of flow splits as stated, "This module worked with no problems for most cases, however at the time of model development, no reasonably effective way could be found for the GIS module to accommodate the numerous flow splits, such as the Tucson Boulevard Diversion…" The model developed as part of this study has the ability to simulate flow split hydraulics by inputting the physical parameters of the diversion structures.

The more robust model detailed in the remainder of this chapter will provide the capability to perform the engineering evaluations recommended in the Facility Plan. The model selected for performing engineering analyses is MOUSE, which is described in greater detail in the next chapter.

[1] Water Environment Federation, Guide to Managing Peak Wet Weather Flows, 2006.

6.5.1.1 Model Capabilities / Limitations

Developed by the Danish Hydraulic Institute (DHI), MOUSE is a powerful conveyance system computational modeling package. Similar to InfoWorks, MOUSE finds a complete solution to the St. Venant equations, which enables it to simulate virtually any hydraulic phenomena including open channel flow, surcharged and pressurized flow, reverse flow, weirs, gates, pump stations, overflows, backwater effects, all within a dynamic simulation that enables modelers to account for travel time, system storage and peak flow attenuation. MOUSE uses a variable time-step kinematic wave formulation to solve for the flow conditions, resulting in a high degree of computational accuracy and stability. In addition, DHI has developed MikeUrban, a GIS-centric model manager that greatly enhances the power of both modeling and GIS applications.

The graphical post-processor, MikeView, enables modelers to quickly evaluate and analyze simulation results. Quantities of interest such as conduit flows, flow depths, manhole flooding, available pipe capacity, are readily analyzed and displayed. Profiles of selected sewer segments can be viewed and animated to better comprehend system limitations and bottlenecks.

One of the limitations of MikeUrban is that it is challenging to have multiple constraints, boundary conditions, and loads applied to a subset of data, such as different per capita flows in different basins. Rather it uses a “population equivalent” (PE) value to account for variability in per capita flow rates. This issue arose during the Ina Road WRF sewershed calibration and ultimately, the population values were adjusted to a PE value that resulted in the appropriate wastewater flow rate. This issue will be addressed further in Chapter 6.5.1.3.

Most importantly the model is only as accurate as the information that was used to create it. The conveyance system GIS database was relied upon heavily for model development. Generally, only pipes 15-inch and larger were included. Pipe segments missing invert elevation data were identified and were interpolated for using the nearest upstream and downstream invert elevations. Approximately 13 percent of the pipe inverts were missing. In addition, there were obvious erroneous values which prevented network flows to be conveyed downstream; these were also corrected via interpolation. While all of these estimates were reasonable and should not adversely affect model accuracy within the scope of this master planning study, minor differences between simulated and actual hydraulics may occur.

6.5.1.2 Set-Up / Configuration

Model network was first simplified, or “skeletonized”, to remove manholes along pipes of uniform size and slope, thereby reducing simulation times without sacrificing accuracy. The modified network was imported into MikeUrban for final debugging. Plans for key hydraulic structures such as weirs, gates, and diversions, were used as the source documents for adding appurtenances to the model.

Using the basin population estimates from the TAZ data, loads were assigned to the model nodes. Generally, a visual inspection of pipe network connectivity was performed such that subcatchment loads were assigned to model nodes at the point on the interceptor where the majority of the subcatchment

flows seemed to discharge into it. This necessary simplification could result in excessive flows passing through some portions of the system, while some flows may short circuit other parts of the interceptor network. In general, these limitations should be considered minimal as subcatchment boundaries were delineated so as to minimize these errors.

Several point loads listed in the 2006 Facility Plan were added into the model. These flows came from sources such as the University of Arizona, the Davis-Monthan Air Force Base, and Tucson Mall. These loads could not be accounted from population databases.

There are several diversion structures in the collection system that regulate and split flow into the various interceptors. The following structures were included in the model so as to accurately simulate their hydraulics: Craycroft, Tucson Boulevard, 18th and Vine, and Alameda Siphon (**Figure 6-8**).

6.5.1.3 Calibration Summary

Hydraulic model of the conveyance system was calibrated using data from the BASIN model of the sewersheds and the flow meter data. The Roger Road WRF and the Ina Road WRF inflows were included. As for the BASIN model, for the Roger Road WRF system a per capita flow rate of 85 gpcd was used to estimate the load from each basin sub-basin. For the Ina Road WRF system, the variable per capita flow rates were accounted for recalculating the "population equivalent" to a value that matched the BASIN flow rates while using 85 gpcd.

A significant step in the model calibration was simulating the multiple diversion structures contained in the network. Examples include the Alameda Siphon, the Tucson Boulevard Structure, and the Craycroft Diversion (**Figure 6-8**). Some of the elevations contained within the record drawings did not match GIS data to preserve the hydraulics of the various structures, therefore relative elevations were used.

Once the model was debugged, a simulation was run using average dry weather flows (ADWF) and the results were compared to the meter data and the BASIN model flows. This comparison is shown graphically on **Figure 6-9**. Since the model essentially used the same loading technique as the BASIN model, MOUSE model flows would be expected to generally match those of the BASIN model rather than the flow monitoring data. However, the BASIN model used estimated flow splits at the diversion structures whereas the MOUSE model simulated diversion hydraulics resulting in some minor differences between the two.

Figure 6-8
Diversion Structure Locations

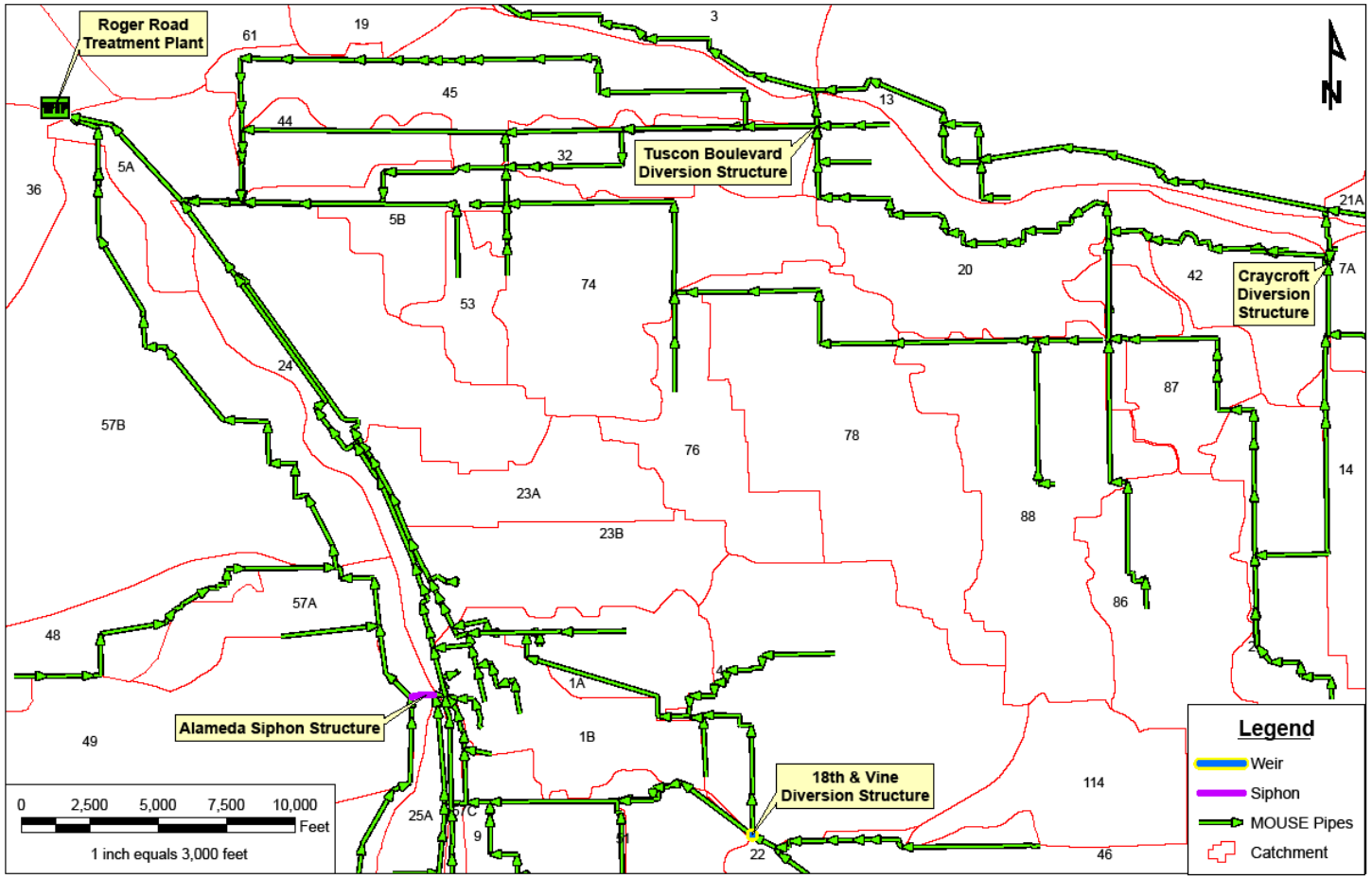
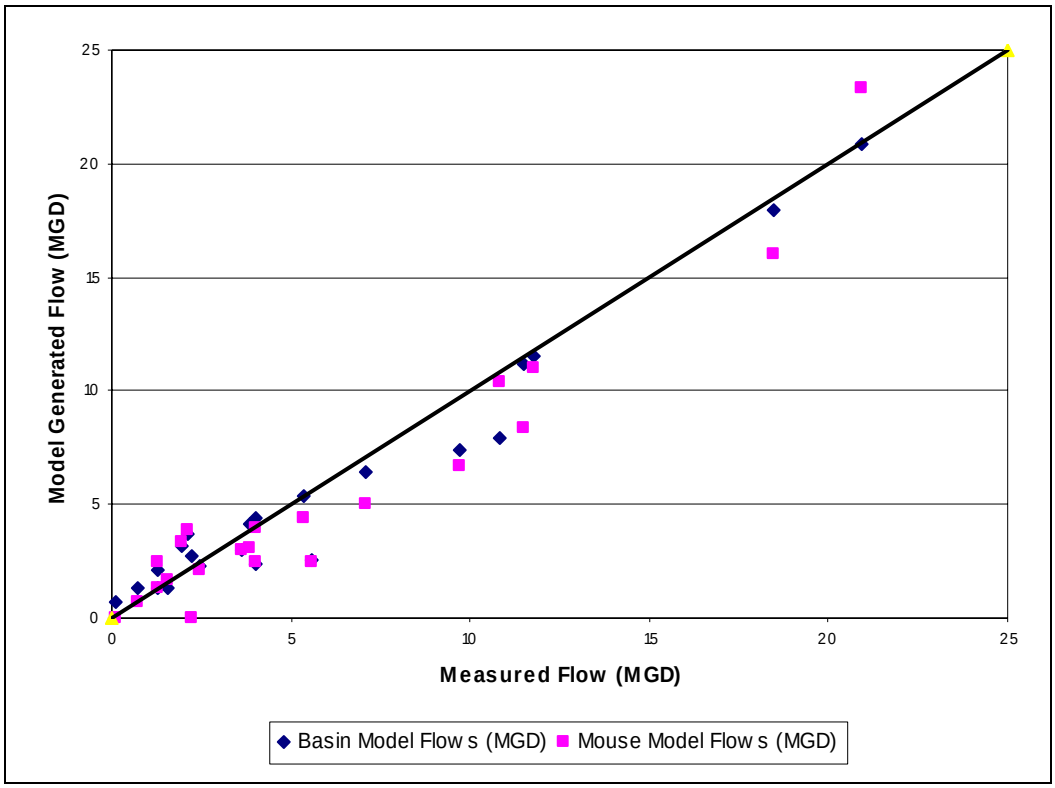


Figure 6-9
MOUSE Model Calibration

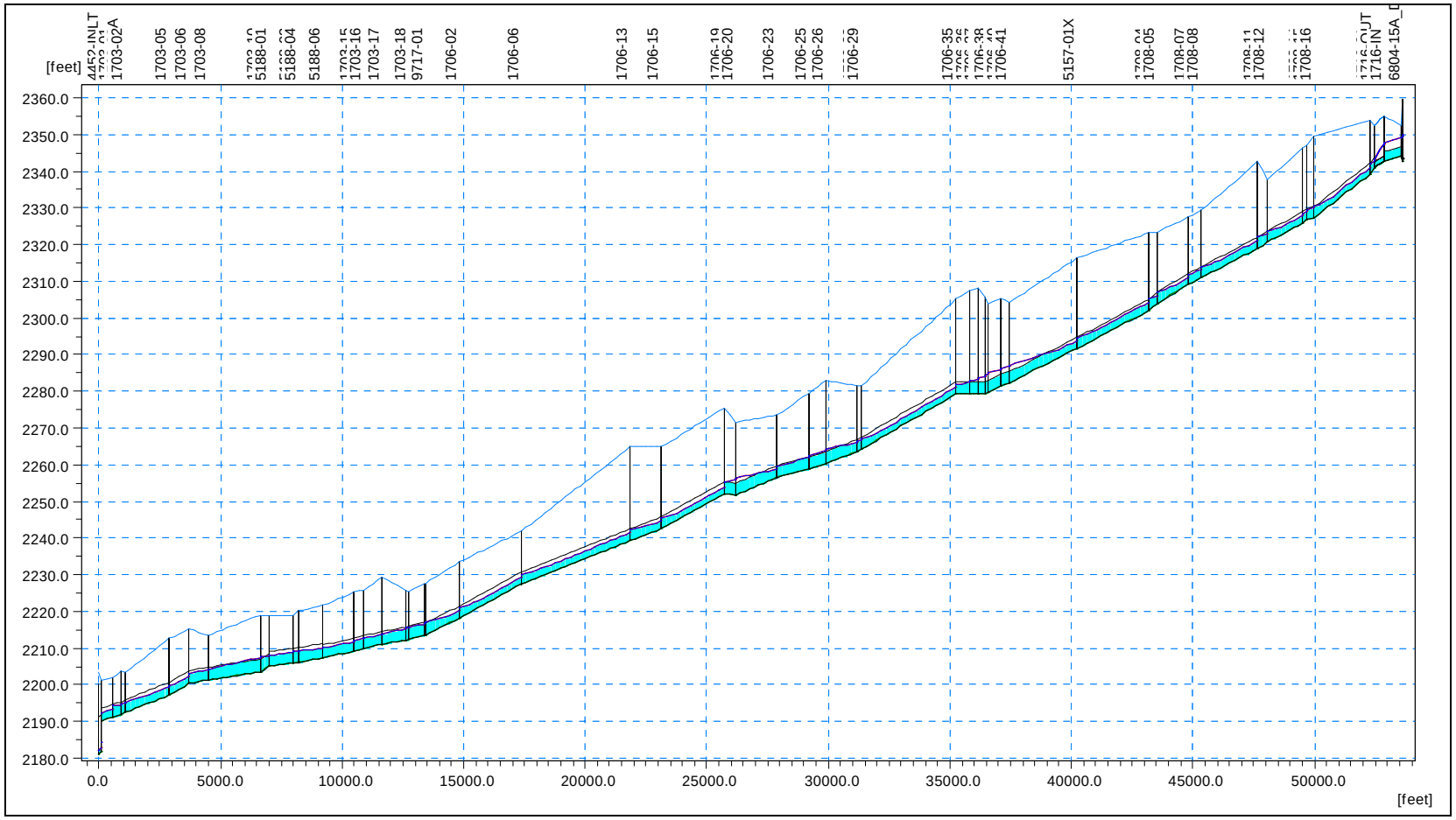


6.5.1.4 Tucson Boulevard Diversion Capacity Test

There has been some uncertainty as to the maximum amount of flow that could be diverted to the North Rillito Interceptor (NRI) via the Tucson Boulevard diversion structure. On July 28, 2005 a stress test was performed to maximize the flow through the diversion to the Ina Road WRF. This was done by closing the gate that allowed the flow to travel west to the Roger Road WRF, thereby transferring all flow north to the NRI. The test revealed that diverting approximately 12 mgd of flow into the NRI would reach the limit of its conveyance capacity without exceeding capacity

The conveyance system model was modified to simulate the same Tucson Boulevard diversion configuration to confirm that the results compared favorably to those of the stress test. For this test slightly more (13.5 mgd) of flow was diverted to the NRI. Flow monitoring data indicated depth of flow in the diversion to be 17 inches. The model predicted a depth of 25 inches. The difference is due in large part to the fact that the model simulated an additional 1.5 mgd of flow. The pipe profile on **Figure 6-10** is that of the simulation result. While the NRI is flowing slightly more than full in a few places, it is able to convey a maximum flow of 13.5 mgd of diverted flow reasonably well. However, additional flow may lead to excessive surcharging in some locations.

Figure 6-10
NRI Profile during Tucson Boulevard Diversion Stress Test



6.5.2 Planned System Upgrades

As of the completion of this evaluation the new Santa Cruz Central interceptor was the only planned system upgrade that was of a magnitude that warranted consideration. As of the date of publication of this report this sewer in under construction and not in service. For analyses it was presumed that this sewer would be placed into operation by the year 2010. Plans were obtained to determine the necessary physical sewer information to represent this new sewer in the hydraulic model.

6.5.3 Hydraulic Deficiencies / Excess Capacity

Referring to **Table 6-1**, there was no observed system surcharging during the 12-month flow monitoring period. This would seem to indicate that the system currently has sufficient capacity to accommodate existing dry and wet weather flows. However, a hydraulic simulation was run to evaluate the hydraulic adequacy of all elements of the skeletal network.

Once the model calibration was completed, a simulation was run under dry weather conditions with a typical diurnal pattern applied to system loads. **Figure 6-11** is a profile of the NWO sewer during peak dry weather flow. It is, for the most part, able to convey these flows at less than 85 percent of its peak capacity (75 percent full).

As a check of model results, the d/D of the model at the flow monitoring site was compared to the 12-month peak water levels from meter NWO-1. The model predicted a d/D of 0.56 while the median daily peak d/D from the monitoring data was 0.52, a difference of 8 percent.

This analysis indicates that a substantial portion of the downstream reaches of the NRI may be flowing at over 85 percent capacity. As a check of model results the peak d/D from the model was compared to that of the meter at site NRI-1. The model predicts a peak d/D of 0.65 while the median measured value was 0.56, indicating the model is conservative by 16 percent. A profile of this portion of the system from Shannon Road to the Ina Road WRF is shown on **Figure 6-12**. The portion of the sewer between manholes 1703-10 and 1703-06, which parallels I-10 just before crossing the interstate near Ina Road WRF, appears to be near capacity.

Figure 6-11
NWO Sewer Profile during Peak Dry Weather Flow

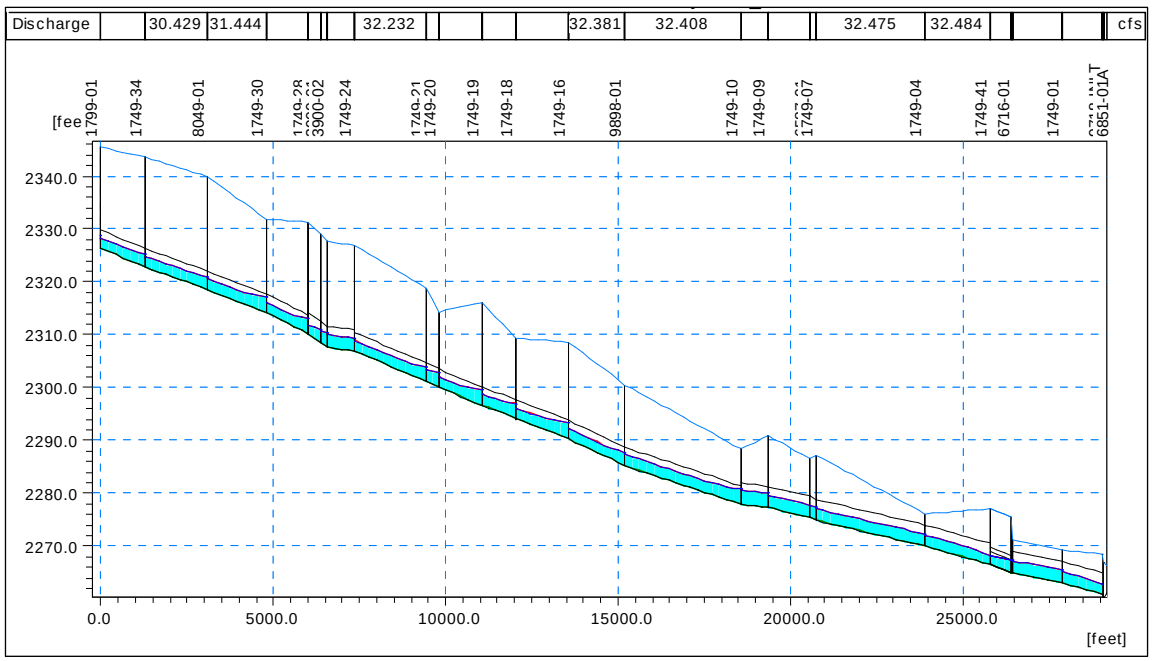
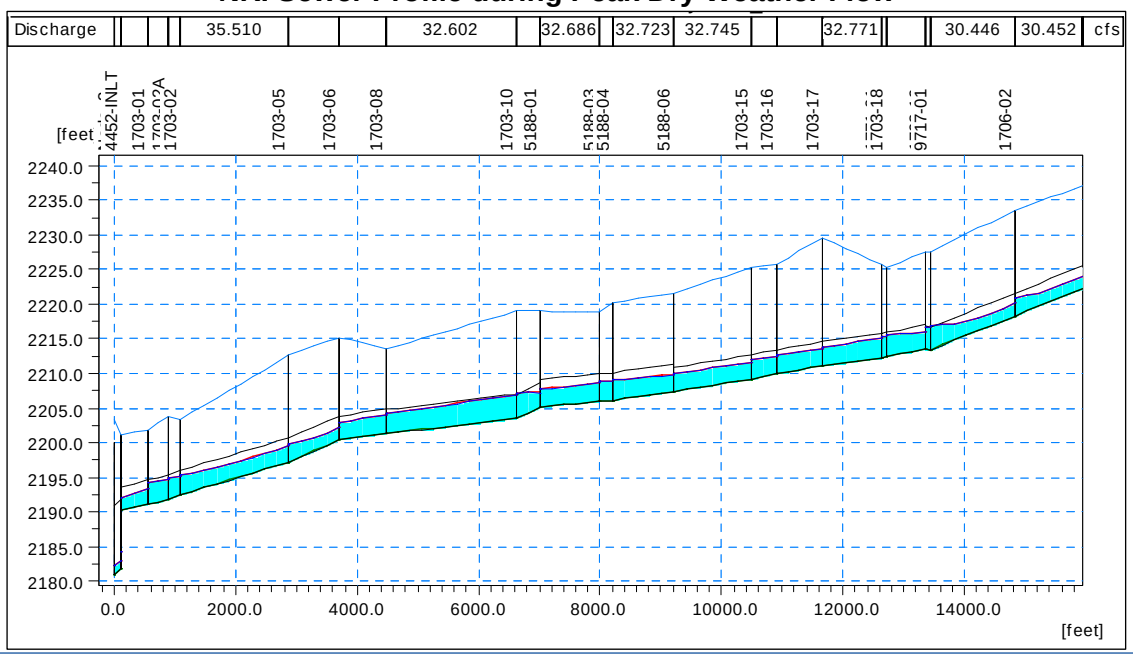


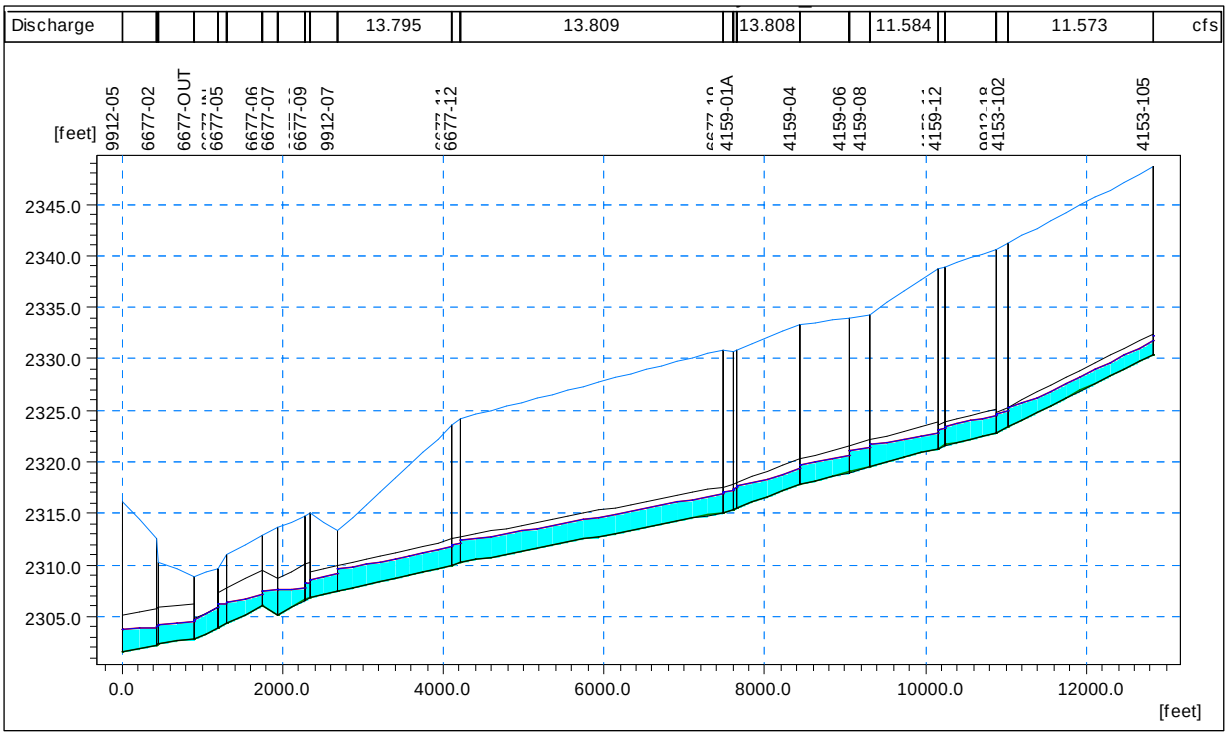
Figure 6-12
NRI Sewer Profile during Peak Dry Weather Flow



Portion of the Santa Cruz Central Interceptor (SCC) between the Alameda Siphon and Grant Road also appears to be flowing above 85 percent of its design capacity, however, no flow metering data are available with which to confirm these results. Nevertheless, a profile of this sewer shown in **Figure 6-13,** indicates that substantial lengths of this sewer are flowing near capacity. Installation of the new Santa Cruz Central interceptor by the year 2010 should alleviate the capacity issues of the NWO and SCC interceptors.

Figure 6-13

SCC Sewer Profile During Peak Dry Weather Flow



Further review of the conveyance system seems to conclude that with the exception of those sewer segments discussed above, the majority of the conveyance system currently has excess capacity available as indicated in **Figure 6-14**. The construction of the new Santa Cruz Central interceptor and plant interconnect pipeline should relieve these current hydraulic deficiencies.

A preliminary evaluation of the adequacy of the system to convey the 10-year event was also performed. This was done by applying the peaking factor curve to the ADWF for pipes with ADWF greater than 10 mgd. For those with ADWF less than 10-mgd wet weather flow was derived from the per acre 10-year wet weather flow rates. The resultant peak 10-year flow estimates were then compared to pipe design capacities as shown in **Figure 6-15**. Results of this analysis, has the pipes color coded according to the percentage of their capacities utilized during the 10-year event. For this evaluation flows are not considered excessive until they exceed 100 percent rather than 85 percent as the wet weather flow as discussed under peak pipe flows

Figure 6-14
2005 Hydraulic Capacity Evaluation

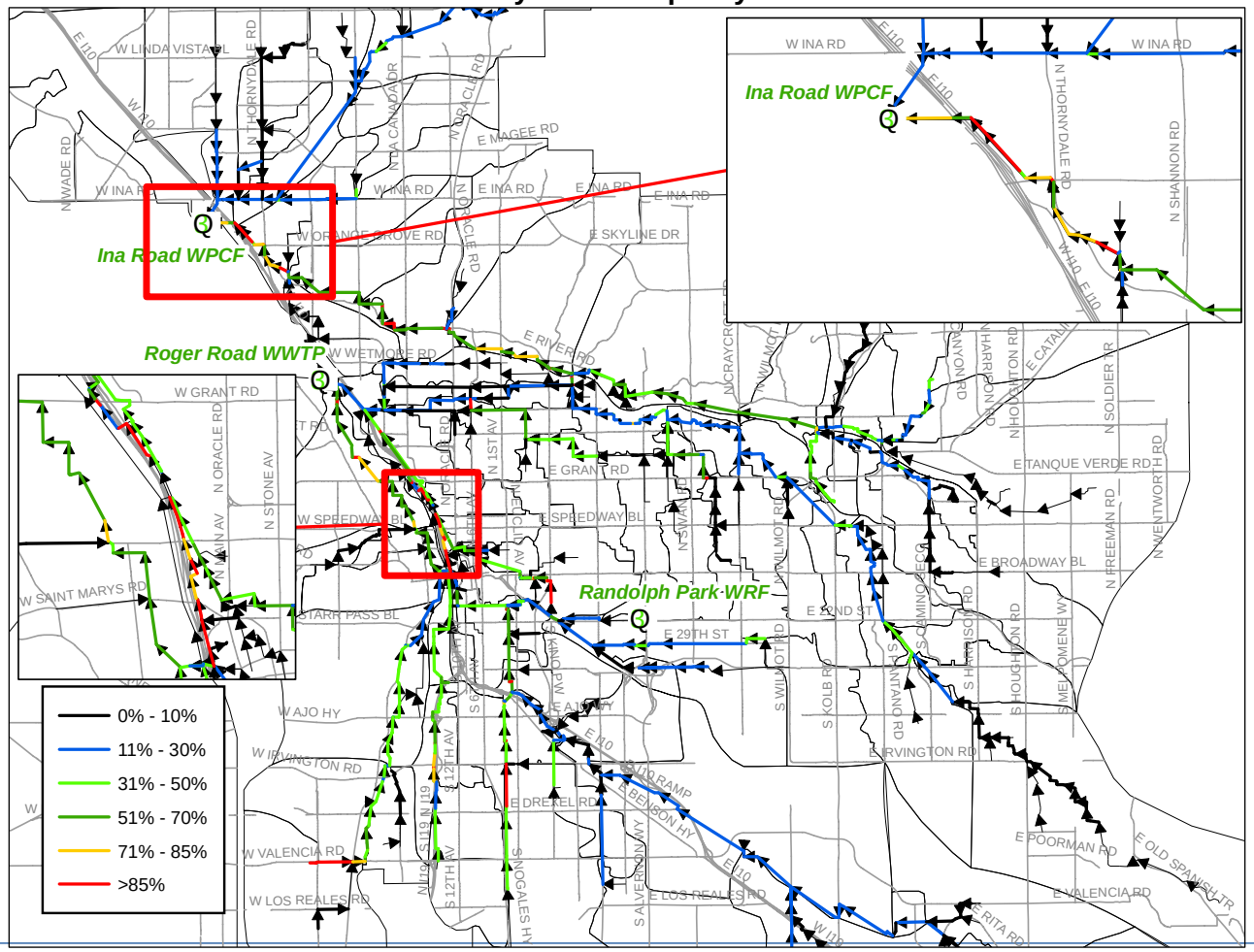
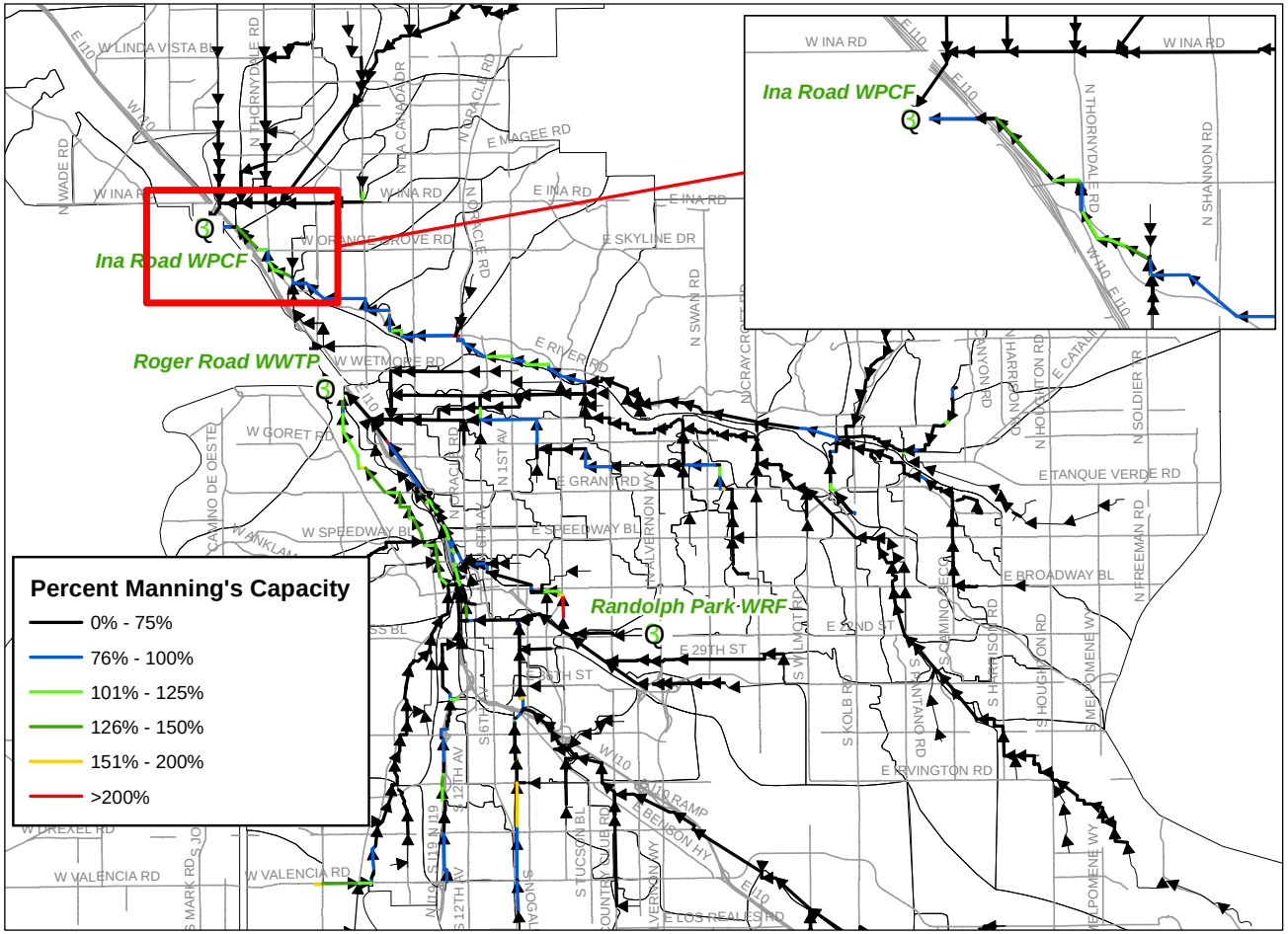


Figure 6-15
2005 Wet Weather Hydraulic Evaluation



6.5.3.1 2030 System Hydraulic Evaluation

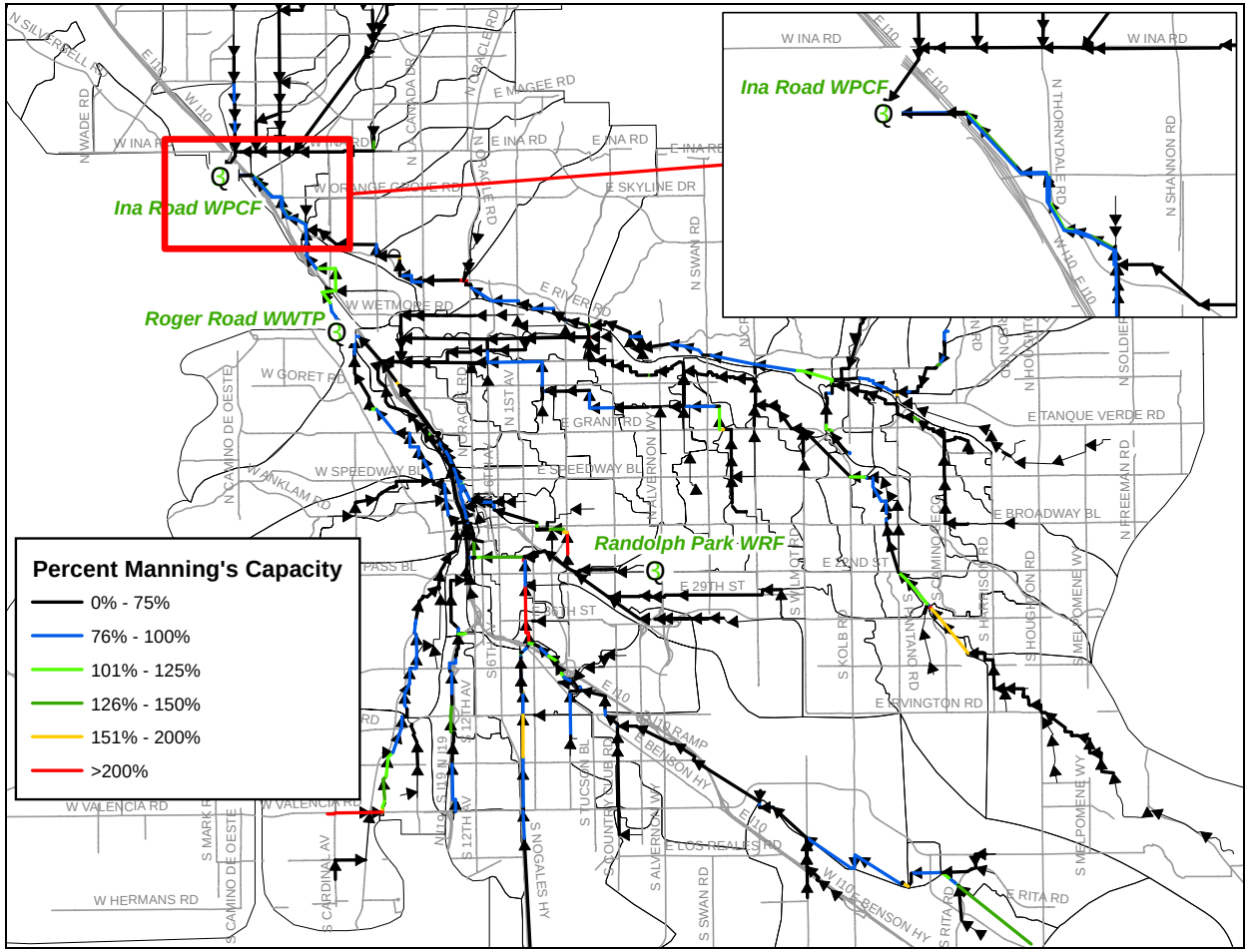
For this analysis a slightly more conservative approach was taken for the conveyance capacity evaluation than was used within the 2006 Facility Plan analysis. First of all, the Facility Plan presumed that as the Ina Road WRF service population expands, the per capita rates would remain at their 2005 levels. In addition, the Facility Plan presumed that those customers on septic would remain so in 2030. For this analysis, however, a per capita flow rate of 85 gpcd was used and all customers and those currently on septic were presumed to be served by PCRWRD by the year 2030. Finally, the revised peaking factor curve accounting for wet weather was used to compare estimated 2030 peak wet weather flows to pipe capacities.

Results of the hydraulic evaluation are presented on **Figure 6-16**, with pipes color coded according to the ratio of peak 10-year flow to pipe capacity. Non-Metro reaches of the SEI and PTI interceptors have inadequate capacities to convey the 10-year wet weather flows. Additional capacity will have to be provided for approximately 6 miles and 2.3 miles of these sewers, respectively. Of particular concern is the 2-mile stretch of the SEI flowing north from Interstate 10 (I-10) to 18th. This stretch of sewer will not have adequate capacity to pass the 2030 dry weather flows, and widespread sewer backups could occur during rainfall events.

From the model results an optimal flow balance will not be achieved between the existing Santa Cruz and new Santa Cruz interceptors. This is due in large part to the hydraulics of the structures at Alameda that divide the flows between these interceptors. This need not be a cause for great concern however, because as flows back up in one interceptor, it will push additional flow into the other, thereby balancing the flows during an actual peak wet weather event.

The North Rillito interceptor also appears to have some capacity issues in the year 2030. However, these could be mitigated by reversing the flow in the Tucson Boulevard diversion or Craycroft diversion to send additional flow to the SRI, which has excess capacity. Flow could then be transferred from Roger Road WRF service area to Ina Road WRF via the plant interconnect pipeline. The optimal balance of flow between the NRI and SRI is ultimately dependent on the route selected for the plant interconnect pipeline.

Figure 6-16
2030 Wet Weather Hydraulic Evaluation



6.5.3.2 Houghton Area Master Plan (HAMP)

A detailed hydraulic study of the Houghton Area Master Plan (HAMP) development was performed to analyze the impact that it will likely have on the flows in the interceptors that are expected to receive the additional flow.

A study report on the HAMP for the year 2030 included two sub-basin configuration scenarios. The first configuration matches that of the 2006 Facility Plan, while the second scenario redirects a portion of Basins 43B and 97 into Basin 113, with the resultant flow being redirected from the SEI to the Pantano Interceptor (PTI). This modification changes the populations that are connected to the SEI and PTI interceptors which were consequently updated in the model. The second scenario was replicated in the hydraulic model by overlaying TAZ and the revised sewer basins boundaries and updating the 2030 sub-basin populations accordingly. The model was then re-run and the output analyzed.

Results of scenario 1, which match the Facility Plan sub-basin delineation, is presented on **Figure 6-17**. Those pipe segments that are expected to be flowing at above their design capacities are highlighted. The corresponding labels indicate the pipes' expected 2030 flows, and the percent increases in capacity that would need to be provided to convey these flows with an appropriate peaking factor. Similarly, **Figure 6-18** indicates the simulation results with a portion of the HAMP flows redirected to the PTI. Under this scenario only the PTI would require an increase in capacity.

The overall effect of the second scenario is that flow is unloaded from the Southeast Interceptor and is re-routed into the PTI. While this proposal relieves the Southeast Interceptor of a significant portion of overloading, it does cause a large amount of the flow to backup in the PTI. Portions of the sewer limit the conveyance capacity and would need to be upgraded.

Figure 6-17
HAMP Capacity Analysis, SEI Scenario

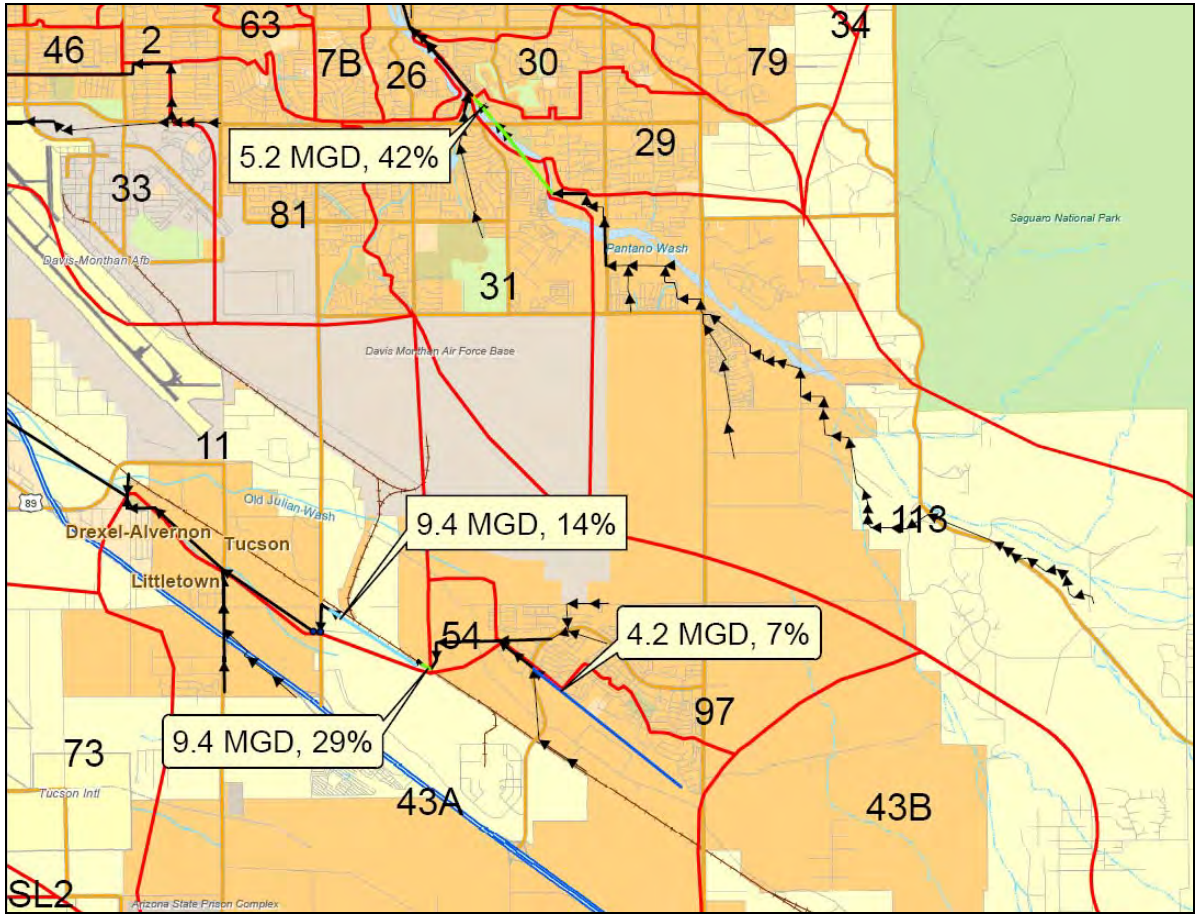
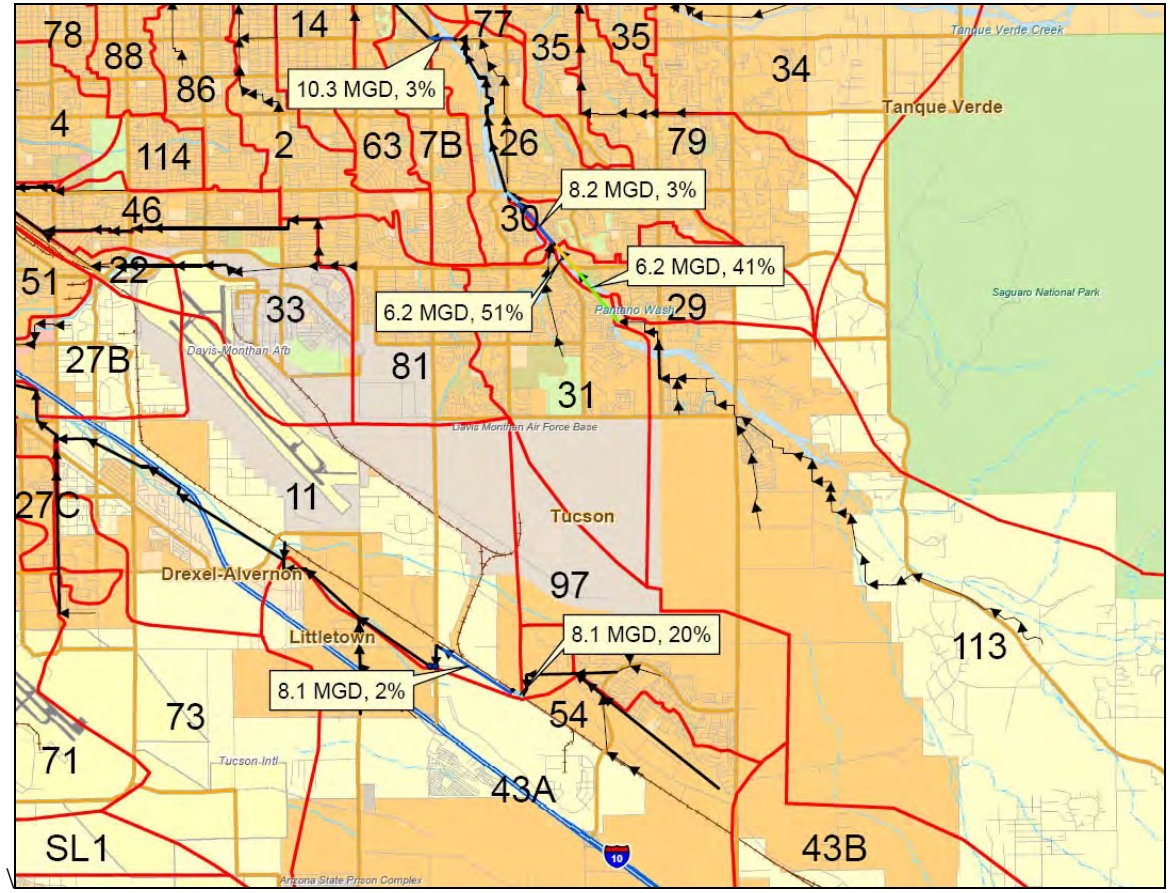


Figure 6-18
HAMP Capacity Analysis, PTI Scenario



6.5.4 Plant Interconnect

Ability to transfer flow between the Roger Road service area and Ina Road WRF is critical for the management of wastewater to accommodate growth. Based on current growth projections, it is anticipated that Roger Road WRF's capacity will be reached by the year 2011, or 2012. This interconnect, or some other method of transferring supplemental flows, to the Ina Road WRF must be placed into operation by this time. Because of the capacity limitations at Roger Road WRF, there is urgency in advancing the construction of the plant interconnect pipeline (Santa Cruz Interceptor Phase IV).

Three alternatives were given consideration for transferring flow between facilities. These include implementing the "Existing" plan specified in the 2006 Facility Plan, transferring "some" flow between the two facilities, and transferring all flow from the Roger Road service area to Ina Road WRF. The "Existing" plan is the selected option that best fits within the overall wastewater plan.

Regardless of which alternative is selected, there are effluent demands that must be met. For example, Tucson Water has stated that it requires 30 mgd at its Sweetwater facility for reclaimed water use. In addition, a minimum of 2 mgd to the Santa Cruz River may be required for maintenance of riparian habitat. Therefore, any alternative which involves treating less than 32 mgd at the Roger Road facility will require that the balance be pumped back from Ina Road WRF to supplement the effluent needs at that location.

6.5.4.1 Routing Alternatives

There are four route alternatives that were given consideration for conveying the wastewater from the Roger Road service area to the Ina Road WRF as shown on **Figure 6-19**. These are:

- Alternative 1 – Parallel existing sludge force main interconnect;
- Alternative 2 – Silverbell Road;
- Alternative 3 – Prince and Romero to El Camino Del Terra and De La Tierra;
- Alternative 4 – Alternative 3 route to El Camino Del Cerro, under I-10, then Alternative 1.

Alternative 3 makes it difficult to transfer the flow in the Santa Cruz interceptors and impossible to capture flows in the NWO, therefore it was eliminated from further consideration.

Which route is selected has a bearing on the design capacity of the plant interconnect pipeline. The reason is that the third and fourth alternatives involve joining the plant interconnect pipeline and the NRI at W El Camino Del Terra and N De La Tierra, and "augmenting" the NRI from that point to the Ina Road plant. Under this scenario that upstream portions of the NRI would need to be increased in order to accommodate the 10-year peak flow. However, additional capacity requirements are slight (generally less than 10 percent), and peak flows could likely be forced through with a minimum of surcharging until the point where the interconnect would meet it. From this point to the Ina Road plant, referred to as "Augmentation", the existing NRI will not have adequate capacity to convey the 10-year storm in 2030.

Therefore, a portion of its flow (13 mgd) would need to be transferred into the new plant interconnect pipeline, which would be sized to accommodate the additional flow.

The other two routing alternatives do not utilize any portion of the NRI. Therefore, in order to alleviate the capacity limitations in the downstream reaches of the NRI.Figure 6-16, the Tucson Boulevard diversion or Craycroft diversion (but not both) could be reversed in order to transfer flow from the NRI to the SRI, which has excess capacity. Once the transferred flow reaches the Roger Road plant site it could be conveyed to Ina Road WRF via the plant interconnect pipeline. Under this scenario, 13 mgd of the peak 10-year flow would need to be transferred from the NRI to the SRI, roughly half the flow in the NRI at this point.

The existing sewer configuration prevents a reversal of flow through either flow management structures to accomplish the diversion. Two alternatives were developed for reversing the diversion of flow through either the Tucson Boulevard or Craycroft diversion structures. The locations of these facilities are depicted on **Figure 6-20**. For Tucson Boulevard approximately 2150 feet of 36-inch pipe would need to be constructed in order to direct flow from the NRI to the SRI as indicated on Figure 6-21. This distance does not include the siphon under Rillito Creek, which could likely be used as is. Two options were considered for reversing the flow through the Craycroft structure (**Figure 6-22**). Option 2 is not considered a viable alternative as this would require surcharging the upstream collection system in order to divert the 13 mgd required. Option 1 would require constructing approximately 2950 feet of 30-inch pipe. The costs of the Tucson Boulevard and Craycroft - Option 1 alternatives are approximately $1.1M and $1.26M, respectively.

Figure 6-19
Plant Interconnect Routing Alternatives

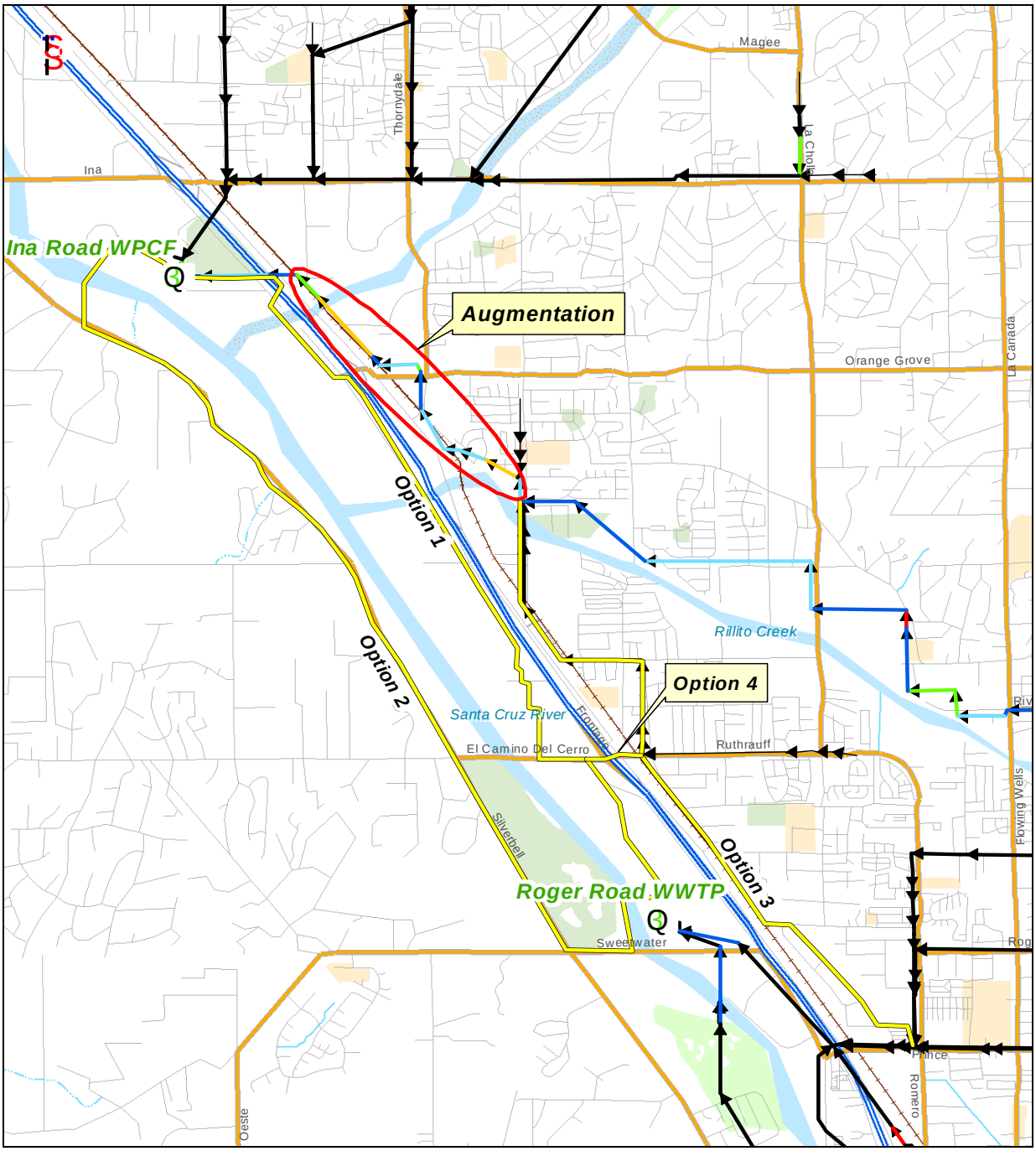


Figure 6-20
Tucson Boulevard and Craycroft Diversion Locations

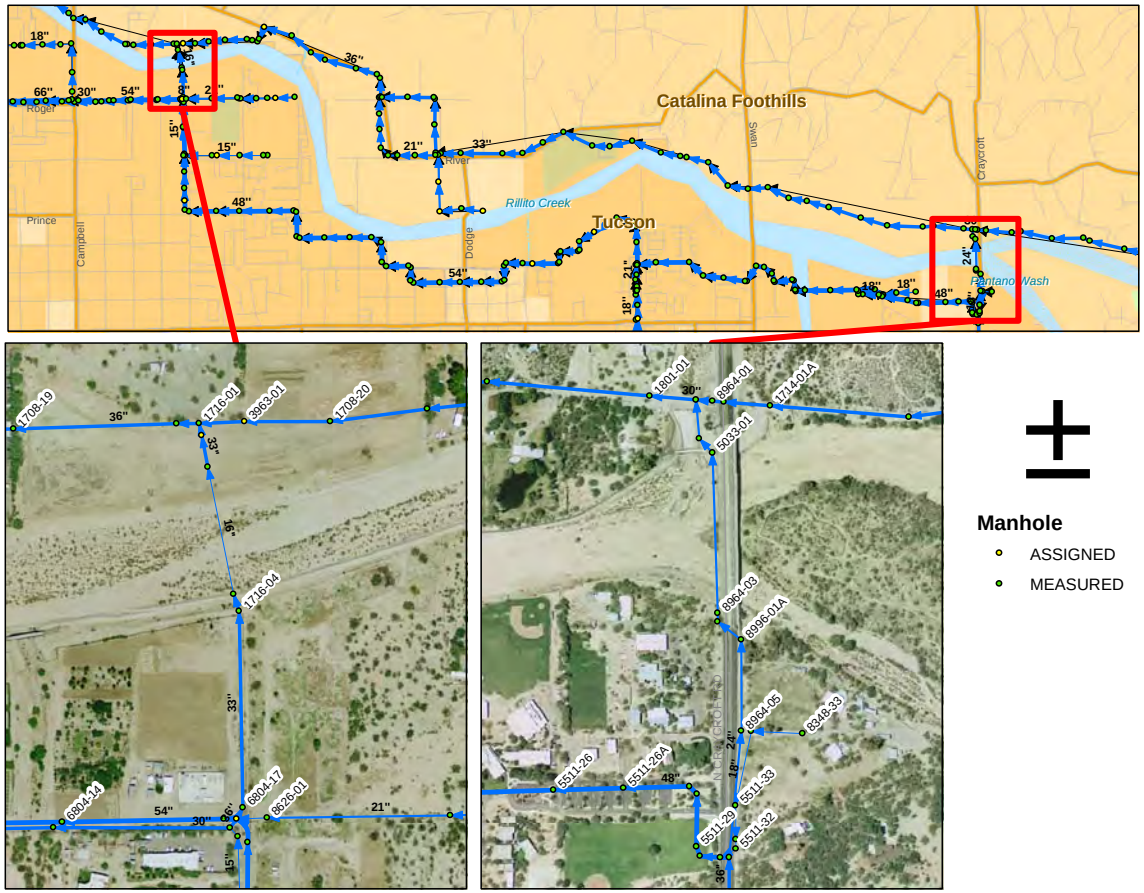


Figure 6-21
Tucson Boulevard 36-Inch Reverse Sewer

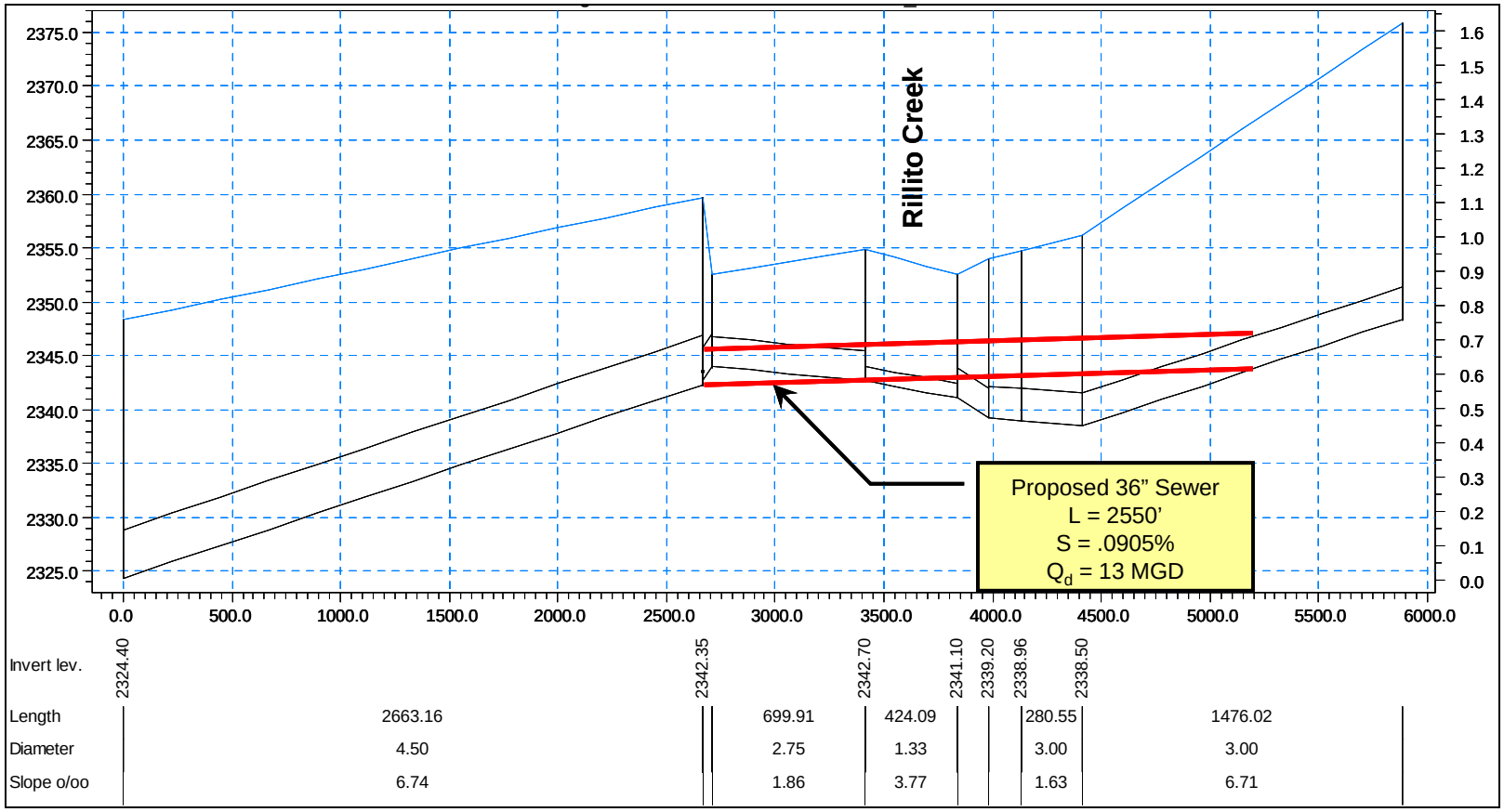
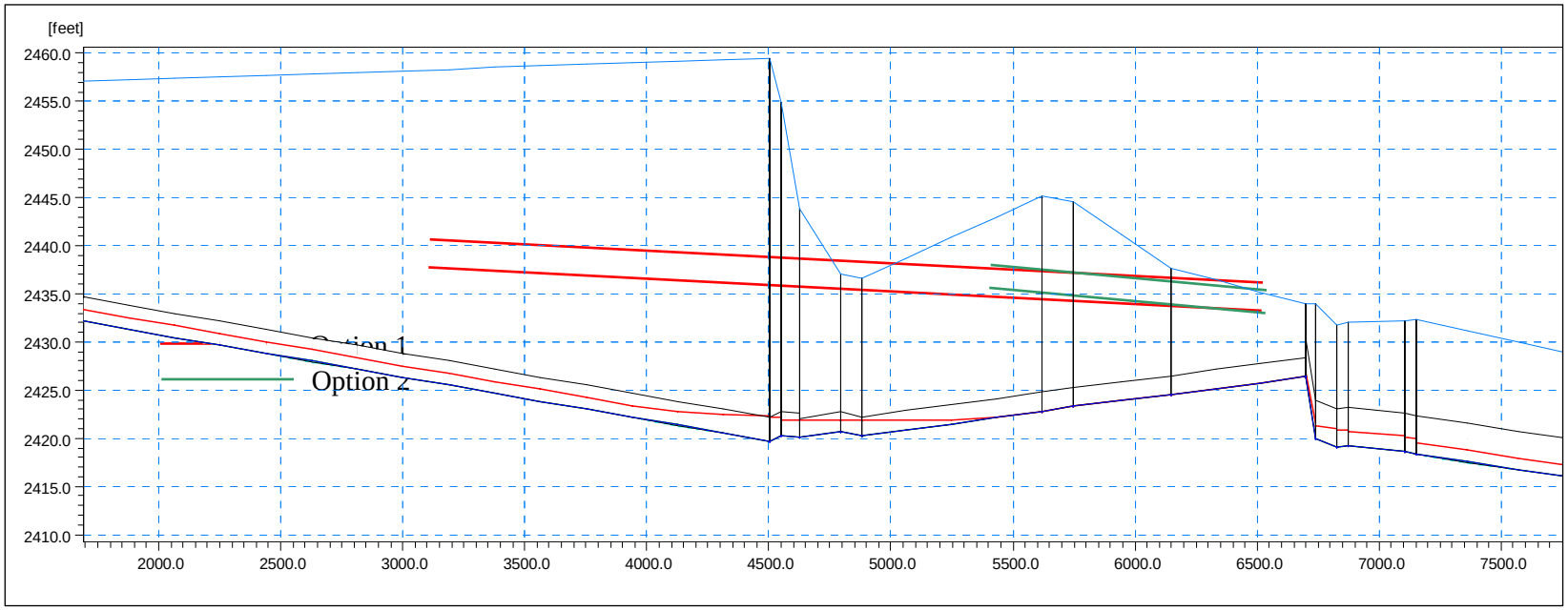


Figure 6-22
Craycroft 30-Inch Reverse Sewer



6.5.4.2 "Existing" Plan

The interconnect configuration for the existing plan calls for treating 32 mgd of the 60 mgd year 2030 ADWF at Roger Road WRF and transferring the remaining 28 mgd from the Roger Road service area to Ina Road WRF. However, these are average daily flows and do not consider peaking factors and wet weather impacts. To the ADWF of 60 mgd a peaking factor of 1.38 needs to be applied. With a service area of ~200,000 acres an additional 54 mgd of wet weather flow is added to be treated either at Roger Road WRF or conveyed to Ina Road WRF. Presuming the Roger Road plant will have a peaking factor of 2, the division of dry and wet weather flows between Roger Road WRF and Ina Road WRF could be as indicated in **Table 6-5**. This operational configuration would enable Roger Road WRF to operate in a steady-state mode during dry weather by transferring all dry weather flow diurnal variability to Ina Road WRF. In this operational configuration, in the year 2030, 3 to 50 mgd would be transferred to Ina Road WRF during dry weather. This transfer could increase to 72 mgd during wet weather. If additional flow is transferred to Roger Road WRF to alleviate the NRI, then the plant interconnect pipeline would require an additional 13 mgd (85 mgd total) of capacity. This was the target capacity used in the design of routing alternatives 1 and 2.

Table 6-5
2030 Flow Split, "Existing" Plan, Roger Road WRF Steady State

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	32	32	32	64
Transfer To Ina Road	28	3	50	22	72
Total	60	35	82	54	136

Another operational alternative could be to split the variability of dry weather flows between the Roger Road WRF and Ina Road WRF. This option would result in 2030 dry weather flows transferred to Ina Road t WRF o range from 17.5 to 41 mgd. However, as **Table 6-6** indicates, when wet weather flows are considered the design capacity of the plant interconnect pipeline becomes independent of the operational configuration of Roger Road.

Table 6-6
2030 Flow Split, "Existing" Plan, Roger Road WRF Variable Flow

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	17.5	41	23	64
Transfer To Ina Road	28	17.5	41	31	72
Total	60	35	82	54	136

If either routing alternatives 1 or 2 are selected, the plant interconnect pipeline will need to have an additional 13 mgd of capacity in order to accommodate the transfer of flow from the NRI, resulting in a design capacity of 85 mgd. If routing option 4 is selected, the pipe would require a design capacity of 72 mgd until it reaches the NRI, at which point its capacity would need to be increased to 85 mgd to alleviate overloading of the NRI.

6.5.4.3 Transfer Some

This alternative is similar to the "Existing" alternative, but calls for treating 20 mgd of ADWF at Roger Road WRF. A delineation of flows treated at Roger Road WRF and to be transferred to Ina Road WRF is indicated in **Table 6-7**. A treatment and wastewater transfer analysis has determined that this option is not economically viable.

Table 6-7
2030 Plant Flow Split, Transfer Some

	Qavg (mgd)	Qmin (mgd)	Qmax (mgd)	Q (Wet Weather) (mgd)	Q peak (mgd)
Roger Road WRF	20	12	26	14	40
Transfer to Ina	40	23	56	40	96
Total	60	35	82	54	136

6.5.4.4 Transfer All

Under this alternative the Roger Road WRF would be decommissioned. Therefore all peak dry and wet weather flows would need to be transferred from the Roger Road service area to Ina Road WRF. The resultant design capacity of the plant interconnect pipeline is 136 mgd.

If this alternative is selected, provisions will need to be provided to pump up to 37 mgd from Ina Road WRF back to Tucson Water's Sweetwater facility and the Santa Cruz River fro riparian habitat. The existing reclaim pipeline network does not have sufficient capacity to convey this volume of flow, so a new pump station and force main would be required. To reduce construction costs, this force main should be designed and constructed at the same time and in the same trench with the plant interconnect pipeline.

It is further noted that Tucson Water intends to construct additional infiltration basins on City of Tucson property along Interstate 1-10 north of Sweetwater Drive. The placement of the additional basins must be considered in the alignment of the plant interconnect pipeline.

6.5.4.5 Summary of Interconnect Alternatives

Preliminary designs of Routes 1, 2, and 4 under the "Existing" plan option were developed. These are indicated on **Figure 6-23**, **Figure 6-24**, and **Figure 6-25**. Pipes were sized according to the capacity requirements described above. Ground elevation profiles were derived from Pima County contour and digital elevation map (DEM) data. Pipe sizes and slopes were set to follow grade to the maximum extent practicable. Siphons were avoided to the maximum extent possible, because they can cause operational difficulties. Nevertheless, all routes will require at least one siphon.

Pipe profiles include information on scouring flows for each segment of pipeline. This is the minimum flow required to maintain a scouring velocity of 2.5 fps in the pipe. At flows less than the scour flow sedimentation is more likely to occur and accumulate within the system.

Figure 6-23
Alternative 1 Plant Interconnect, Existing Sludge Force Main Route Plan

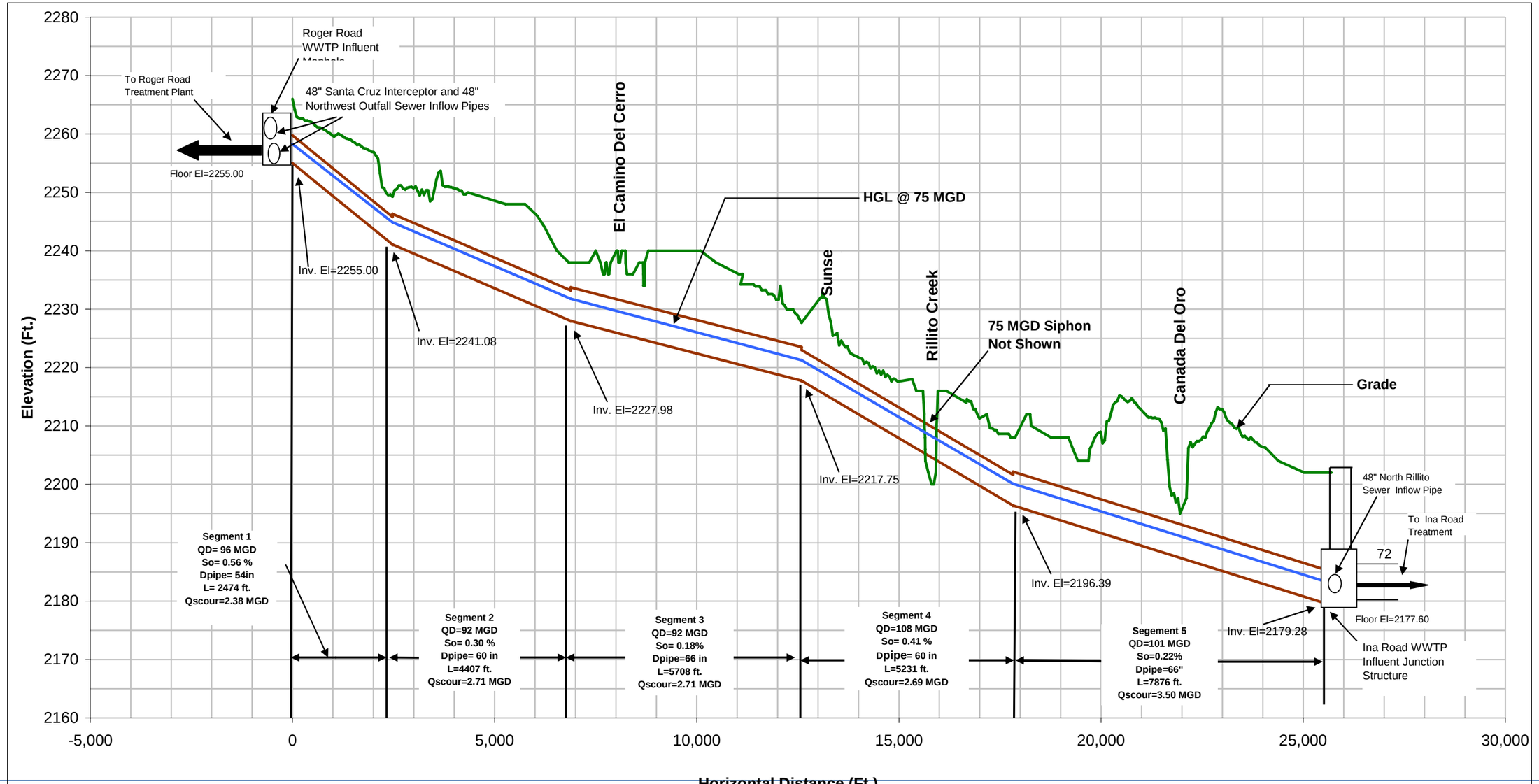


Figure 6-24
Alternative 2 Plant Interconnect, Silverbell Road Route

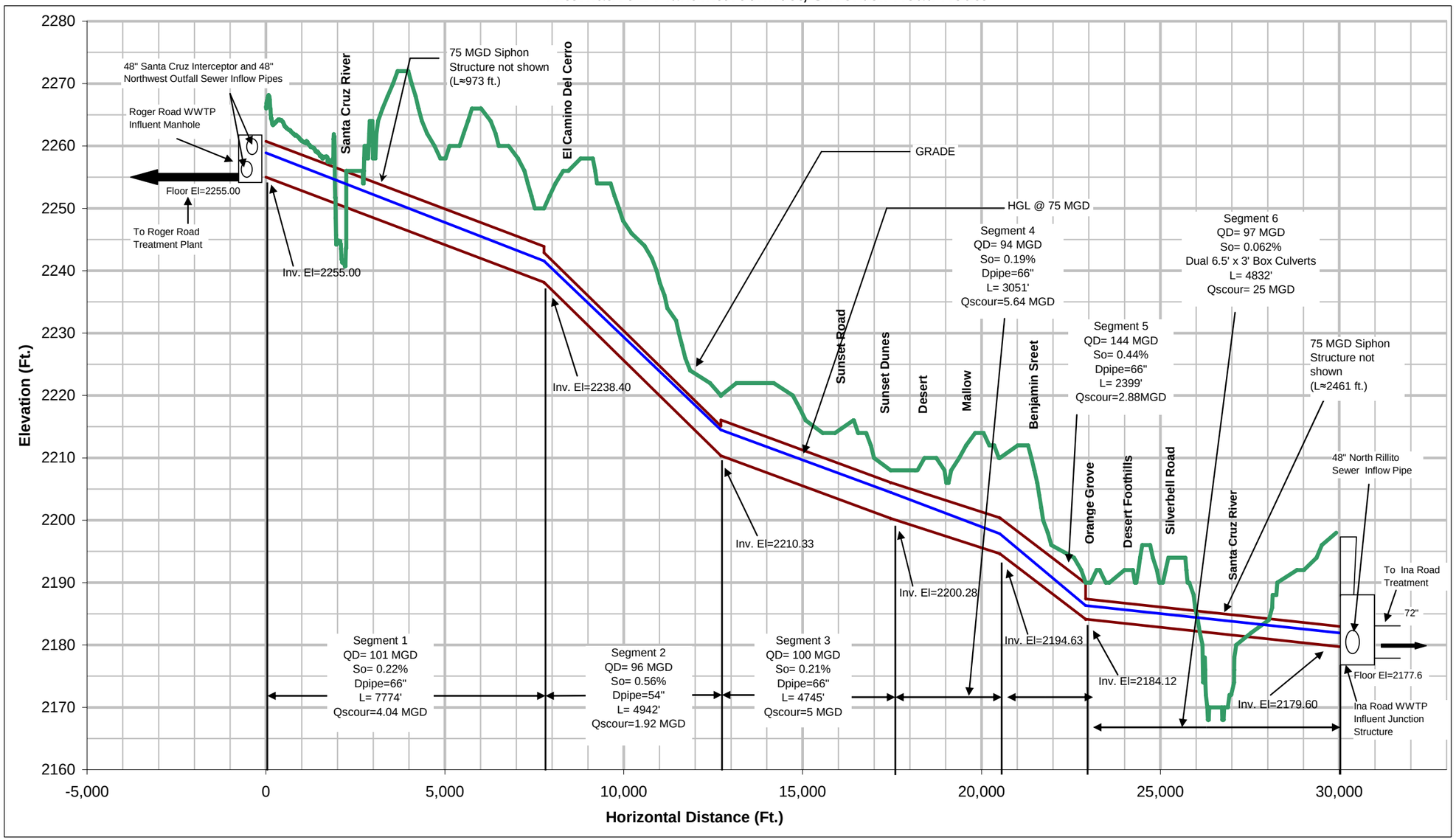
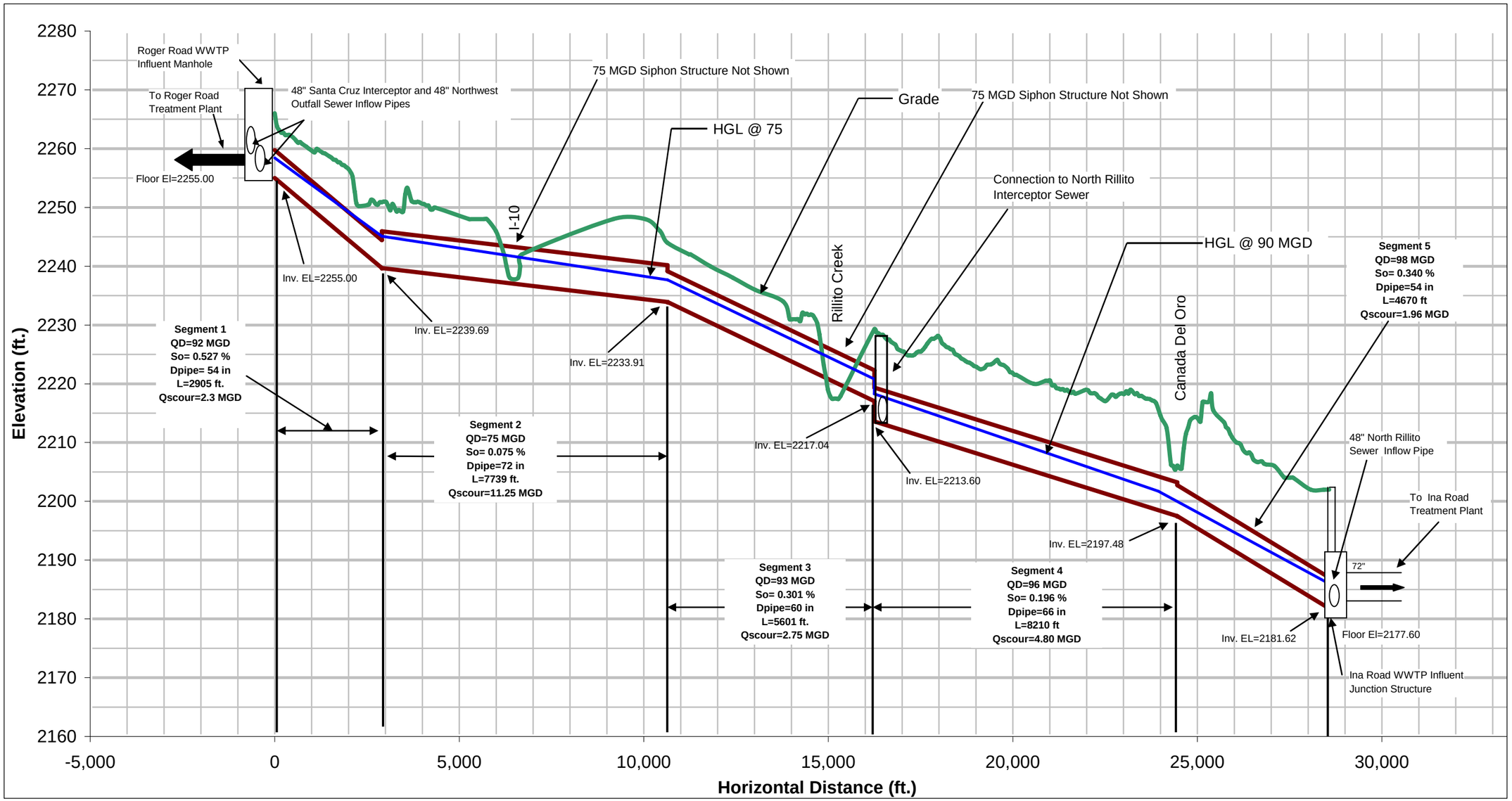


Figure 6-25
Alternative 3 Plant Interconnect, Combine Alternative 1 and 3 Route



Findings of the plant interconnect pipeline analyses is provided in **Table 6-8**. Costs were derived using the unit costs described in a later subchapter of this chapter. These are for construction costs only, and do not include engineering or contingency costs for purchase of right-or-way or realignment of the existing sludge force main in the Route 1 alternative.

Table 6-8
Summary of Interconnect Alternatives

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	54" - 66"	$18.90	R.O.W. acquisition
	Route 2	54" - 66"	$29.60	
	Route 4	54" - 72"	$28.00	
Transfer Some	Route 1	54" - 60"	$17.80	R.O.W. acquisition
	Route 2	54" - 66"	$28.90	
	Route 4	48" - 66"	$25.90	
Transfer All	Route 1	66" - 96"	$26.70	R.O.W. acquisition
	Route 4	72" - 84"	$37.10	

6.5.4.6 Interim Solution – Transfer of Additional Flow to Ina Road WRF

Plant capacity is anticipated to be exceeded at the Roger Road WRF in the year 2011 or 2012. The plant interconnect pipeline should be operational by then, although an interim solution for transferring additional flow to Ina Road WRF may be necessary as a contingency. While not preferable due to the limited capacity of the NRI, analyses revealed that as much as 12 mgd of additional flow could be diverted from the SRI to the NRI during dry weather. This capacity for dry weather flow may provide up to an additional 6 mgd of transfer flow to Ina Road WRF. This may serve as an interim solution during the design and construction of the plant interconnect pipeline, if needed.

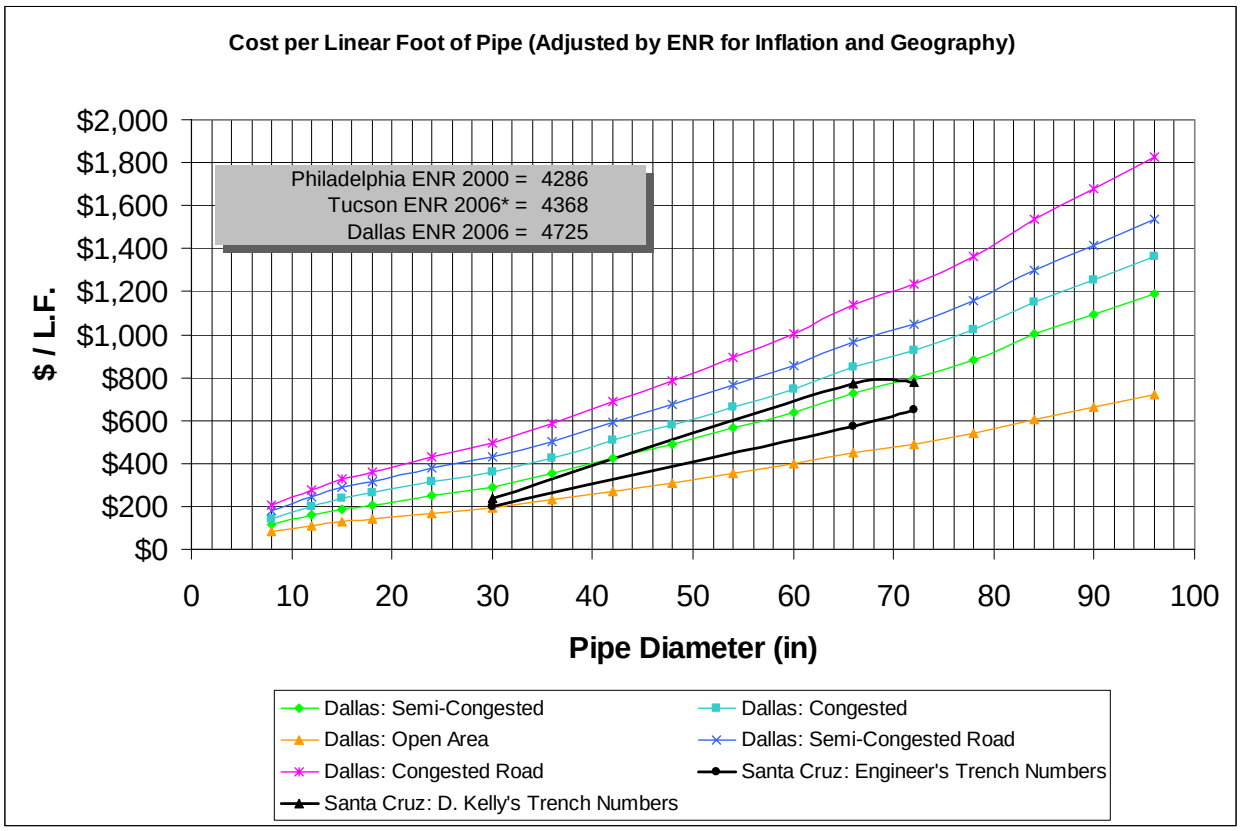
However, this transfer of additional flow should only take place during periods of dry weather. Wet weather flows can quickly exceed the capacity of the NRI contributing to sewer surcharging. Therefore, the diversion of the additional flow would need to be limited to dry weather, or when the NRI has

adequate capacity available. Control of the diversion of flow from the SRI to the NRI may require the installation of a set of gate operators and controls to avoid overloading the NRI.

6.6 Cost Comparisons

Preliminary cost curves were developed which depict pipe unit costs vs. size. The result is a family of curves with each cost curve representing a uniform level of construction "congestion" (**Figure 6-26**). These cost curves had originally been developed in 2000 for the City of Richmond, Virginia, with the nearest ENR Index city being Philadelphia. These unit costs were converted to the 2006 values of the ENR Index city of Dallas, Texas, which represents similar cost factors to Pima County. Finally, these curves were calibrated to match the lowest bid for the construction of the new Santa Cruz interceptor. This was done by creating a Tucson ENR Index which was adjusted to obtain a reasonable fit between the "semi-congested" cost curve and the lowest construction cost bid tab.

Figure 6-26
Sewer Construction Cost Curves



For expediency in developing cost estimates, pipe costs were simplified into a $/inch*ft basis. The result is a single unit cost for each level of congestion as indicated in
Table 6-9. The weighted average value at the bottom of each column was used in the development of all sewer costs.

Table 6-9
Sewer Construction Unit Costs

	$ / (inch*ft)				
D_{pipe} (in)	Semi-Congested	Congested	Open Area	Semi-Congested Rd.	Congested Road
8	14.32	18.06	10.22	22.52	25.44
12	13.37	16.76	8.92	20.29	23.08
15	12.58	15.88	8.42	19.17	21.84
18	11.55	14.56	7.78	17.64	20.17
24	10.53	13.08	6.93	15.70	18.07
30	9.74	11.98	6.53	14.28	16.51
36	9.77	11.86	6.43	14.01	16.28
42	10.05	12.05	6.46	14.02	16.33
48	10.20	12.12	6.45	14.00	16.36
54	10.43	12.30	6.53	14.13	16.56
60	10.61	12.44	6.60	14.25	16.74
66	11.06	12.88	6.78	14.66	17.25
72	11.04	12.82	6.75	14.56	17.16
78	11.33	13.09	6.90	14.83	17.50
84	11.91	13.70	7.19	15.46	18.28
90	12.17	13.96	7.36	15.74	18.64
96	12.41	14.19	7.53	16.02	19.00
Weighted Average =	**$11.26**	**$13.22**	**$7.01**	**$15.18**	**$17.81**

6.7 Capital Improvement Plan

The hydraulic analyses and the unit costs development were compiled to develop a CIP for the conveyance system over the 25-year planning period. Recommended system improvements are indicated on **Figure 6-27**. The 2030 wet weather flow simulation was the primary means of determining which sewers would require upsizing. However, not every pipe expected to flow at over 100 percent of design capacity in the year 2030 was recommended for replacement. From experience it was presumed that pipes could carry more than their design capacities with an acceptable amount of surcharging in a 10-year event. Only those expected to carry over 125 percent of their design capacity during a 10-year storm and having a length of at least 500' were recommended for replacement.

Corresponding costs are detailed in **Table 6-10**. The costs are provided in 2006 dollars and include an allowance for engineering at 15 percent and a contingency allowance of 30 percent. Years in which these system improvements are forecast to be constructed are included on the table.

Figure 6-27
Capital Improvement Projects

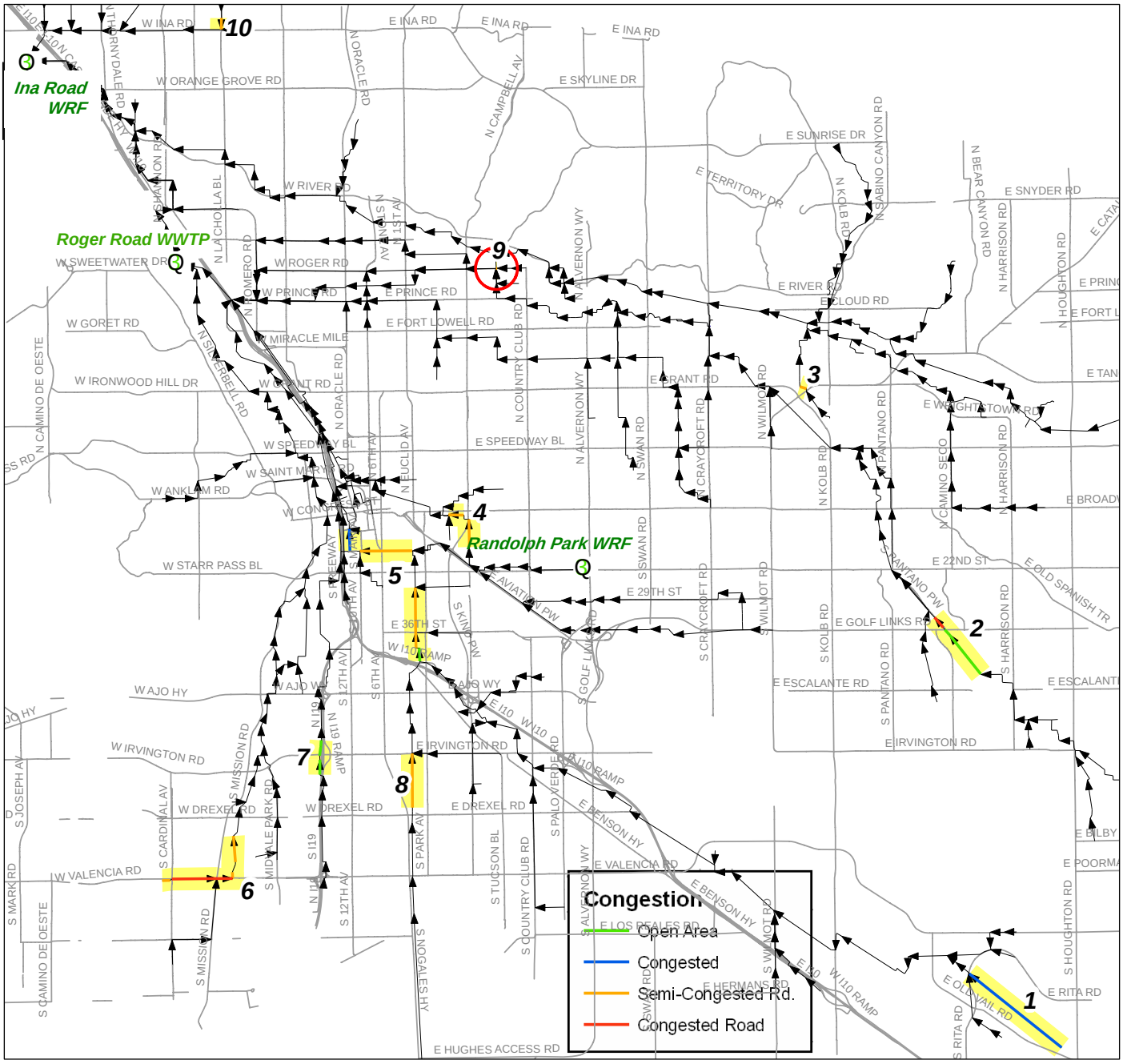


Table 6-10
Capital Improvement Plan Costs

Project	MH Start	MH End	Year	Item	Qty.	Units	Unit Cost	Costs				Type
								Constr. (X1,000)	Eng. Services (X1,000)	Contingency (X1,000)	Total (X1,000)	
1	4636-30A	4190-05A	2020	Replace 18" pipe with 21"	10,336	FT	$290.22	$3,000	$450	$900	$4,350	Congested
				Project 1 Subtotal							*$4,350*	
2	6036-21	3979-101	2015	Replace 18" pipe with 24"	1,183	FT	$433.58	$513	$77	$150	$740	Congested Road
	3919-01	8031-01		Replace 18" pipe with 24"	5,486	FT	$166.33	$913	$137	$270	$1,320	Open Area
				Project 2 Subtotal	*6,669*						*$2,060*	
3	8635-11	8635-10	2020	Replace 18" pipe with 21"	620	FT	$350.02	$217	$33	$60	$310	Semi-Congested Road
				Project 3 Subtotal	620						*$310*	
4	5627-08A	9907-49	2010	Replace 18" pipe with 21"	5,050	FT	$376.69	$1,902	$285	$573	$2,760	Semi-Congested Road
				Project 4 Subtotal	*5,050*						*$2,760*	
5	8130-01	1779-02	2015	Replace 30" pipe with 42"	1,153	FT	$271.29	$313	$47	$90	$450	Open Area
	9917-20	9910-21		Replace 33" pipe with 36"	5,402	FT	$504.30	$2,724	$409	$817	$3,950	Semi-Congested Road
	5667-01	5662-01		Replace 30" pipe with 42"	3,875	FT	$588.64	$2,281	$342	$687	$3,310	Semi-Congested Road
	1779-02	5667-01		Replace 30" pipe with 42"	1,415	FT	$588.64	$833	$125	$252	$1,210	Semi-Congested Road
	9910-21	9910-19		Replace 36" pipe with 42"	550	FT	$506.07	$278	$42	$80	$400	Congested
				Project 5 Subtotal	*12,395*						*$9,320*	
6	8149-05	1726-29	2010	Replace 15" pipe with 21"	3,943	FT	$401.46	$1,583	$237	$480	$2,300	Congested Road
	3983-05	8149-05		Replace 15" pipe with 24"	887	FT	$376.69	$334	$50	$96	$480	Semi-Congested Road
	1726-29	1726-26		Replace 18" pipe with 24"	1,388	FT	$433.58	$602	$90	$178	$870	Congested Road
	1726-26	1726-19		Replace 24" pipe with 30"	3,776	FT	$428.37	$1,618	$243	$489	$2,350	Semi-Congested Road
				Project 6 Subtotal	*9,994*						*$6,000*	

Table 6-10 (Continued)
Capital Improvement Plan Costs

Project	MH Start	MH End	Year	Item	Qty.	Units	Unit Cost	Costs				Type
								Constr. (X1,000)	Eng. Services (X1,000)	Contingency (X1,000)	Total (X1,000)	
7	4630-09	4630-02	2015	Replace 21" pipe with 24"	3,013	FT	$166.33	$501	$75	$154	$730	Open Area
				Project 7 Subtotal	*9,994*						*$730*	
8	1751-09	1751-01	2010	Replace 18" pipe with 24"	4,712	FT	$376.69	$1,755	$266	$529	$2,570	Semi-Congested Road
				Project 8 Subtotal	*4,712*						*$2,570*	
9	8626-01	6804-15A	2010	Replace 8" pipe with 15"	100	FT	$287.54	$29	$4	$7	$40	Semi-Congested Road
				Project 9 Subtotal	*100*						*$40*	
10	9521-02	9549-05	2020	Replace 15" pipe with 18"	1,006	FT	$317.51	$319	$48	$93	$460	Semi-Congested Road
				Project 10 Subtotal	*1,006*						*$460*	
Misc			2010	Fully Open Gate at Manhole 9910-21 Diversion								
	1708-22	6804-15A		36" Reverse Sewer	2,150	FT	$504.00	$1,084	$163	$323	$1,570	
Grand Total								**$20,819**	**$3,123**	**$6,228**	**$30,170**	

*Project Numbers referenced on **Figure 6-27**

CHAPTER 7

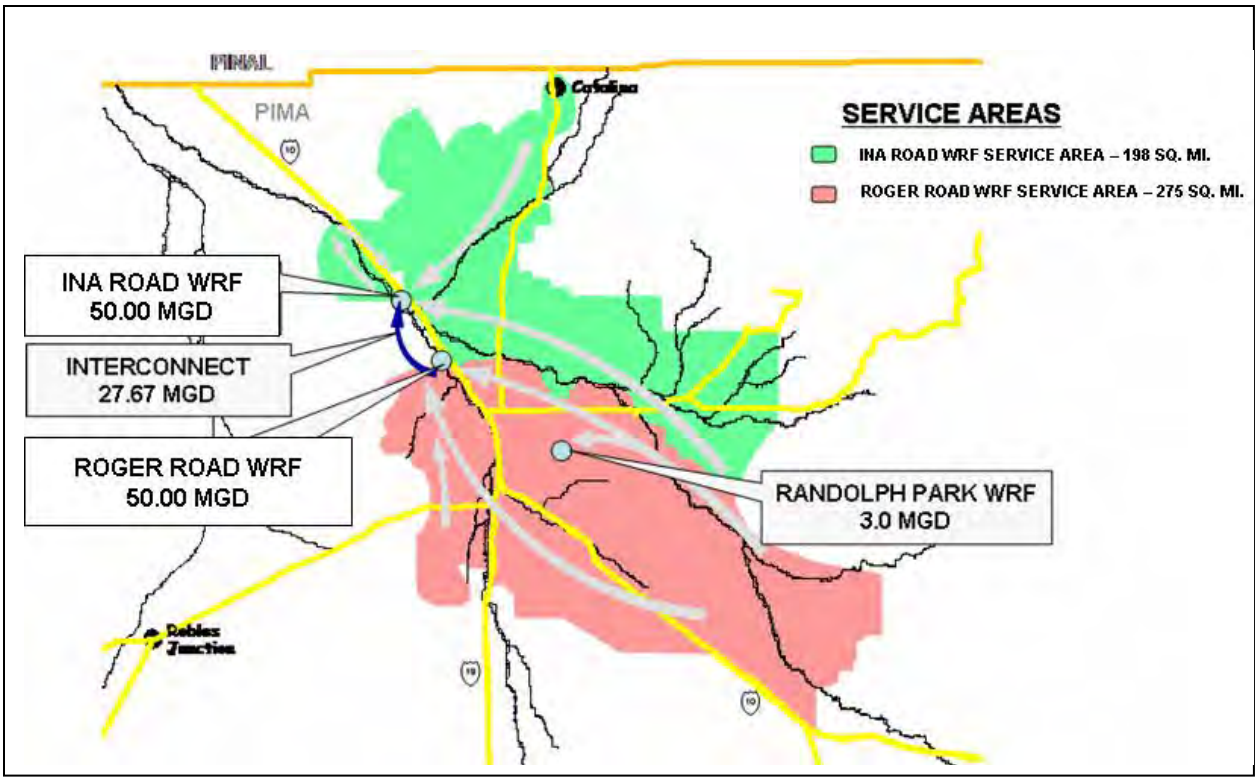
Recommended Treatment Plant Plan

Chapter 7 - Recommended Treatment Plan

7.1 Introduction

The two major wastewater treatment plants, Roger Road WRF and Ina Road WRF, service the metropolitan Tucson region and require new construction, reconstruction and expansion at the existing plant sites to meet near future regulations and population growth needs. The existing Roger Road WRF is located north and west of the City of Tucson center, and Ina Road WRF is located approximately 5 miles northwest of the Roger Road WRF site, both along the Santa Cruz River. Both plants are located east side of the Santa Cruz River and west side of I-10. **Figure 7-1** illustrates the location of the treatment plants relative to the Metropolitan Tucson service areas.

Figure 7-1
Year 2030 Location of Major WRF s Relative to the Metropolitan Tucson Service Area



A new wastewater treatment works without primary treatment is recommended for Roger Road WRF and the existing treatment facilities will be decommissioned and demolished once the new WRC is operational. It is recommended that the Ina Road WRF facilities be modified to accommodate the treatment of transferred wastewater and biosolids from the Roger Road WRF site.

A new gravity interconnect pipeline will be constructed between the two plants to transport raw wastewater from the Roger Road WRF service area to Ina Road WRF to balance flows between the plants. The existing sludge force main between the plants will continue to serve the facilities. Also, a new pump station facility will be constructed by Tucson Water to convey reuse water through an existing water reuse service distribution system from Ina Road WRF to the existing storage reservoir and pumping station facility to meet some reuse water demand.

The metropolitan communities and residential areas are located within close proximity from both treatment plants and the population density is expected to increase in the surrounding area within the year 2030 planning horizon. A 350-foot buffer zone required by ADEQ currently exists at the Ina Road WRF and will be maintained throughout planned improvements and expansions. A 350-foot buffer zone required by ADEQ will be maintained between the new WRC and the property lines to serve as a buffer area. A comprehensive odor control system at the treatment facilities is recommended to assure that emissions are in compliance with Pima County DEQ Air Quality Permit requirements.

The recommended treatment plant plan for the year 2030 facilities plan includes the following topics:

- Transportation corridors and other area infrastructure
- Land use and area development
- Special projects
- Location of future treatment expansions
- Expansion of treatment infrastructure
- Expansion of treatment utilities and utility corridors
- Architecture and landscape
- Support facilities
- Plant storm water plan
- Year 2030 master plan layout for selected alternative
- Summary

7.2 Transportation Corridors and Other Area Infrastructure

7.2.1 Transportation Corridors

Major road access to both wastewater treatment facilities is from I-10. Access to the existing and new WRC is from the frontage road along I-10 onto Sweetwater Drive, which is near the major intersection of I-10 and Prince Road.

Road access to the Ina Road WRF is off of Ina Road, west of the interchange of I-10 and Ina Road. Future access to Ina Road is planned to be moved onto the I-10 frontage road to the south of the intersection of Ina Road with the interstate highway. **Figure 7-2** illustrates the major transportation corridors near the treatment plants.

Figure 7-2
Major Transportation Corridors near Reclamation Plants

7.2.2 Stormwater/Flood Control Planning

Storm water plans will be developed for the new WRC and modified for the Ina Road WRF to meet the Pima County Flood Control District design requirements for onsite detention systems and upholds PCRWRD's philosophy of no off-site discharges of storm water. The storm water plans will be developed in conjunction with detailed designs for each facility and will address storm water issues both during construction and post construction. Each storm water detention system will be designed to hold a 100-year, two-hour rainfall event on site.

7.3 Land Use and Area Development

7.3.1 Current Land Use

Current land use is limited to the existing treatment facilities at both treatment plant locations, except the existing sports complex with baseball diamond at the southeast side of the Ina Road WRF facilities.

7.3.2 Future Area Development

Extraordinary multi-faceted recreational and ecological facilities for use by the region are being studied within the corridor from the areas of the new WRC north towards the Ina Road WRF. The study anticipates that the future facilities will be located on the land owned by the City of Tucson, Pima County and the State of Arizona. **Figure 7-3** illustrates a possible site plan of the new park development. Before the plan can be finalized the needs of PCRWRD and Tucson Water will need to be incorporated.

Figure 7-3
Future Area Development Site Plan

The plan includes the construction of tournament grade facilities for amateur soccer, softball and baseball along I-10 at the site of the Roger Road WRF and the restoration of riparian habitat along the Santa Cruz

River. Walking and biking trails, picnicking areas and other features would connect Columbus Park to the new recreational areas and the surrounding communities. In addition, the plan offers the potential for a connection to the Silver Bell golf course to make one large public space for community use. The Transportation Department has plans to improve the intersection of Camino del Cerro and I-10 which would greatly improve access to the park site.

The new recreational facilities would have the capacity to attract out-of-region events that in turn would support economic development to the area, including hotel, shopping and restaurant facilities. The recreational facilities would include baseball fields, soccer fields and softball fields.

7.4 Special Projects

The Tres Rios Del Norte Project Ecosystem Restoration Feasibility study is being conducted by the Corps of Engineers with support by Pima County Regional Flood Control District (PCRFCD), City of Tucson and City of Marana. The study covers 18 miles of the Santa Cruz River from Prince Road to North Sanders Road and encompasses 19,800 acres. Objectives of the study are:

- Ecosystem restoration
- Flood damage control
- Ground water recharge
- Recreation
- Cultural resource preservation

The restoration area is divided into three reaches:

- Price Road north to Ina Road (Reach 1)
- Ina Road north to Avra Valley Road
- Avra Valley Road north to North Sanders Road

Out of the three reaches, Reach 1 directly involves the effluent discharge from the two major WRFs. Reach 1 covers the Santa Cruz River from the Roger Road WRF discharge to the Ina Road WRF discharge. The recommended plan for Reach 1 is to develop cottonwood and willow tree habitat, mesquite bosque habitat along with other native plant and shrub species at the edges and to create wetland areas in the river bottom. Wetland areas will have water depths of 6 inches to 9 feet. The recommended plan requires approximately 2 to 7 mgd of effluent water including consumptive and evaporative losses, direct precipitation, constructed ground water recharge and channel losses.

7.5 Location of Future Treatment Expansions

At the existing Roger Road WRF there is a “green space” on the south side of the existing plant that is available to site a new facility to treat 32 mgd of wastewater as well as north of the existing Roger Road WRF. The site south of the existing treatment works would be the new water reclamation facility campus (WRC) along Sweetwater Drive on the south side of the existing treatment facilities and west of the existing Tucson water reclaimed water filtration plant, reservoir and pumping station operations. The location along Sweetwater Drive meets the regulatory requirements for 350-foot setbacks using City of

Tucson owned land. The plan maximizes the availability of public land for alternative uses such as new sports complex, enables upstream discharge to the Santa Cruz River to sustain riparian habitat and locates operations adjacent to the existing and future reclaimed water operation. The site to the north of the existing treatment works would be located adjacent to the Santa Cruz River and removed from existing operations. Further, the site to the north can expand on the environmental theme for future park consideration. Because of the constrictions issues and integration with the future park theme the north site is recommended. The costs to construct at the either the north site or south site are considered similar. The recommended plan at Roger Road WRF is for a new WRC without primary sedimentation tanks. The existing facilities will continue operations until the new facilities are commissioned and then the existing facilities will be demolished.

Figure 7-4 illustrates the recommended new facilities without primary treatment at Roger Road WRF. **Figure 7-5** illustrates the extent of demolition of the existing Roger Road WRF facilities after new treatment plant is operational. **Figure 7-6** illustrates the site plan for future expansion of facilities capacity by 50 percent beyond the year 2030.

Figure 7-4
New WRC – 32-mgd Facility

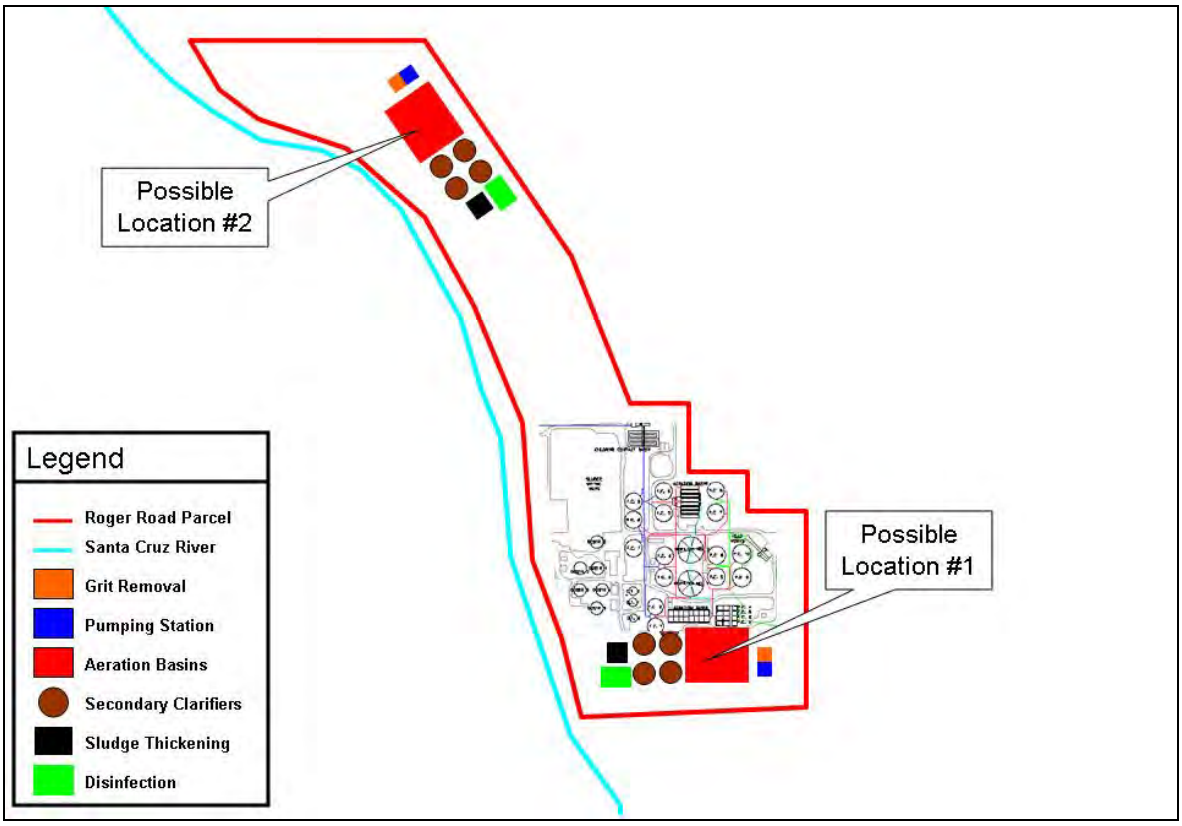


Figure 7-5
Demolition After New WRC Construction

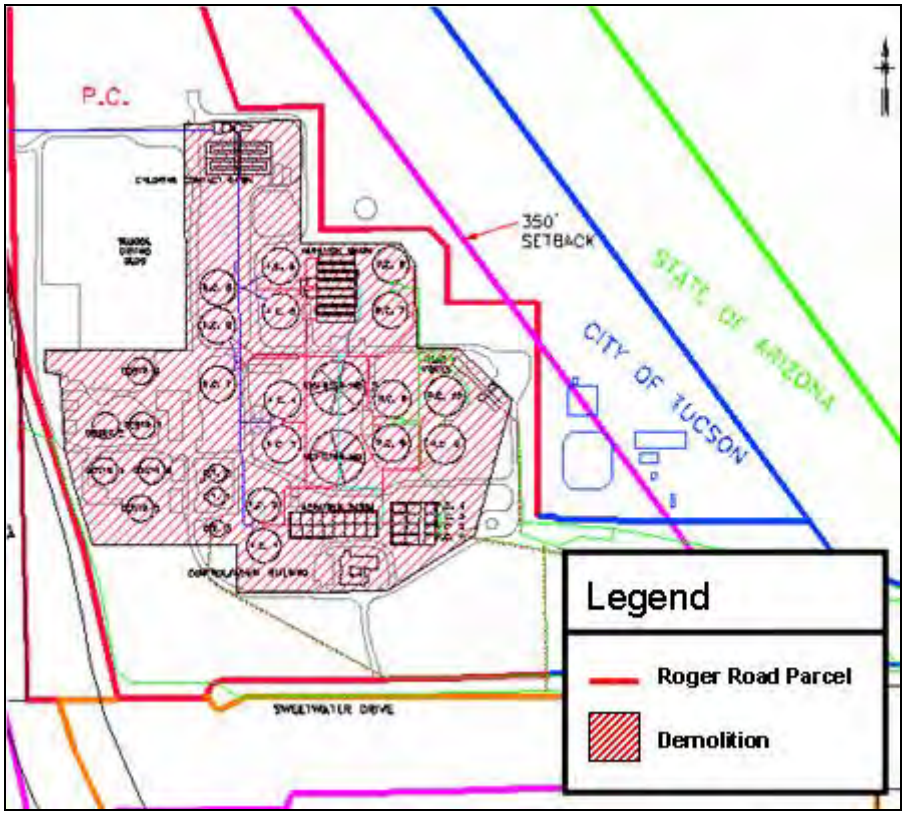
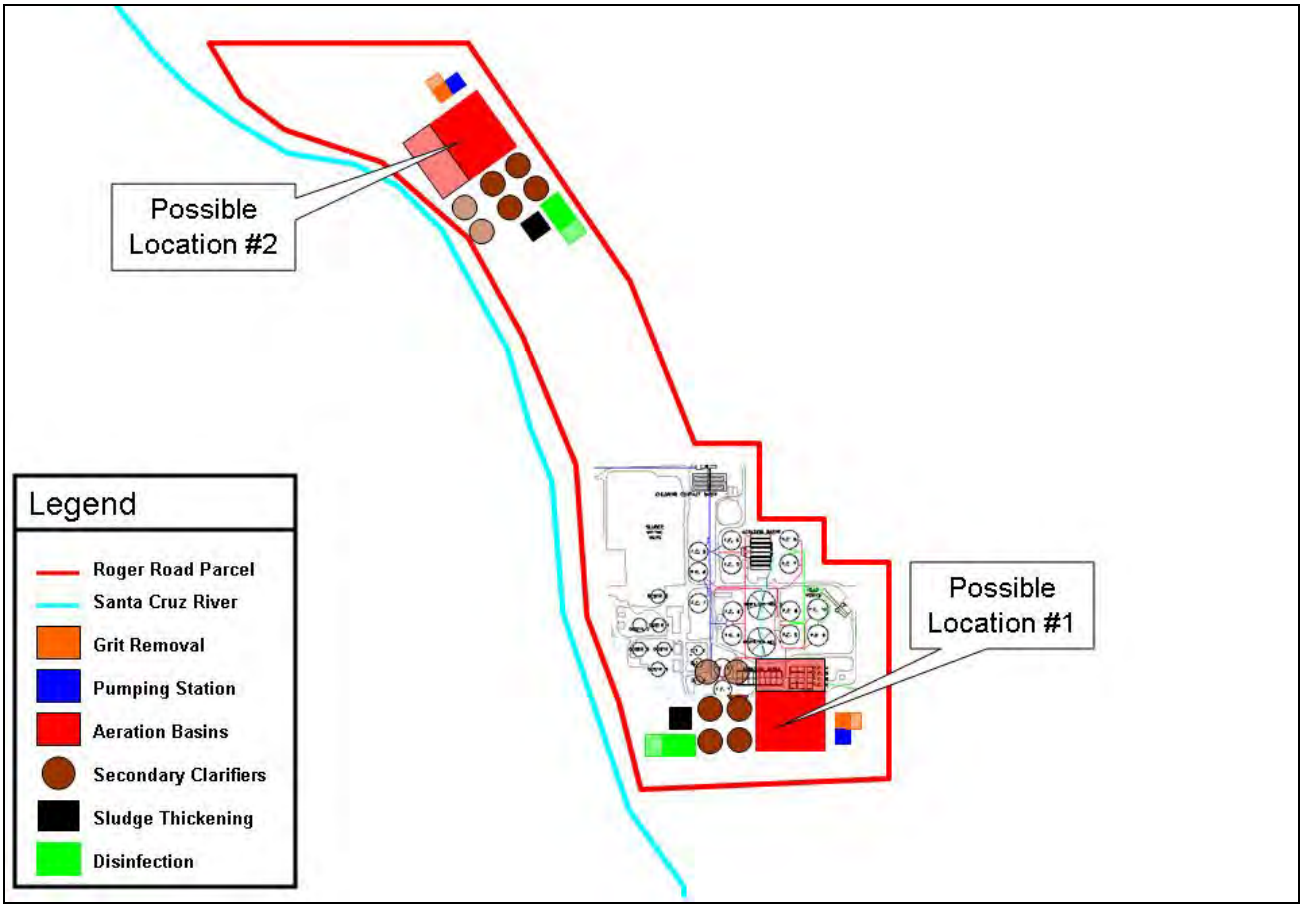


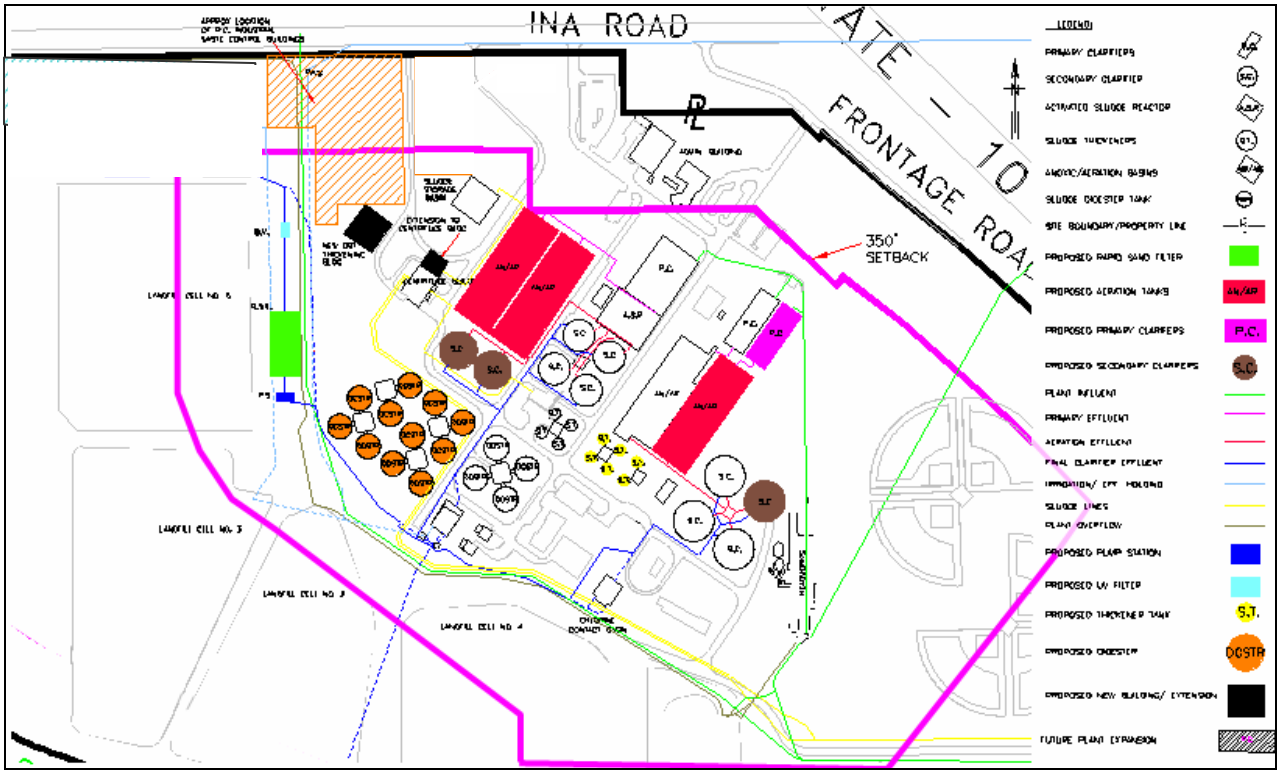
Figure 7-6
Roger Road WRF Future Expansion Beyond Year 2030



At Ina Road WRF the future facilities will treat 50 mgd of wastewater and will become the centralized location for handling and treatment of biosolids. The recommended plan includes addition of new facilities and rehabilitation of the existing facilities while maintaining the existing 350-foot setback and includes space for the addition of biosolids processing facilities for future production of Class A biosolids.

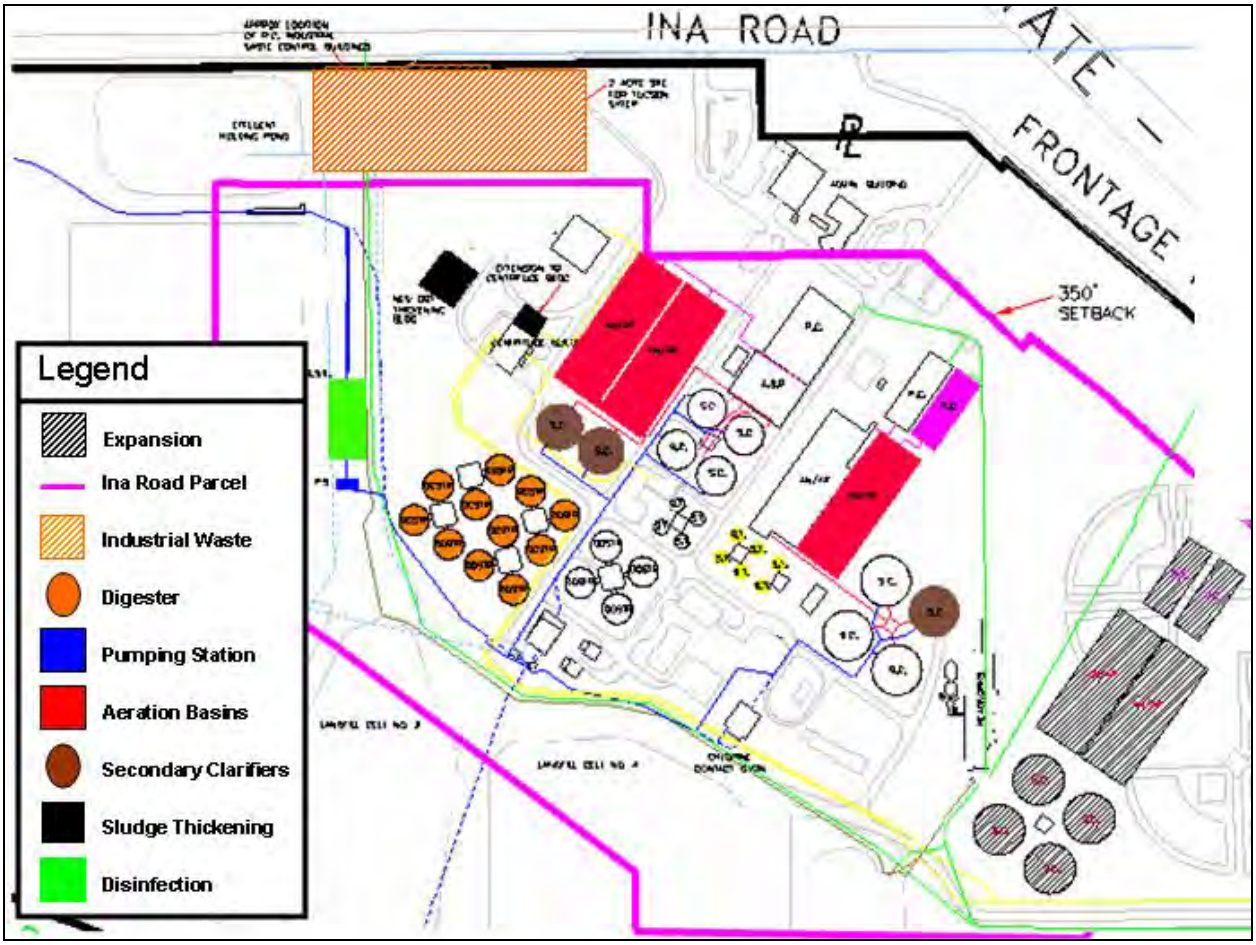
Figure 7-7 illustrates the recommended the year 2030 facility at Ina Road WRF. **Figure 7-8** illustrates site plan with the space required beyond the year 2030 for expansion of both the wastewater and biosolids treatment capacity by 50 percent. This plan would utilize some of the County-owned property at the sports park south of the existing plant.

Figure 7-7
Ina Road WRF 50-mgd Site Plan for Year 2030



* Site requested by Tucson Water for their facilities.

Figure 7-8
Ina Road WRF 50-mgd Site Plan with Future Expansion Beyond Year 2030



7.6 Expansion of Treatment Infrastructure

For the new WRC, located north of the existing plant a new influent pumping station will be constructed adjacent to the new facility. A new effluent discharge structure and effluent transport conduits will be constructed south of the existing effluent discharge line.

For the expanded facilities at Ina Road WRF, the existing influent flow split structure will be modified to distribute the flow to existing primary clarifiers as well as to new primary clarifiers. The existing flow split structures from primary effluent throughout the secondary treatment system will also be modified. A new effluent discharge structure will be constructed to handle the effluent from the disinfection system and outfall conduit.

7.7 Expansion of Treatment Utilities and Utility Corridors

7.7.1 Power Supply

Roger Road WRF: The plant is presently served by a 2400 volt, 3-phase, 3-wire delta ungrounded electrical service from Tucson Electric Power Company. The utility service drop consists of 3-500kVA transformers feeding a Main Switchgear that is configured in a hot sequence arrangement with six fusible contactors. 2400 volt power is distributed to Power Centers and transformers throughout the site. The Power Centers and transformers step the voltage down to 480 volts, 3-phase on the secondary to feed Motor Control Centers. The majority of the secondaries are connected delta ungrounded. Motor control centers are configured in a Main-Tie-Main circuit breaker arrangement with one main served from the utility source and the other from the plant generators. The MCCs provide power to the plants process equipment loads and supporting systems.

The plant generators consist of 3-400kW, 480 volts, 3-phase, 3-wire delta ungrounded natural/methane duel fuel engine driven generators. The generators may be operated in parallel or totally isolated from each other. Generator power is distributed via three switchboards with feeder breakers serving individual motor control centers.

The existing power distribution system will remain to serve the existing plant with minor alterations made to provide power to interim and temporary plant improvements.

New Water Reclamation Campus: The new WRC will be served with a new power distribution system. The new system will have redundant power sources. This may consist of one utility source and on site power generation for backup. The primary distribution system will consists of 13.8kV Switchgear configured in a Main-Tie-Main circuit breaker arrangement. Redundant 13.8kV, 3-phase power feeders will be distributed throughout the site. Pad mount transformers will be provided with 480 volt, 3-phase, 4-wire wye connected secondaries to serve Switchgear and Motor Control Centers. Other secondary voltages may be provided as required to serve large motor loads (Pumps, Blowers, etc.). Switchgear and Motor Control Centers will be configured in a Main-Tie-Main circuit breaker arrangement. The overall system will be designed with the flexibility to serve loads at startup and possible future expansions.

Ina Road WRF: The plant is served from two utility sources with multiple service drops and on site generators. The original treatment plant constructed during the 1970's and the Centrifuge Building added in the 1980's is powered by the generators at the plant power generation facility. The plant expansion is powered from three separate TEP incoming utility electric services.

The plant power generation system consists of seven 650kW, 4160 volts, 3-phase generators connected in parallel to 4.16kV Switchgear “A/B”. The existing plant power generation system utilizes sludge gas and purchased natural gas as a fuel source (see Chapter 5 for discussions and recommendations regarding the future use of sludge gas). Switchgear feeder breakers distribute power to six outdoor unit substations and three 400 horsepower Oxygen Compressors. The unit substations are connected delta-wye with their secondaries rated 480-volts, 3-phase. The secondary of each unit substation serves a close coupled walk-

in aisle 480-volt switchboard with the exception of the two at the Centrifuge Building. The Centrifuge Building unit substations serves a motor control center directly from the secondaries of the substation transformers. Those configured with secondary switchboards distribute power to motor control centers and other utilization equipment.

The three TEP incoming utility electric services are located at the Headworks, New RAS/WAS Pump Station and the Blower Building. TEP provides incoming power at 13.8kV, 3-phase that is stepped down at each location to the required utilization voltages using Plant owned transformers and unit substations.

A unified power distribution system will be implemented as the plant is expanded. The unified system will feature redundant power sources. This will consist of dual utility sources, on site generators or combinations of both. The three existing utility services will ultimately be decommissioned and the equipment combined into the new distribution system. The new distribution system will be similar to that described for the new WRC The exception being the implementation of 4160V distribution equipment for utilizing the existing on site generators if reused in the future plant expansions.

7.7.2 Potable Water Supply

Potable water is supplied to the treatment plants by the City of Tucson. A new potable water supply network will be provided for the new WRC and the existing potable water system will be decommissioned upon startup of the new facilities.

7.7.3 Reuse Water Supply

The new WRC will be located north of the existing facilities, which will be demolished. A new reuse water supply system with new pump station will be constructed by Tucson Water to provide reuse water from the new effluent disinfection facilities to their operation.

At the Ina Road WRF a reuse water system will be constructed to supply reuse water to the water distribution network. If Class A+ reuse water is produced at the Ina Road WRF, then a new supply, reservoir system, disinfection system and distribution piping will be constructed by Tucson Water on a parcel of land provided by Pima County. If Class B+ reuse water is produced then Tucson Water would have to add filtration to its operation at the site. Pima County has not committed to the actual location of the property to be provided to Tucson Water. Source of the reuse water will be disinfected plant effluent.

7.7.4 Plant Air Supply

A new plant air supply system will be provided for the new WRC facilities. The existing plant air supply system at the Ina Road WRF will be upgraded to facilitate the needs for the expanded future facilities.

7.8 Architecture and Landscape

Existing facilities consist of a wide variety of architectural styles and landscape types, reflecting independent decisions made at each plant expansion. Through the year 2030 planning horizon,

architectural and landscaping design will be guided by a single architectural and landscape theme to harmonize the existing and new facilities consistent with the new land use plan.

Objectives of the architectural and landscape plan are to conceal process and mechanical components, to control off-site view-sheds, and to unify architecture and landscaping throughout the WRFs. Most of the treatment components are basins, and their walls extend only a few feet above grade. Several associated buildings house treatment systems, equipment and personnel. The architectural and landscape plan integrates these elements in a style that reinforces the public friendly concept and the important role of the wastewater treatment in environmental protection and water reclamation.

Roger Road WRF will be a new facility constructed adjacent to a public space open for recreation and community sports activities. Architectural features and desert landscape developments provide a public friendly image and reflect a water campus concept. Use of indigenous materials and energy conserving building systems will be integrated into the design of the facilities.

7.8.1 Personnel Facilities

The Personnel facilities will include the required quantities of offices, conference rooms, miscellaneous storage and lunchrooms. Toilet and locker rooms will be designed for future staff level requirements. The Personnel facilities for the new WRC will be new facilities, planned to incorporate Plant Laboratory functions as well. The existing Ina Road WRF will be assessed and rehabilitated or expanded.

7.8.2 Maintenance Facilities

Maintenance facilities for the Roger Road WRF will be new facilities, designed in conjunction with the new WRC and tailored to meet the identified needs. The existing Ina Road WRF will be assessed and revised as needed to accommodate planned plant expansion requirements.

7.8.3 Laboratory Facilities

A new central laboratory will house appropriate laboratory area functions for regulatory compliance analysis to be performed. The central laboratory function will be combined with personnel functions in a new facility to be located at or near the new WRC.

There is also a need for plant laboratory space for routine, unit process monitoring of operations. Such plant lab spaces will be incorporated into structures adjacent to and serving the various unit processes at the new WRC. Existing plant lab spaces at the Ina Road WRF has been assessed in the past with the County deciding to build a new central laboratory. Additional plant laboratory spaces will be provided in structures adjacent to and serving the various unit processes associated with expansion facilities.

7.8.4 Parking

Adequate parking space will be allocated at each plant for employees, visitors and plant vehicles. Covered parking is required for employees and visitors vehicles at both Ina Road WRF and Roger Road

WRF. Maintenance vehicle parking space adjacent to process facilities and other plant buildings does not necessarily need to be covered.

7.9 Support Facilities

Support facilities will each be designed with massing, shape and materials to harmonize with the other structures at each location, as well as with the predominant textures, colors and forms of the surrounding landscape.

7.9.1 SCADA System

The County has decided to have a central SCAD Control Center for their entire wastewater system. Actual location has not yet been determined by the County. The general instrumentation and process control concept at Roger Road WRF and Ina Road WRF is to provide three levels of control.

- Field or local control at the equipment or field device
- Process control for all equipment and devices located within specific process areas
- System or central control through a distributed control system

At the field or local level a control panel will be provided to control or monitor each piece of equipment or field device. Control at this level will be used for equipment or system interface, equipment maintenance and for intermittent process operations.

At the process level a control panel will provide process control and monitoring capabilities for a specific process area or system. Process control may control several pieces of equipment that are interrelated for that process area or operating unit. The process panel may be located in a central area of a specific process or system area. The process panel will provide equipment status, alarms, control devise and process measurements.

Central control will be through a distributed control system. The control system will have established hierarchy to place control priorities for limiting equipment control to one location at a time and incorporating the highest priority at the equipment location and the lowest priority through the distributed control system.

The systems at Ina Road WRF will be expanded to operate under the above operational control concept. The new WRC will be provided with a fully integrated and functional instrumentation and control system.

Electrical power usage will be monitored in different areas of plants. A comprehensive equipment tagging for equipment, valves, field devices and signals will be established and coordinated with the instrumentation and control system.

The Central SCADA Control Center will also monitor all the security elements to be incorporated with the new or expanded facilities.

7.9.2 Odor Control

The odor sources in the wastewater works may be broadly divided into two categories, wastewater collection system and wastewater treatment plant. Main odor sources from the collection system are manholes, drop structures, siphons, pump station wet wells and discharges from the wastewater transport pipelines. Major odor sources from the treatment plant include headworks, screen and grit facilities, pump station wet wells, splitter boxes, primary clarifiers, aeration tanks and sludge treatment and handling facilities.
The year 2030 plan will provide a long-term solution for potential odors from both collection system and wastewater treatment plants. The odor control measures will include:

- Minimize odor potential in the collection system with pH adjustment, oxygen addition, chemical addition, etc.
- Cover the openings and channels in the treatment processes properly
- Collect and treat the odorous air
- Disperse the treated air into the atmosphere in the way to minimize the odor impact to the surrounding communities

7.9.3 Chemical Handling

Chemical handling includes storage, preparation, metering and delivering chemicals used in the wastewater treatment processes. Chemicals for laboratory functions are not included in this chapter. Chemical addition is a critical part of certain processes, while it enhances others. Areas where chemicals are introduced into the wastewater treatment systems and processes are:

- *Wastewater Treatment:* Sodium hypochlorite is added into the return activated sludge system or surfaced sprayed on the aeration basins to control nuisance microorganisms, such as Nocardia.

- *Effluent Disinfection:* Currently, sodium hypochlorite is added to the plant effluent for disinfection. Sodium bisulfite is added at the end of the contact basins to de-chlorinate any residual chlorine in the plant effluent prior to its release to the receiving stream. The future effluent disinfection technology for the plants may change and alter the chemicals applied.

- *Sludge Thickening:* Polymer is added to the sludge as a coagulant to optimize performance of the thickening process.

- *Sludge Dewatering:* Polymer is added to the digested sludge as a coagulant to optimize the performance of the dewatering centrifuges.

- *Odor Control:* Currently, sodium hydroxide and sodium hypochlorite and granular activated carbon are used for odor control at various locations around the wastewater treatment sites. Future odor control systems may employ scrubber technologies that use these chemicals. The System Wide Odor Control Plan provides odor control system recommendations.

For purposes of handling, delivery and storage chemical systems will need to be centralized to the extent practicable at each of the plant sites. Chemicals will be stored in appropriate containers with secondary containment where appropriate and necessary.

7.9.4 Security

Onsite security system will include perimeter fencing, controlled plant access and egress, internal access controls and management of personnel onsite, including staff, vendors and visitors. Electronic surveillance will be employed to monitor critical areas of the facilities via SCADA. The security plan will include emergency response plans for man-made threats and natural disasters.

7.10 Plant Stormwater Plan

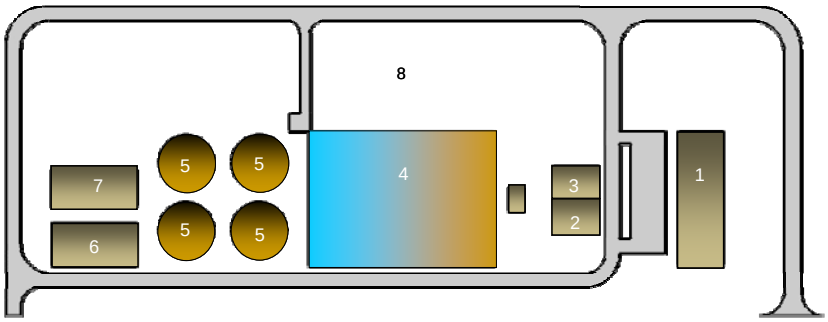
Stormwater detention systems for the facilities at Roger Road WRF and Ina Road WRF are required by Pima County Regional Flood Control District and must be maintained. The storm water plan must meet the Pima County Regional Flood Control District design requirements for onsite detention systems and upholds the philosophy of off-site discharges. The storm water detention system will be designed to hold a 100-year, two-hour rainfall event on site.

7.11 Year 2030 Master Plan Layout for Selected Alternative

Figure 7-9 and Figure7-10 illustrate the year 2030 master plan layout for the facilities at Roger Road WRF and Ina Road WRF, respectively.

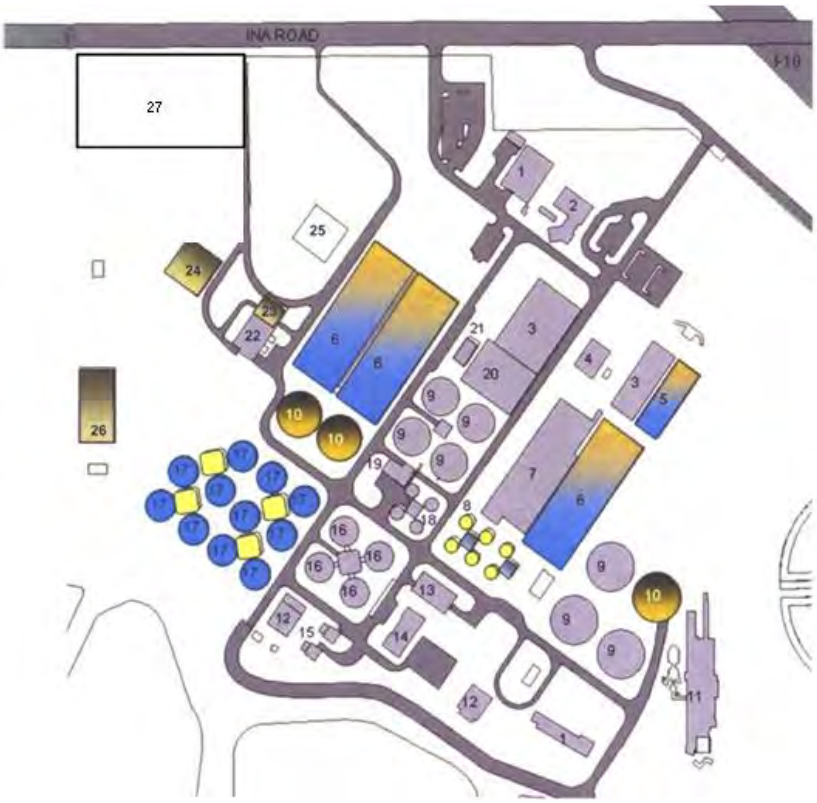
Figure 7-9

Roger Road WRF – Year 2030 Master Plan Layout



Legend:
1. Administration Facility
2. Headworks (Influent PS, Screens)
3. Grit Removal Facility
4. Bardenpho Aeration Tanks
5. Final Clarifiers
6. Disinfection Facilities
7. Sludge Thickening/Transfer Facility
8. Area for Future Expansion

Figure 7-10
Ina Road WRF – Year 2030 Master Plan Layout



Legend:

1. Existing Warehouse
2. Existing Administration Building
3. Existing Primary Clarifiers
4. Existing Blower Building
5. New Primary Clarifiers
6. New Aeration Tanks
7. Existing Aeration Tanks
8. New Sludge Thickeners
9. Existing Secondary Clarifiers
10. New Secondary Clarifier
11. Existing Headworks
12. Existing Chlorine Contact Basin
13. Existing Energy Recovery Building
14. Existing Training Center
15. Existing Chlorination Buildings
16. Existing Digesters
17. New Digesters
18. Existing Sludge Thickeners
19. Existing Vacuum Filtration Building
20. Existing Activated Sludge Reactor
21. Existing Oxygen Production
22. Existing Centrifuge Building
23. Extension to Centrifuge Building
24. New GBT Thickening Building
25. Existing Sludge Storage Basin
26. New Disinfection Facilities
27. Pima County Industrial Waste
28. Tucson Water Facilities (not shown

7.12 Conceptual Basis of Design

A conceptual Basis of Design was prepared for the expansion upgrade of Ina Road WRC and the new WRC. The report is included in **Appendix I**

7.13 Summary

The recommended treatment plant plan for the year 2030 provides a Water Reclamation Campus adjacent to the existing Roger Road site and, upgrades and expansion of the existing plant at Ina Road. This will affect many aspects of the existing treatment facility features as summarized below.

- New infrastructure to be constructed and existing infrastructure to be expanded or upgraded
- Expansion of infrastructure to accommodate increased flows to be handled at both plant locations
- Provision for new and/or expansion of utilities including power, potable water and plant air supply.
- Provision for new and/or expansion of water reuse facilities by Tucson Water
- Reshaped transport corridors, and storm water and flood control measures
- New multi-faceted recreational, commercial and ecological development in the vicinity of the existing Roger Road WRF.
- Ecosystem restoration and creation of riparian habitat in the Santa Cruz River
- Provision for future expansion beyond the year 2030 at both treatment facilities
- Architecture and landscape amenable to public friendly image

CHAPTER 8

Regional Facility Overview

Chapter 8 - Regional Facility Overview

8.1 Introduction

Wastewater generated within the conveyance boundaries tributary to Roger Road WRF and Ina Road WRF is collected and treated by the metropolitan facilities (Roger Road WRF, Ina Road WRF and Randolph Park WRF). Non-Metro facilities serve wastewater treatment needs outside the metropolitan service area boundaries. The outside areas are referred to as the Non-Metro regions. The Non-Metro regions are experiencing rapid population expansion. Growth is projected to continue for years, thereby increasing influent flow into PCRWRD's collection/treatment systems. PCRWRD recognizes the value of long-range planning in making timely, cost effective decisions regarding the Non-Metro facilities. Thus, PCRWRD has commissioned this study to identify the optimal strategy for the Non-Metro facilities' treatment of current and projected wastewater flows.

Data presented in this chapter draws upon information provided from PAG and presented in the 2006 Facility Plan. The Facility Plan documents the long-range facility planning process for PCRWRD establishing the capital improvement needs for the next 25 years based on the regulatory, expansion and rehabilitation requirements. Non-Metro facility information for this study is compiled from a series of facilitated workshops consisting of PCRWRD staff, consultants and other stakeholders, as well as several previous planning and engineering efforts performed for, or by the PCRWRD. This chapter describes Non-Metro facilities and proposes their incorporation into Non-Metro schemes, and locations for Non-Metro treatment facilities.

8.2 Non-Metro Facility Evaluation

Pima County's Non-Metro regions include facilities operated by PCRWRD and by others. The facilities addressed in this chapter correspond to the eastern half of Pima County and a small portion of Pinal County. Existing PCRWRD operated facilities include:

- Arivaca Junction Wastewater Reclamation Facility
- Avra Valley Wastewater Reclamation Facility
- Corona de Tucson Wastewater Reclamation Facility
- Pima County Fairgrounds Wastewater Reclamation Facility
- Green Valley Wastewater Reclamation Facility
- Marana Wastewater Reclamation Facility
- Mt. Lemmon Wastewater Reclamation Facility
- Rillito Vista Wastewater Reclamation Facility

Facilities located in the Non-Metro region but not operated by PCRWRD include:

- Arizona Sonora Desert Museum
- Sahuarita

The proposed or existing non-PCRWRD operated facilities not examined within the ROMP include:

- Adonis
- Ajo Improvement Co.
- Arizona State Prison
- Lukeville
- Milagro Subdivision
- MTC
- Organ Pipe Cactus National Monument
- Saguaro Ranch Guest Ranch
- Sahuarita High School Wetlands
- University of Arizona Science and Technology Park
- US Forest Service – Palisades Ranger Station

Key issues addressed during this evaluation include:

- Examine PCRWRD and non-PCRWRD operated facilities
- Determine current and future facility influent flows
- Determine current and future facility biosolids handling, treatment, and disposal
- Determine current and future facility effluent water reuse
- Determine Non-Metro regions

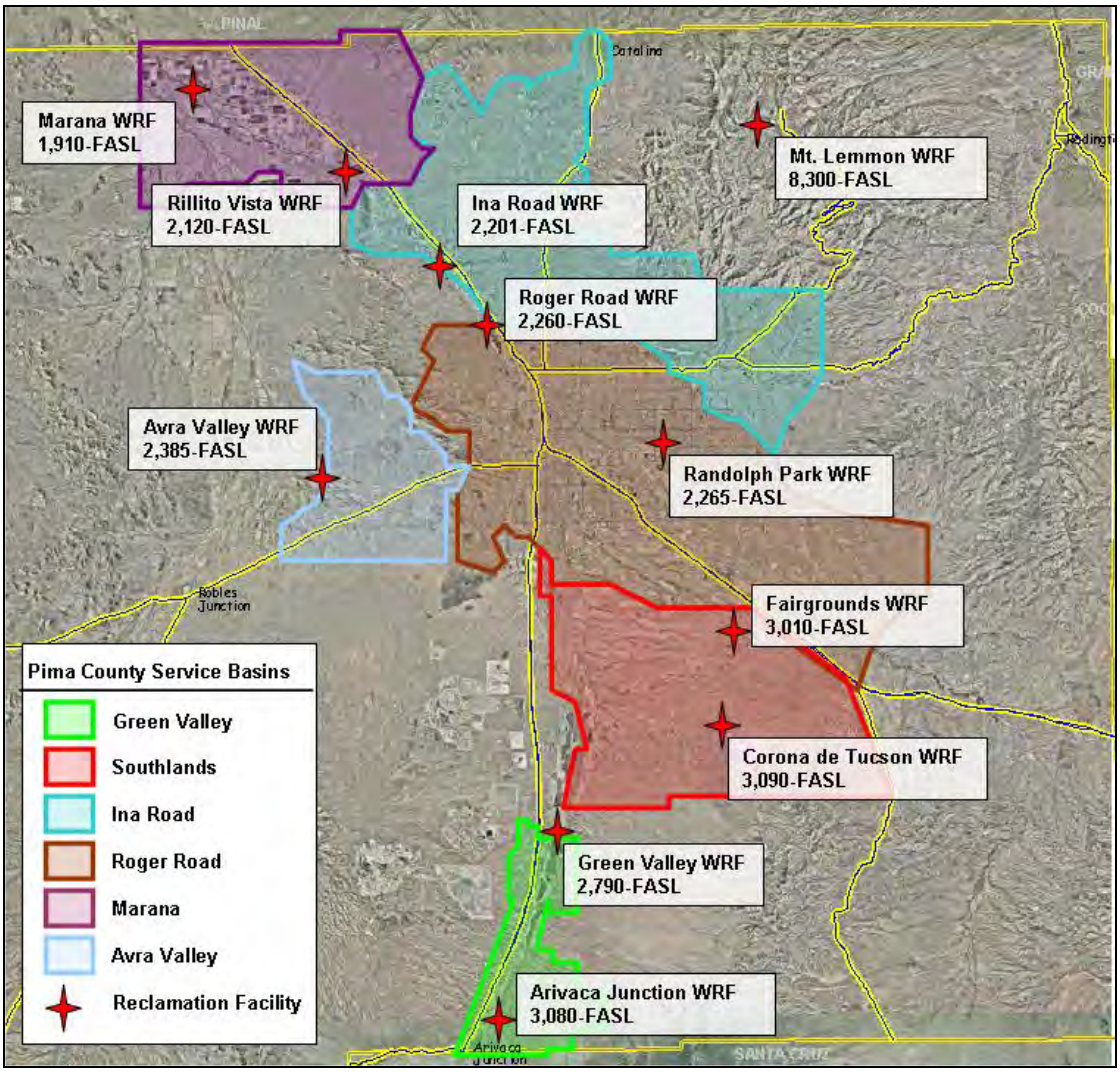
8.2.1 PCRWRD Operated Facilities

PCRWRD maintains and operates wastewater treatment facilities within the City of Tucson, South Tucson, Oro Valley, Marana, Green Valley, and non-incorporated areas. The following chapters evaluate each PCRWRD operated Non-Metro facility. Each evaluation includes a description of the facility, treatment process, permits, effluent, biosolids, and outlook. The following lists the resources used to complete the evaluation.

- Description – Facility descriptions discuss location, current population served, service area, permitted treatment capacity, and average daily influent flows.
  - Location obtained from the Facility Plan and the 2005 PAG Effluent Generation and Utilization document.
  - Current population served obtained from 2005 PAG Effluent Generation and Utilization document.
  - Service areas are the approximate areas serviced by the current treatment facility and are described by the PAG Section 208 Areawide Water Quality Management Plan. **Figure 8-1** shows eastern Pima County's wastewater treatment facility service basins and service areas from PCRWRD MapGuide Sewer Maps (December 2006).
  - Permitted treatment capacity values obtained from Arizona Department of Environmental Quality (ADEQ) documents provided by PCRWRD.
  - Average Daily Influent Flow determined by calculating the 2006 average daily flow. It is noted that the Non-Metro wastewater treatment facilities, just as the metropolitan wastewater treatment facilities, experience winter peaks and summer lows.

- Treatment Process –Processes for each facility compiled from the 2006 Metro Area Facility Plan Update, PAG 208, Pima County Effluent Generation/Utilization Plan, and PCRWRD staff.
- Permits – Reported permits supplied by PCRWRD staff.
- Effluent – Effluent data provided by the Facility Plan, the 2005 PAG Effluent Generation and Utilization Report, and by PCRWRD staff.
- Biosolids – Biosolids data provided by the Facility Plan and PCRWRD staff.
- Outlook – This chapter presents outlooks for the Non-Metro treatment facilities based on current and planned activities. The facility outlooks were developed from data provided by PCRWRD staff, the Facility Plan, Facility Expansion Plans, and, in Avra Valley's case, the draft Southwest Infrastructure Plan (SWIP).

Figure 8-1
Eastern Pima County Treatment Facility Service Areas (FASL-Feet above Sea Level)



8.2.1.1 Arivaca Junction Wastewater Reclamation Facility

Arivaca Junction Wastewater Reclamation Facility is located in unincorporated Pima County 3,080 feet above sea level (FASL) on the southern border of Pima County approximately 30 miles south of Tucson just east of Interstate 19. Arivaca Junction WRF's service area consists of 323 lots of approximately 840 people and is entirely residential. The facility has a permitted treatment capacity of 0.1 mgd (maximum daily flow average of 60,000 gallons per day) and treated an average daily influent flow of 0.059 mgd in 2006 (59% capacity).

Process
Arivaca Junction WRF contains a single 3.2-acre, 13-ft deep, unlined aerated facultative stabilization pond (side slope of 3:1) with two surface aspirating aerators/mixers.

Permits
Arivaca Junction WRF currently holds an Aquifer Protection Permit (P-100640) and a Type 2 Reclaimed Water General Permit (R105345) for Class C effluent. The facility's groundwater point of compliance is located approximately 400 feet southeast (down gradient) of the wastewater treatment pond.

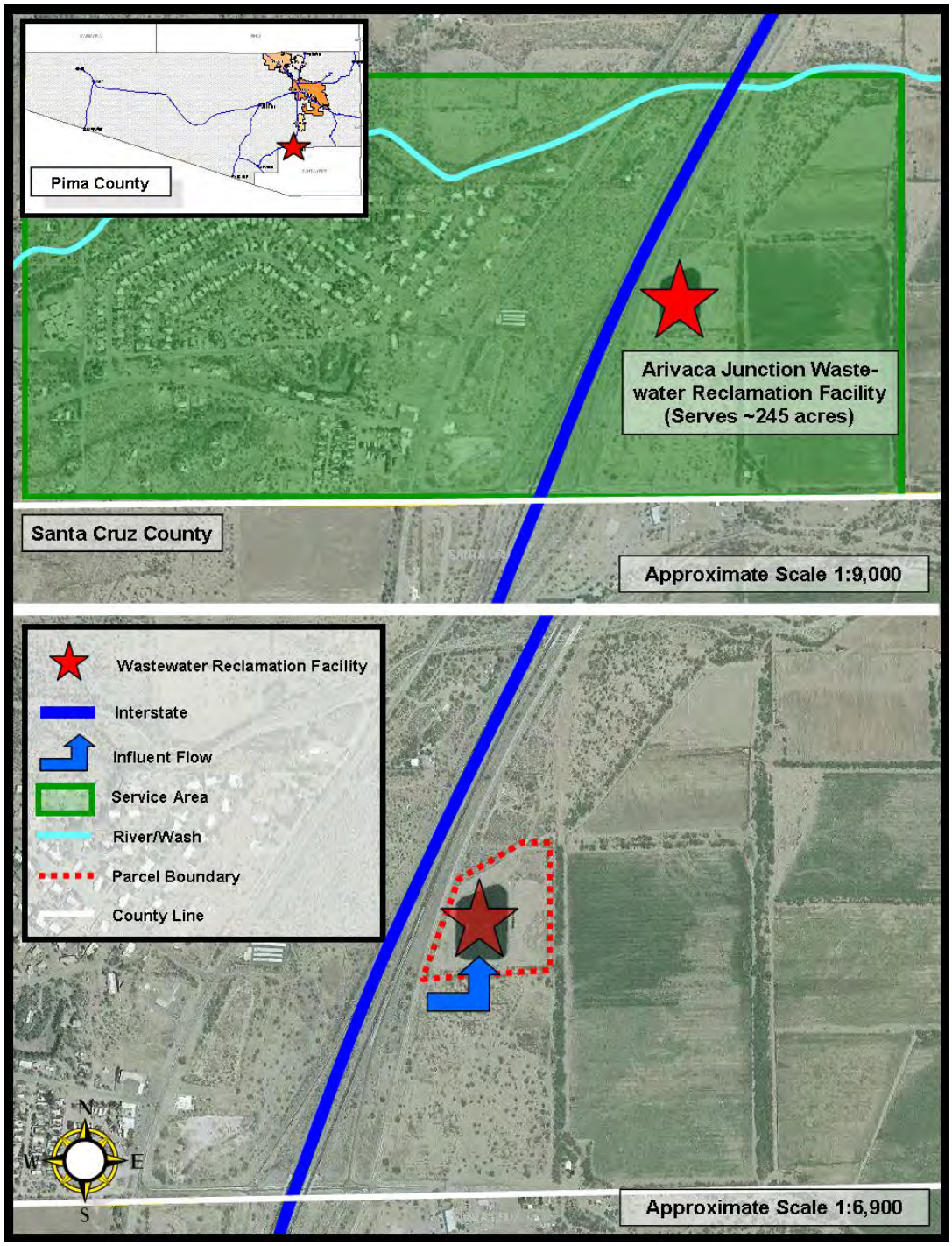
Effluent
Effluent disposal for Arivaca Junction WRF is through percolation, evaporation, and reuse. Percolation is approximately 0.010 mgd while evaporation ranges from 0.007 to 0.014 mgd. The facility is classified for Class C reclaimed water as regulated by a valid Reclaimed Water Permit. A reuse agreement for delivery of the Class C effluent for restricted agriculture use is in place with nearby Reventone Ranch. Prior to effluent delivery to the adjacent ranch, it is disinfected through the addition of sodium hypochlorite. The effluent is not metered and is discharged approximately once every 6 weeks taking approximately 5 days with an average flow of 350 gallons per minute.

Biosolids
The procedure for biosolids is to scrape from one lagoon when necessary and haul to a landfill.

Outlook
Arivaca Junction WRF expects to close once construction of the gravity sewer line between Arivaca Junction WRF and Green Valley WRF is completed. Wastewater flow from Arivaca Junction WRF will be transported to Green Valley's facility for treatment. Completion of the gravity sewer line is scheduled for 2007/2008.

Aerial photos of Arivaca Junction WRF's sewer basin and plan view are on **Figure 8-2**.

Figure 8-2
Arivaca Junction Wastewater Reclamation Facility



8.2.1.2 Avra Valley Wastewater Reclamation Facility

Avra Valley WRF is located in unincorporated Pima County 2,382-FASL in a rapidly growing area about 20 miles southwest of Tucson in southern Avra Valley, north of Hwy 86 (Ajo Way) and east of Three Points. The facility serves about 12,104 people in 2005 and is located on a 138-acre parcel of Pima County owned land. The current service area is roughly four miles to the north, south, west and three miles to the east from the center of the intersection of Hwy 86 (Ajo Way) and San Joaquin Road. The service area is about 70% rural residential and the other 30% is made up of federal and state land, urban residential, industrial, commercial, and multiple use. Avra Valley WRF treated an average daily influent flow of 1.079 mgd in 2006 (49% of the available 2.2 mgd capacity).

Process

Avra Valley WRF's treatment process is a BNROD and consists of a flow equalization basin, an oxidation ditch, two secondary clarifiers, four sludge-drying beds, and four percolation basins. Sewage enters the facility through a lift station where it is discharged to a screening channel. Influent is then equalized in a 0.37 million gallon basin and flows to a 1.33 million gallon oxidation ditch (1.6 mgd permitted treatment capacity as of January 26, 2007. Prior to 2008, an additional 0.6-mgd capacity will be added.). The process is based on extended aeration, nitrification, and de-nitrification within the oxidation ditch by cycling the aeration on and off.

Permits

Avra Valley WRF currently holds an Aquifer Protection Permit (P-100642), Type 2 Reclaimed Water General Permit (R105498) for Class B+ effluent.

Effluent

Effluent is primarily disposed of through percolation, evaporation and plant irrigation reuse, and spraying into the Black Wash only when needed. Future use of the effluent is proposed for a riparian restoration project developed by PCRWRD, Pima County Regional Flood Control District, and other stakeholders.

Biosolids

Waste activated sludge mixed liquors flow into the secondary clarifiers from the oxidation ditches via a distribution box where the sludge settles and further processes produce Class B+ effluent. Sludge from the clarifiers is sent to two gravity thickeners and hauled by tanker truck to the nearest sewer tributary to Roger Road WRF. Four sludge drying beds are available for emergency use.

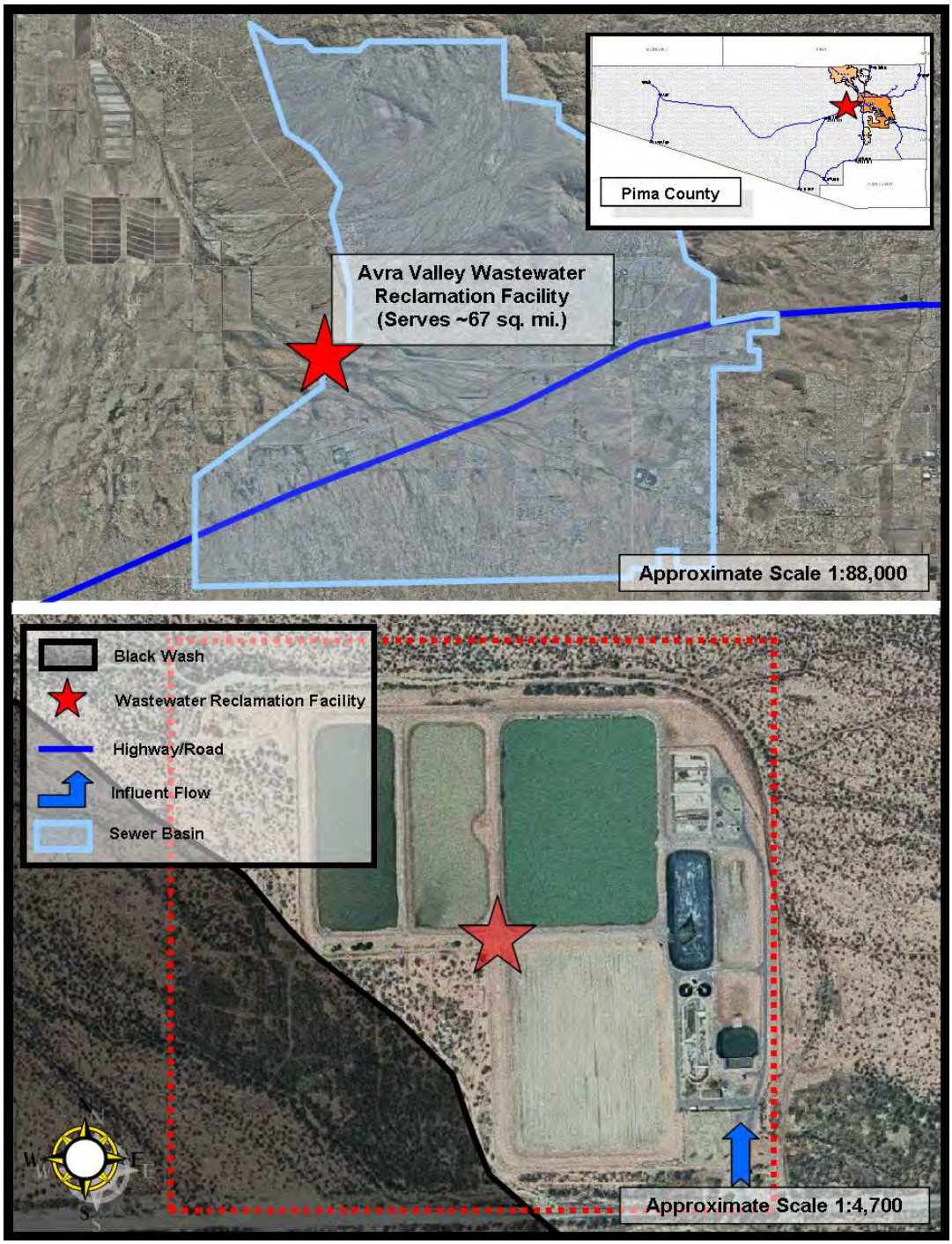
Outlook

Avra Valley WRF is the only facility located within the County's SWIP report. The Southwest region has been identified as an area of rapid population growth and County planners commissioned the SWIP report to assist in decision-making related to development of the Southwest area's infrastructure (including wastewater infrastructure, transportation, parks and recreation, and flood control). Within the SWIP, the phasing, financial impacts, and funding possibilities are discussed. In regards to the Southwest region's wastewater infrastructure, the SWIP concludes the majority of the wastewater collection and conveyance system has enough capacity for current peak wet weather flow but requires expansion and upgrades to accommodate proposed future flows in the conveyance system.

The PCRWRD Avra Valley WRF Expansion Plan recommends two concurrent expansion projects, the first is to increase current 1.6 mgd BNROD capacity to 2.2 mgd through interim improvements and the second is to have a dual oxidation ditches online and permitted to treat 4.0 mgd by 2009. Current design improvements include a new inlet gravity sewer and influent lift station, headworks modifications, two BNRODs, clarifiers, continuous backwashing deep bed filters, ultraviolet disinfection, and sludge holding equipment with an area to provide sludge treatment in the future. A study to determine optimum biosolids processing for both the existing BNROD and new BNROD for the site is currently underway. Avra Valley WRF also plans to treat effluent to Class A+ treatment requirements prior to discharge to percolation basins and/or the Black Wash spray fields.

Aerial photos of Avra Valley WRF's sewer basin and plan view are on **Figure 8-3**.

Figure 8-3
Avra Valley Wastewater Reclamation Facility



8.2.1.3 Corona de Tucson Wastewater Reclamation Facility

Corona de Tucson WRF is located in unincorporated Pima County 3,090-FASL and is located approximately 15 miles south of Tucson in an area that is currently rural but facing very rapid population growth. The plant site is northwest of the intersection of Sahuarita Road and Houghton Road. A 2000 census showed a population of 993 for the Traffic Analysis Zones in which the service area is located. Almost half of the service area is residential with the other half consisting of specific plan, multiple use, and commercial areas. The facility has a permitted treatment capacity of 1.3 mgd and average daily influent flows for 2006 were 0.135 mgd (10% capacity).

Process
Sewage enters Corona's WRF through a gravity interceptor, then through a Parshall flume flow-metering chamber. The sewage then flows into a series of "splitter manholes" dividing the flow between the two concrete-lined stabilization ponds of 3.3- and 3.7-acres with an average operating depth of 4-feet. Ponds can be operated in series or parallel. The treated water overflows from the stabilization ponds into the 10.2-acre evaporation pond with a 6.1-acre unlined SAT pond used as a recharge basin.

Permits
The facility has an APP (P100644) for discharge to the SAT basins.

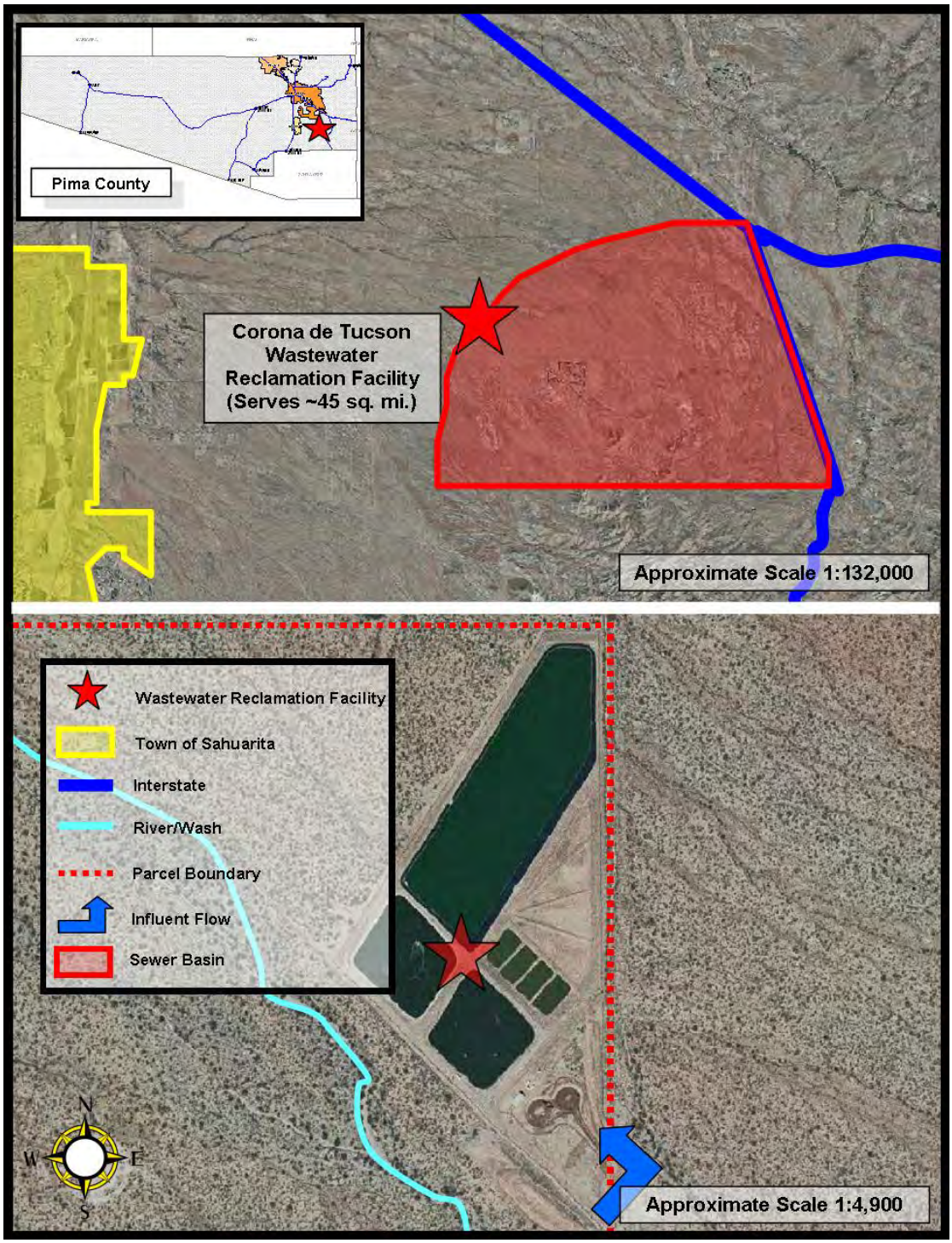
Effluent
Effluent discharges to a plastic lined evaporation pond.

Biosolids
Biosolids removed from the plastic lined evaporation ponds when needed. Dewatering solids to 4% to 6% before transferring to the County conveyance system, Roger Road WRF, Ina Road WRF, Green Valley WRF, or other location should be investigated.

Outlook
Corona de Tucson WRF is also in an area of rapid population growth and the facility recently placed two new, 0.5 mgd permitted, closed loop reactors to be online in mid 2007. The existing lagoons will remain online as backup capacity. The new WRC will include new headworks, Parshall flume, RAS/WAS station, polymer storage, sludge holding tanks, a sludge pump, and a mechanical/electrical/ administration complex. Effluent will be disposed of via the SAT basins regulated by the facility's APP. Biosolids will be pumped to the facility's sludge holding tanks before being hauled and discharged into the South East Interceptor to Roger Road WRF for final processing and disposal at the Ina Road WRF biosolids processing facility.

Corona de Tucson WRF's service basin and facility are shown on **Figure 8-4**.

Figure 8-4
Corona de Tucson Wastewater Reclamation Facility



8.2.1.4 Green Valley Wastewater Reclamation Facility

Green Valley WRF is located in Sahuarita,790-FASL south of Tucson along the east side of the Santa Cruz River. The facility served about 17,469 people in 2005. The facility was built in 1964, expanded in 1972, 1981, and 2004. The 2004 expansion included the addition of a 2.0 mgd treatment train utilizing BNROD and increased the total capacity to 4.1 mgd ADWF. The 2.0 BNROD process is the primary form of treatment and the facultative pond system is used as a backup. The Green Valley service area covers both the east and west sides of Interstate 19 and serves primarily the community of Green Valley and parts of the Town of Sahuarita. Land use in the service area is primarily residential with some commercial. Most of the property serviced is on the west side of the Santa Cruz River. The service area has an east-west width ranging from one to four miles and covers approximately 9.5 miles north of south, starting just below Twin Buttes Road and extending past Duval Mine road. The facility has a permitted treatment capacity of 4.1 mgd (2.0 mgd BNROD and 2.1 mgd aerated lagoons) and treats an average daily influent flow of 1.764 mgd in 2006 (43% capacity).

Process
Green Valley WRF is split into two processes. The first is a 2.1 mgd Class B effluent producing process. It consists of two trains of primary and secondary aerated lagoons followed by two effluent maturation/settling lagoons and four percolation basins. The second process is a 2.0 mgd BNROD Class A+ effluent producing process. The BNROD process operates on an extended aeration, nitrification, and denitrification process within the oxidation ditch by cycling the aeration on and off. Flows greater than BNROD's capacity are directed to the aerated lagoons and polishing ponds.

Permits
Green Valley (GV) WRF's APP (P100629), issued on July 1, 2003, require discharge monitoring to be performed at the point of discharge to the percolation beds and the Santa Cruz River as well as reuse and recharge areas. Groundwater monitoring is required at the point of compliance wells GV-01 and GV-02. Type 3 Reclaimed Water General Permit (R105574) allows direct reuse of Class B+ (Lagoons) and Class A+ (BNROD with filtration) effluent. AZPDES (AZ0024937) allows discharge into the Santa Cruz River.

Effluent
Effluent is disposed of through percolation, reuse, and delivery. PCRWRD has a contract to deliver up to 1 mgd of Class A+ and B effluent to Robson/Quail Creek Inc.

Biosolids
Green Valley WRF is the only Non-Metro facility with biosolids treatment and disposal capacity. The sludge is thickened, digested, and dried (Class A biosolids) before being utilized as a mine tailing reclamation product at the ASARCO Mines.

Outlook
Green Valley WRF will be treating flow from the Arivaca Junction WRF's treatment area once the gravity sewer main is completed (completion is developer driven and is not expected before 2009/2010). The gravity sewer corridor transferring flow from Arivaca Junction WRF to the Green Valley WRF is shown on **Figure 8-5**.

Green Valley WRF's service area and facility are also shown on **Figure 8-6**

Figure 8-5
Gravity Sewer Corridor from Arivaca Junction WRF to the Green Valley WRF

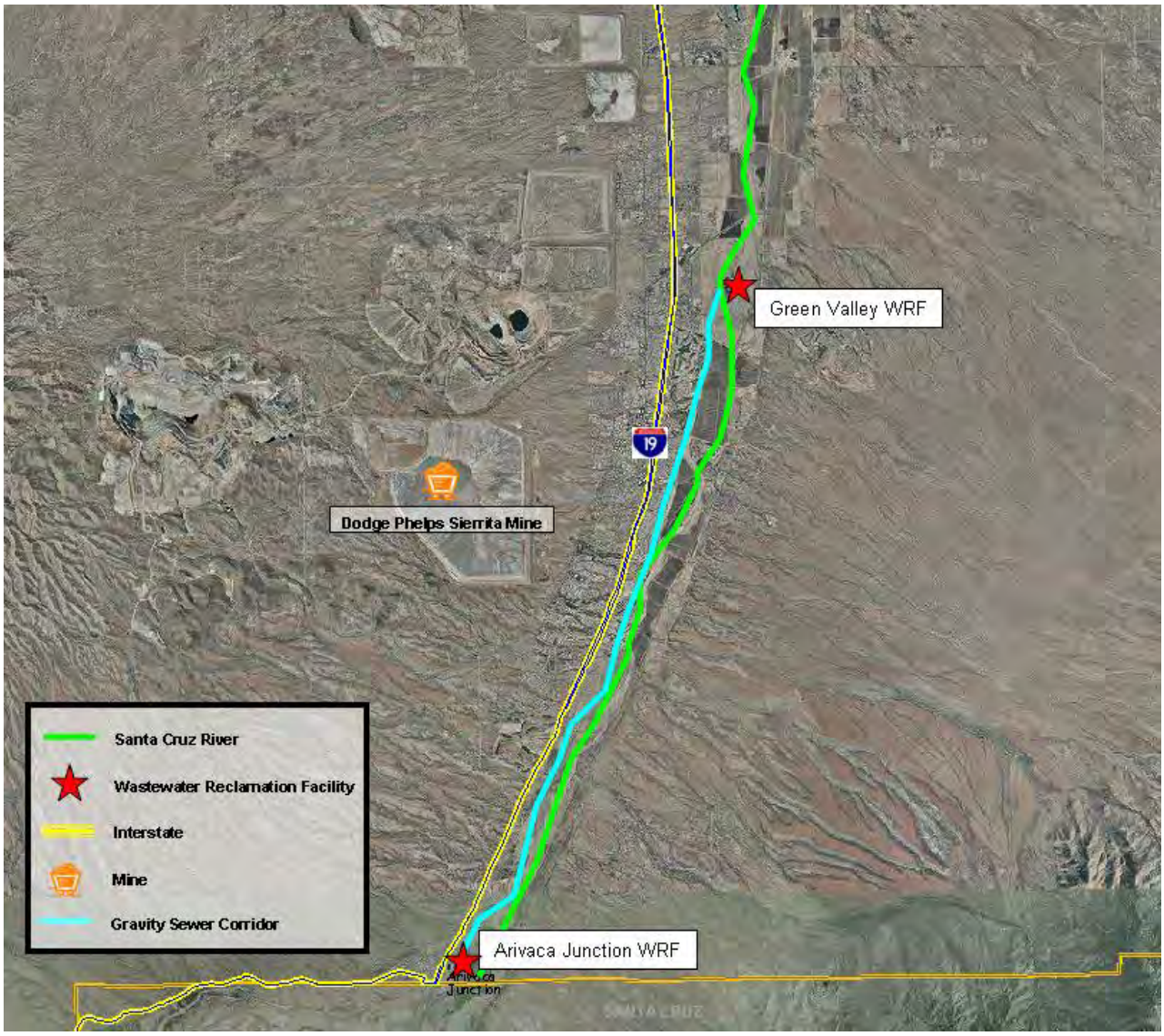
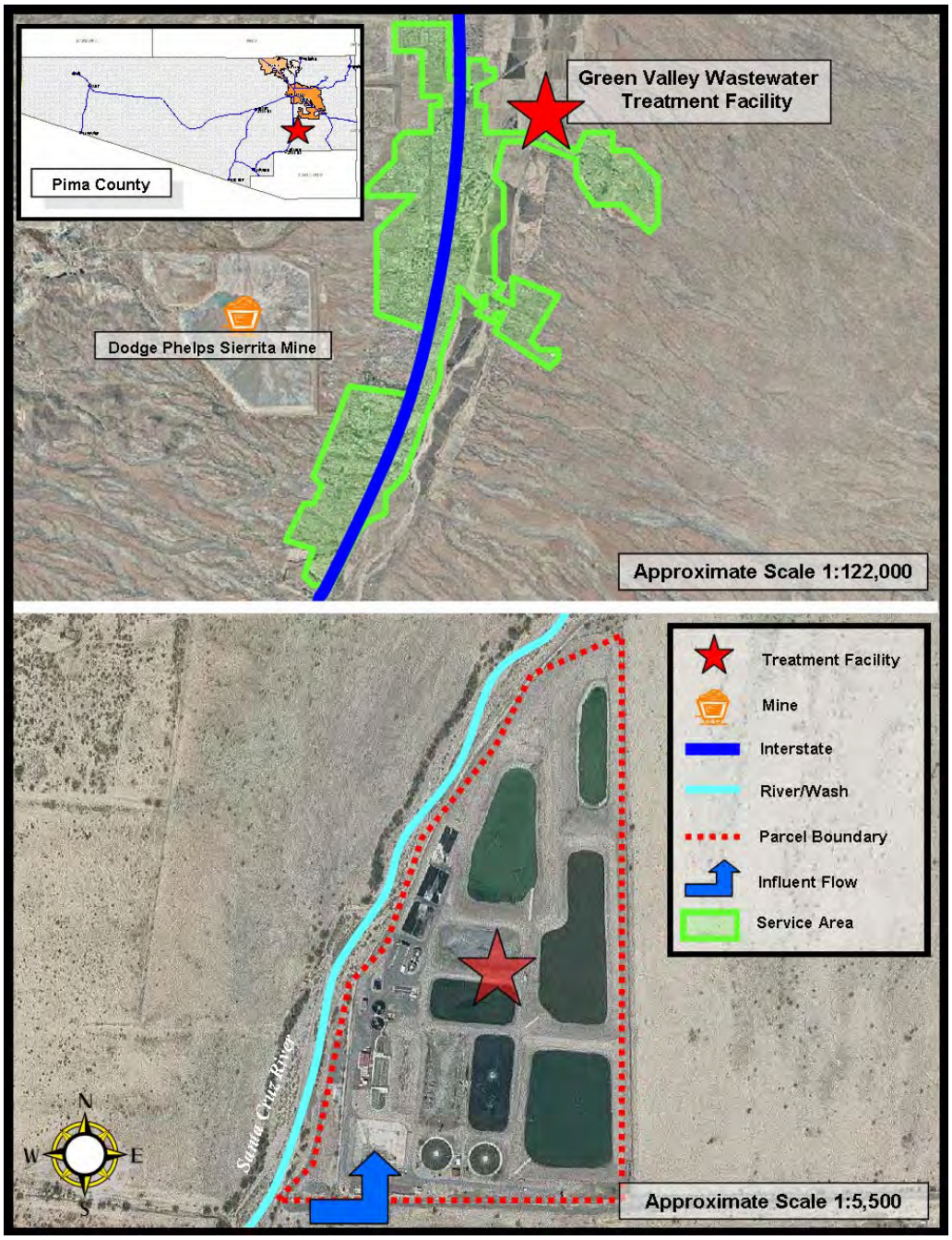


Figure 8-6
Green Valley Wastewater Reclamation Facility



8.2.1.5 Marana Wastewater Reclamation Facility

Marana Wastewater Reclamation Facility (WRF) is located in unincorporated Pima County 1,910-FASL one-half mile north of Marana Road, one mile west of Luckett Road, and one-half mile east of the Santa Cruz River. The facility served about 2,616 people in 2005. Marana WRF is located in an agricultural area owned by Pima County since 1980. The facility currently serves a relatively small area in Marana. Marana WRF is under expansion to serve the rapidly growing northwest area with 66% residential small and medium lots, 12% of the service area corresponds to a specific plan, and only 0.4% is zoned commercial. Marana WRF serves areas north and south of Grier Road and developments south of Moore Road and east of Sanders Road. The facility has a permitted treatment capacity of 0.7 mgd and treats an average daily influent flow of 0.19 mgd in 2007 (27% capacity).

Process
Marana WRF started treatment via two facultative/evaporation ponds (FEPs) in 1986. Accelerated development of the Marana area began in 2000 and continues. Additional treatment capacity was provided. The western FEP was closed and the eastern FEP has been converted into an emergency influent storage basin and is lined with soil cement.

The current wastewater treatment system includes a headworks and a 3-inch Parshall flume with a maximum capacity of 1.1 mgd. To provide wastewater treatment for the accelerated development, three 0.05 mgd biological nutrient removal package plants began operation at the end of 2001 and a fourth was added in 2005 providing a treatment capacity of 0.2 mgd. The four package plants will be supplemented with a 0.5 mgd “Biolac” activated sludge treatment system, as an interim treatment process. The Biolac will be used as a supplemental treatment capacity until the new 1.5 mgd facility is constructed. The four package plants have been taken off line and will be eventually moved elsewhere in the system.

Effluent discharges into a high-density polyethylene (HDPE) lined effluent storage pond and disinfected with chlorine. Odorous air from the treatment of process is collected and treated in an in-ground biofilter located onsite.

Permits
Marana WRF operates according to APP (P100631) issued on November 22, 2006, AZPDES (AZ0024520), and a Type 2 Class B+ Reclaimed Water General permit (R100631). The APP and AZPDES apply to the point downstream of effluent chlorination and upstream of the point of discharge to the Santa Cruz River and the reuse area. The Reclaimed Water permit applies to irrigation of the Marana Riparian Habitat Restoration site and for irrigation on facility vegetation.

Effluent
Effluent is reused onsite through landscape irrigation or for a riparian habitat restoration project or discharged to the Santa Cruz River. Class B+ effluent is produced through a Biological Nutrient Removal process and a chlorination and de-chlorination disinfection process.

Biosolids

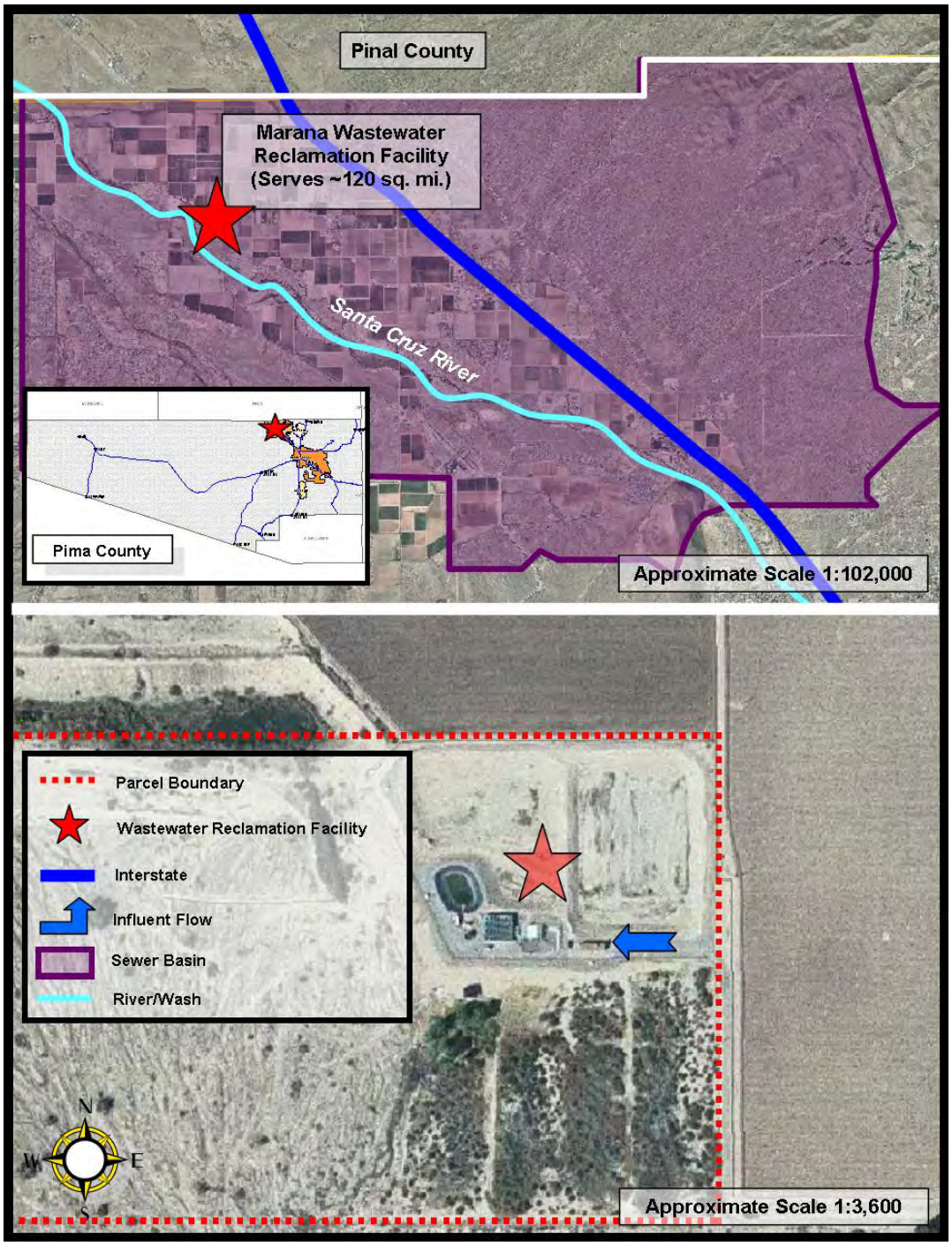
Marana WRF collects sludge in sludge storage tanks before transporting it to Ina Road WRF for processing. Dewatering solids 4% to 6% before transfer to the County conveyance system, Ina Road WRF, or other location should be investigated.

Outlook

The Traffic Analysis Zone data used to project population has indicated that the Marana WRF area population would increase rapidly; however the actual population growth in the area has lagged significantly behind the TAZ data projections. The service area is expanding to match the area's growth and eventually the facility will require expansion to provide capacity beyond the currently planned 1.5 MGD expansion. Possible flows for inclusion to Marana WRF's future capacity are the Rillito Vista WRF and the Continental Ranch Wastewater Pumping Station. An evaluation of the economic feasibility of expanding Marana WRF to include Rillito Vista WRF and the Continental Ranch Wastewater Pumping Station's wastewater. Design of a new 1.5 mgd BNROD facility is being completed, but future construction is not currently scheduled. Once BNROD construction is complete, the existing package plants should be evaluated to determine their remaining life and application for future projects. Plans to relocate two of the existing package plants to a proposed restoration project, the Canoa Ranch Water Reclamation Facility, south of Green Valley WRF have been proposed.

Marana WRF's service area and facility are shown on **Figure 8-7**.

Figure 8-7
Marana Wastewater Reclamation Facility



8.2.1.6 Mount Lemmon Wastewater Reclamation Facility

Mt. Lemmon WRF is located in unincorporated Pima County 8,310-FASL in the small community of Summerhaven on Mount Lemmon, north of Tucson. The facility was constructed in 1982 to end wastewater discharges into the Sabina Creek Watershed. The service area is primarily residential. The area was severely impacted by the 2003 Aspen fire destroying most of the buildings in Summerhaven. Mt. Lemmon WRF's service area is limited by Pima County's agreement with the USFS restricting the number of lots and the discharge limit to the spray field. The facility serves 47 lots as of 2005 and will acquire 30 more sewer front accessible properties. The facility treats an average of 12,500 gpd which is approximately 15% of design capacity.

Process
The Mt. Lemmon WRF consists of a closed loop reactor followed by chlorination-dechlorination units. The facility is the only treatment plant in Pima County experiencing freezing temperatures and is entirely enclosed.

Permits
Mt. Lemmon WRF also has an APP (#P100345), and a Special Use Permit (SAN0139) issued by the United States Forest Service. The APP regulates General Type 4 discharges to the local aquifer via sprayfield irrigation of vegetation on US Forest Service land.

Mt. Lemmon WRF received an AZPDES permit (AZ0022250) enabling backup discharge to three outfalls into receiving waters of unnamed washes all tributary to the San Pedro River and San Pedro/Wilcox Playa River Basin on February 10, 2006. The AZPDES permit and authorization to discharge expires on December 31, 2010. The receiving waters (unnamed washes) have the following designated uses.

- Aquatic and Wildlife ephemeral (A&We)
- Partial Body Contact (PBC)

The AZPDES permit is issued for a period of five years.

Effluent
Treated effluent from the Mt. Lemmon WRF is disposed of via sprayfield irrigation onto forest vegetation, or is disposed of using underground pipelines leading to three combined outfalls; both are regulated by the facility's AZPDES permit. The AZPDES permit states only treated effluent will be discharged to the unnamed wash if freezing or inoperable conditions of the sprayfield exist.

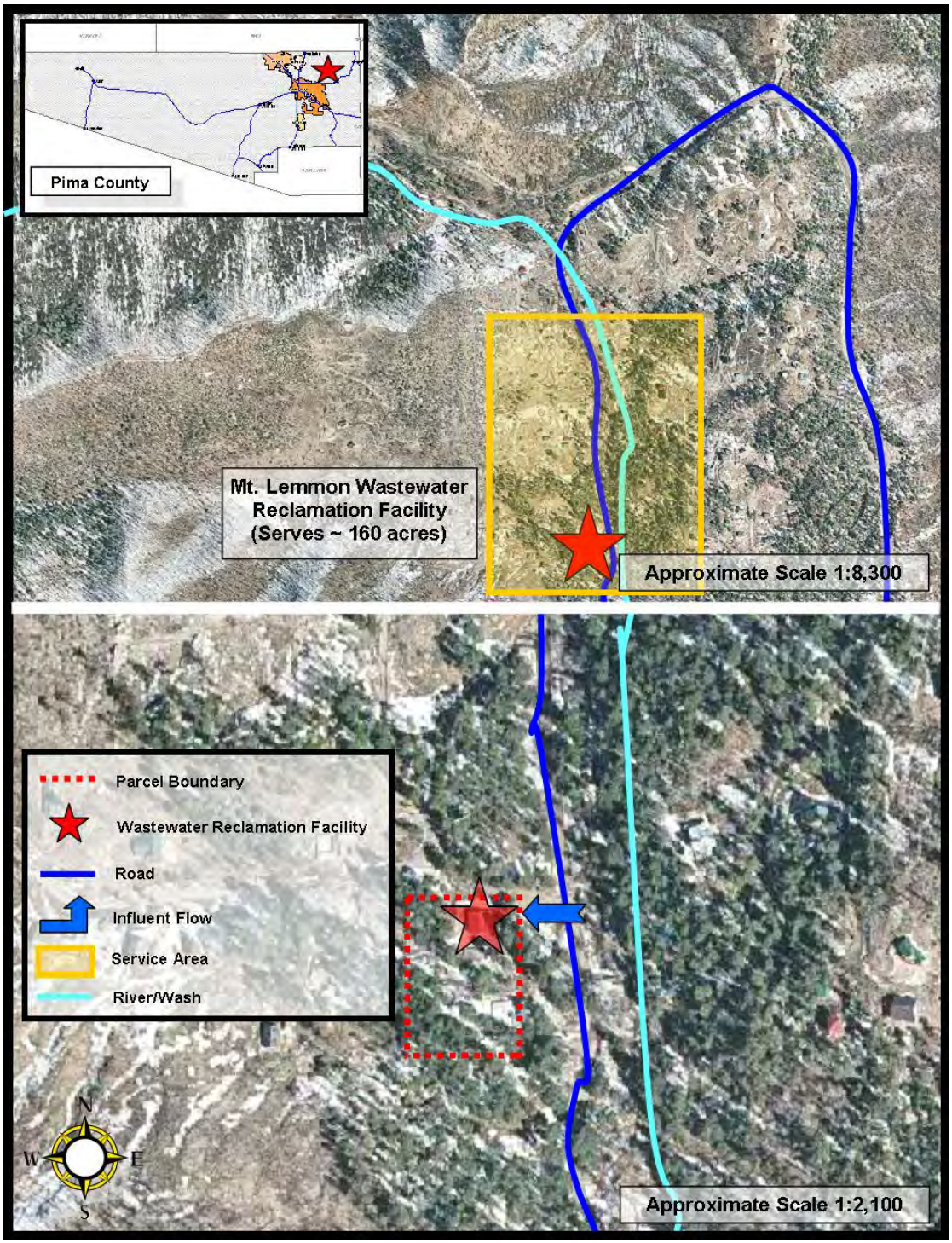
Biosolids
Sludge is deposited into the County conveyance system (manhole 8716-03) for transport and treatment at the Ina Road WRF and further processing at the Regional Biosolids Facility. Dewatering solids 4% to 6% before transfer to the County conveyance system or other location should be investigated.

Outlook

PCRWRD, the County Department of Environmental Quality and the United States Forest Service (USFS) are working together on the Mt. Lemmon Service Area Watershed and Wastewater Management Plan, and the study is currently underway. This plan hopes to identify the conditions and circumstances existing in and around the Mt. Lemmon community, and the significant issues and challenges involved in planning wastewater systems. The study is anticipated to be completed in 2008. Due to its location and limited service, Mt. Lemmon WRF will most likely continue to be a stand alone facility in the future.

Mt. Lemmon WRF's current service area and facility are shown on **Figure 8-8.**

Figure 8-8
Mt. Lemmon Wastewater Reclamation Facility



8.2.1.7 Pima County Fairgrounds Wastewater Reclamation Facility

The Fairgrounds WRF is located 3,010-FASL approximately 18 miles southeast of Tucson at the county fairgrounds south of Interstate 10 and west of Houghton Road. Pima County Fairgrounds WRF serves only the fairgrounds for the Pima County Fair and for various events throughout the year. The Fairgrounds has measurable flow in the month of April when the Pima County Fair is held. The facility has a permitted treatment capacity of 0.035 mgd.

Process
The Fairgrounds WRF consists of two primary stabilization ponds and an overflow pond. Flow is split or directed into a stabilization pond via a manual splitter device.

Permits
The facility has an APP for the three facultative ponds.

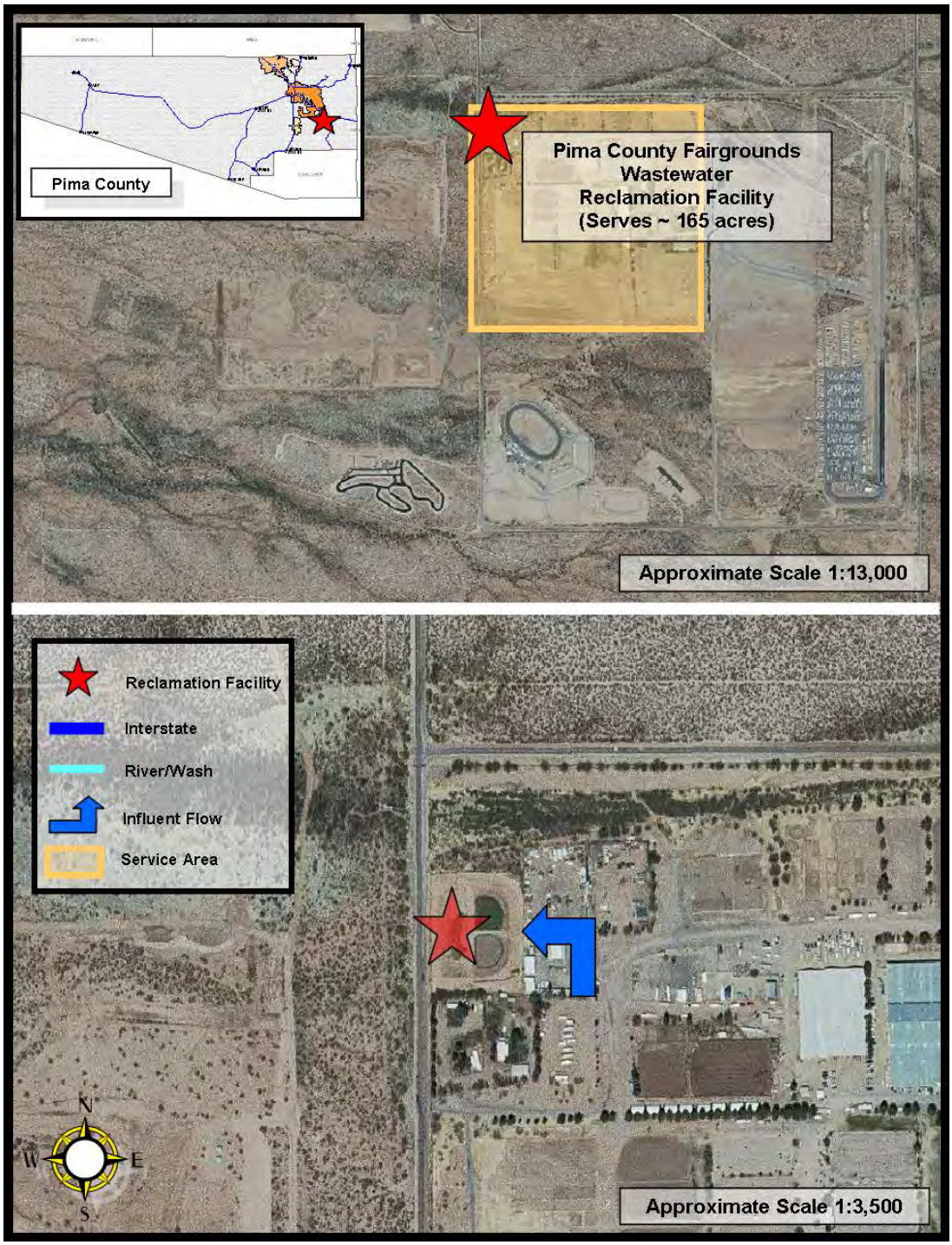
Effluent
The Fairgrounds WRF does not discharge effluent.

Biosolids
Biosolids are dried, scraped, and hauled to a landfill when necessary.

Outlook
Flow originating from the Pima County Fairgrounds can be transferred once a conveyance structure connecting the Fairgrounds to the South East Interceptor, or other location is completed. Such a conveyance structure has not been included in any Capital Improvement Plan budget to date but is under long term consideration. Currently, a basin study is underway to assess the Southlands sewer basin, which includes the Fairgrounds WRF. Possible alternatives to be considered include a conveyance structure connecting the Fairgrounds to the South East Interceptor or connection to another future facility that would support the entire Southlands basin.

PC Fairground's service area and facility are shown on **Figure 8-9**.

Figure 8-9
Pima County Fairground Wastewater Reclamation Facility



8.2.1.8 Rillito Vista Wastewater Reclamation Facility

Pima County's Rillito Vista WRF is located in unincorporated Pima County 2,130-FASL on land owned by Arizona Portland Cement, northwest of Tucson, between Avra Valley Road and Tangerine Road, and between Interstate 10 and the Santa Cruz River. The facility serves 156 people based on the average owner-occupied rate published in the Pima County Sonoran Desert Conservation Plan (SDCP) Housing Report. Rillito Vista WRF's service area boundary corresponds to the Rillito Vista subdivision northwest of Tucson. The area is entirely rural and serves 60 lots. The facility has a permitted treatment capacity of 0.02 mgd and treats an average daily influent flow of 0.012 mgd in 2006 (60% capacity).

Process
The treatment method for this area consists of two stabilization/evaporation/percolation ponds. One pond is in use while the adjacent pond is dried and scraped before returning to service.

Permits
The facility has a general APP (P100636).

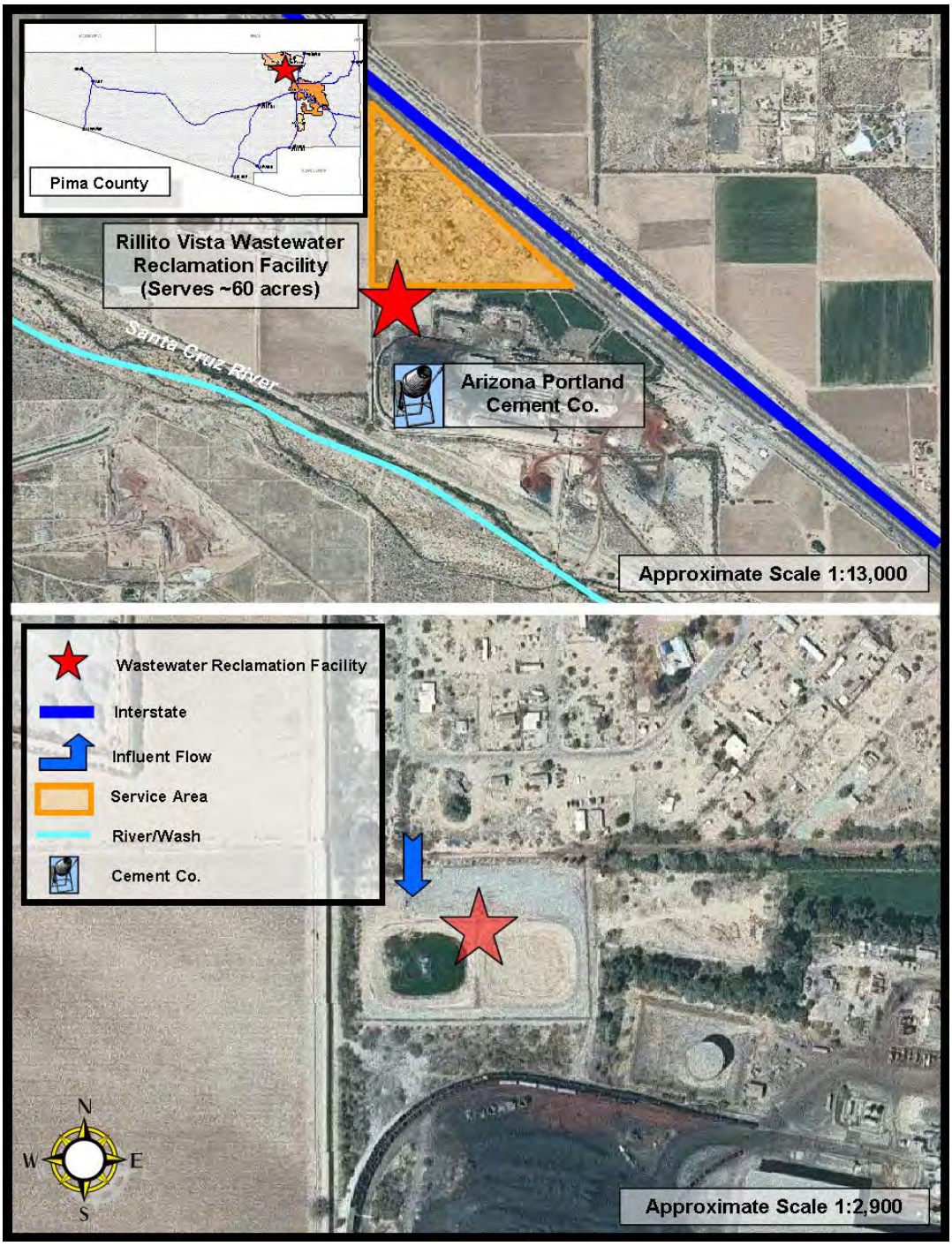
Effluent
The facility does not discharge effluent.

Biosolids
Biosolids are dried, scraped, and hauled for disposal via landfill.

Outlook
Rillito Vista WRF is operated by PCRWRD on land leased from the Arizona Portland Cement Company and treatment should be transferred to a treatment location on County owned property as soon as a conveyance structure connecting the service area to a facility for treatment is completed (Marana WRF or Ina Road WRF). Continued operation on leased land reduces the County's control in providing reliable treatment for its customers.

Rillito Vista WRF's service area and facility are shown on **Figure 8-10**.

Figure 8-10
Rillito Vista Wastewater Reclamation Facility



8.2.2 Non-PCRWRD Operated Facilities

The two non-PCRWRD operated facilities discussed in this chapter include the Arizona Sonora Desert Museum and Sahuarita, however many smaller ones exist. Should any of these non-PCRWRD-operated entities relinquish their wastewater treatment responsibility, PCRWRD may become responsible for providing treatment to meet current and future governmental regulations. PCRWRD is aware of other developer built and operated non-PCRWRD facilities. These are usually in the form of small package plants. This report recognizes the existence of small developer facilities, but they are not individually identified. The western Pima County communities including Ajo, Why, and Lukeville treat wastewater via their own systems and their operations are not expected to change by a significant amount within the next 25 years. Therefore, the western Pima County communities, and small developer built and operated facilities are not included in the Non-Metro scheme.

8.2.2.1 Arizona Sonora Desert Museum Wastewater Treatment Facility

The Arizona Sonora Desert Museum (ASDM) wastewater facilities have been turned over by Pima County to Westland Resources Inc. for operation. The service area consists of the facilities belonging to the ASDM only. ASDM facilities operate according to the Aquifer Protection Permit (P100628) with a maximum monthly average domestic wastewater flow of 0.015 mgd and consists of settling tanks, a flow equalization basin, subsurface leach beds, recirculating sand filter and disposal trenches with sludge hauled to the Butterfield Landfill for disposal.

8.2.2.2 Sahuarita Wastewater Treatment DMA

The Town of Sahuarita became a Management Agency responsible for treatment of the incorporated area in 1999. Its service area is west of Santa Cruz River and south of Pima Mine Road and serves the residential areas of the Rancho Resort and Rancho Sahuarita development. Sahuarita is permitted for a capacity of 0.25 mgd with a current flow of 0.2 mgd. Treatment of Sahuarita wastewater is performed via a biodenitrification process using oxidation ditches. Effluent is discharged to on-site rapid infiltration basins. Solids are digested and placed on sludge drying beds for dewatering prior to transport to the Tangerine Landfill.

8.2.3 Non-Metro Regions

Current facility influent flows are increasing primarily for Marana WRF, Avra Valley WRF, and Corona de Tucson WRF. Projected flow increases at these facilities range from 250 to nearly 3,000 percent. Many of the Non-Metro facilities will be treating over 1.0 mgd by 2010 with all facilities treating more than 1.0 mgd by 2020. 2030 flow projections for these Non-Metro facilities range from 2.1 to 10.5 mgd.

Consolidating treatment into Non-Metro facilities offers advantages over treating wastewater at many satellite facilities. These advantages include:

- Reduced capital investment due to economies of scale: Consolidation reduces the average cost/gallon of wastewater treated when expanding an existing facility or constructing a new one.

- Increased operations and maintenance efficiency: Consolidation reduces the amount of time a "roaming" operations crew spends traveling between satellite facilities. Chemicals may be purchased in bulk, delivered to one location, and stored at one location for use.

- Increased treatment reliability: Larger flows experienced at a consolidated facility buffers treatment disruption due to flow and loading fluctuations more effectively than at a smaller facility.

A Non-Metro treatment facility must be located in an area where the consolidation effort provides benefit over the continued operation at many satellite facilities. This chapter evaluates the Non-Metro areas for possible Non-Metro treatment facility locations.

Five sewer basins make up the Non-Metro area regions: Northwest, Southwest, South, Southeast, and Mountain. The following describe the objectives for determining each region's boundaries.

- Separate topographically confined areas – Some Non-Metro facilities serve populations in topographically separated areas. Conveying wastewater to or from these locations would require a significant investment in time, energy, and money far greater than expanding or upgrading the current facilities to meet future regulations, flow and loading needs of the area served.

- Convey wastewater via gravity – Many of the configuration alternatives are eliminated by considering flow conveyance by gravity only. Conveying flows up gradient requires additional investment in pump and lift stations, energy to run these systems, and operations and maintenance for these systems. A pipeline of sufficient slope to achieve a minimum scour velocity of 2.5 feet per second is required. This report examined conveying flows to locations where a minimum slope of ten (10) feet per mile was possible. Note, however, eliminating pump and lift station construction for an entire Non-Metro region is unlikely. In some instances, guiding flow to treatment locations to meet minimum travel velocities and overcome topographical boundaries may require the construction of pump and/or lift stations.

- Limit conveyance line distances – PCRWRD is committed to eliminating problem odors emanating from the conveyance system in an effort to improve quality of life within the community. These odor problems are exacerbated in a number of ways due to long conveyance structures. Long conveyance structures lead to long residence times increasing the chance for the wastewater to become septic. The region's warm climate leads to increased chemical and biochemical activity and reactions releasing malodorous compounds. The longer wastewater travels before reaching a wastewater treatment facility the greater the chance for these odors to be released into the air and an odor issue to arise. Thus, to mitigate future odor problems, conveyance line distance should be minimized.

- Avoid conveyance line construction in areas of sparse population – Construction of conveyance structures in locations of projected populations allows the County to offset capital costs by collecting connection fees from developers. Connection fees may be used as a credit against the cost of development, or collected as payment to defer capital construction costs. This constraint requires locating the conveyance structure in an area of actual development. An accurate prediction for the location of future development is critical and trusted population

projection/distribution data must be utilized. Construction of conveyance systems in densely populated areas can result in a substantial increase in construction costs. Other disadvantages to constructing conveyance lines through the metropolitan area include economic disruptions for businesses and travel disruptions for commuters. Thus, the option of routing flow from remote areas through the densely populated metropolitan area to the regional treatment facilities is eliminated.

Figure 8-11 shows the five conceptual Non-Metro regions.

Figure 8-11
Non-Metro Regions

It should be noted that the boundaries of these conceptual regions may exclude locations of future tributary flow that could be conveyed to a Non-Metro treatment facility. It is important to remember these boundaries are simply conceptual and have been formed by including existing sewage systems,

areas of proposed rapid population expansion, and excluding national parks, protected areas, Non-Pima County designated management areas, adjacent counties, and areas of where providing sewerage service would currently be considered economically infeasible.

8.2.3.1 Northwest Region

The Northwest region currently includes the Marana and Rillito Vista facilities and could include Continental Ranch Wastewater Pumping Station (CRWWPS) flow via gravity; however, no conveyance structure connecting the two has been designed or constructed. Marana's existing facility location is down-gradient of much of the projected service area population, whereas Rillito Vista WRF is bounded by privately owned property and resides on land leased by the Arizona Portland Cement Company up-gradient of much of the proposed population. CRWWPS is situated within the town of Marana (12 miles, point to point, from Marana) down-gradient of Ina Road and up-gradient of Rillito Vista and Marana. Due to location, land availability, effluent reuse possibilities, and PCRWRD's invested time and capital, Marana's facility will become the Northwest Region's Non-Metro treatment facility and expand to meet treatment demands.

8.2.4 Southwest Region

The Southwest region's projected development poses an interesting opportunity for Pima County. Avra Valley WRF is the only facility serving this region, and is currently undergoing significant upgrades to address capacity needs. Because of these upgrades and coupled with the fact that the Avra Valley facility is located down-gradient from much of its projected service area, the Avra Valley facility will serve as the Southwest Non-Metro facility. This creates an opportunity for Pima County to proactively implement its goals for thoughtful growth and development in this area of the County. Fundamentally, this Southwest region could become the model for Pima County for managing "smart" growth policies, which bring long-term quality of life benefits to the citizens of the area.

8.2.5 South Region

Completion of the gravity sewer line in 2007/2008 will mark the end for the aerated lagoons of Arivaca Junction WRF and the beginning of the transfer of flow to the Green Valley WRF, the South Region's Non-Metro facility. Class C effluent delivery to Reventone Ranch will cease and partial reuse of Arivaca Junction WRF's wastewater may occur pending acceptance of a proposition to construct a water reclamation facility in the Canoa Ranch vicinity to 'scalp and treat' flow providing highly treated effluent for the habitat in the area. PCRWRD has already invested in a 2.0-mgd BNROD facility and plans on providing additional treatment via an additional 2.0-mgd BNROD process by 2010 (providing a total treatment capacity of 4.0 mgd). Green Valley WRF's current activities have positioned the facility to become the South Non-Metro wastewater reclamation facility.

8.2.6 Southeast Region

The Southeast region consists of two Non-Metro facilities, a future facility and the Corona de Tucson WRF. Due to the recent investment in the Corona de Tucson WRF, the facility will expand to provide service for its area until construction of the future facility and individual conveyance lines connecting Corona de Tucson WRF to the future facility is complete. The conveyance line capacity from Corona de

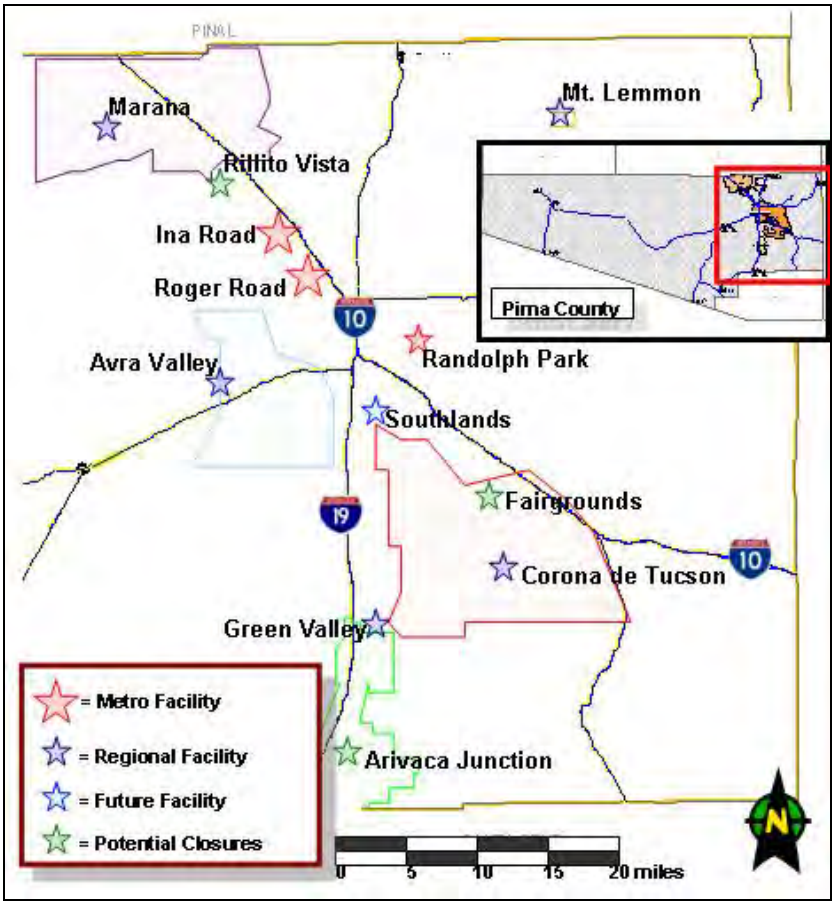
Tucson WRF to Southlands WRF will be designed to include upstream 2030 projected flows and be located in areas of projected development to allow funding to be defrayed from connection fees. A future study must be conducted to determine whether the Corona de Tucson WRF should be phased out or converted to a water reclamation facility providing treated effluent to local customers.

8.2.7 Mount Lemmon Region

Mt. Lemmon WRF will continue operation as a stand-alone facility and flows will not be incorporated into a regional facility due to its remote location.

Figure 8-12 shows PCRWRD's current and future Non-Metro treatment facilities.

Figure 8-12
Current and Future Non-Metro Reclamation Facilities



8.3 Summary

The Non-Metro facilities were constructed to meet wastewater treatment demands for smaller Non-Metro developments. The treatment technologies are varied and require various levels of maintenance and

repair. As developments were constructed, the Non-Metro facilities offered centralized treatment for the areas generating wastewater, supporting the County's growth and development. When the Non-Metro facilities were initially constructed, wastewater treatment consolidation to the regional facilities (Roger Road WRF and Ina Road WRF) from these areas was not an optimal solution because it would have required long stretches of conveyance structures transporting relatively low flows from areas of little population. Initial treatment processes at the Non-Metro facilities consisted of relatively simply operated and maintained aerated lagoons. As populations increased, PCRWRD sought to improve nutrient removal providing the environment with higher quality of effluent. Thus, a shift towards oxidation ditches, closed loop reactors, and package plants occurred. The wastewater treatment level, and operations and maintenance of these activated sludge systems have since proved to be beneficial and a significant amount of time and capital has been invested in the activated sludge systems.

This chapter summarizes the current and planned activities for each of PCRWRD's operated Non-Metro facilities and identified five Non-Metro regions for probable Non-Metro facility locations: Northwest, Southwest, South, Southeast, and Mountain. The next chapter discusses the recommended flow management for the Non-Metro facilities for the 25-year planning period, building upon what PCRWRD has already prepared and constructed.

CHAPTER 9

Outlying Facilities' Strategic Management Plan

Chapter 9 - Non-Metro Facilities' Strategic Management Plan

9.1 Introduction

The PCRWRD currently operates and maintains eight Non-Metro wastewater treatment facilities. This chapter draws upon preceding conveyance system evaluation (Chapter 6) and Non-Metro facility overviews (Chapter 8), as the basis for recommending flow management for the Non-Metro regions. The recommended flow management plan for the Non-Metro areas are in support of the recommended overall treatment strategy and recommended treatment plan. This chapter discusses the following topics.

- Current and future influent flows, biosolids, and effluent
- Current treatment technologies and future requirements
- Non-Metro facility treatment technology options and recommendations
- Non-Metro facility layout recommendations

Descriptions of the Non-Metro facilities are provided in Chapter 8. The Non-Metro facilities include:

- Arivaca Junction WRF
- Avra Valley WRF
- Corona de Tucson WRF
- Green Valley WRF
- Marana WRF
- Mt. Lemmon WRF
- Pima County Fairgrounds WRF
- Rillito Vista WRF

9.2 Current and Future Influent Flows, Biosolids, and Effluent

Treatment technology selection requires an understanding of the influent flows and characteristics, desired level of biosolids treatment, effluent quality, client needs, and existing treatment technologies. The Non-Metro region's growth projections were obtained and reviewed to assist in determining the optimal treatment process for the Non-Metro facilities. The recommendation draws upon information gathered from a series of facilitated workshops consisting of PCRWRD staff, consultants and other stakeholders, as well as several previous planning and engineering efforts performed for or by the PCRWRD. This chapter discusses:

- Influent flows and characteristics
- Biosolids handling, treatment, and disposal
- Effluent quality and water reuse

9.2.1 Influent Flows and Characteristics

Future wastewater flows for the Non-Metro facilities were based on population projections obtained from the PCRWRD Facility Plan and PAG TAZ data. This data was agreed upon between the City of Tucson and

Pima County Wastewater Management's Resolution of Population and Effluent Variances (Joint Memorandum). Population projections examined the current population on septic systems and assumed these populations would continue their septic service. All new population would be sewered (wastewater flow transported to a PCRWRD operated treatment facility) unless they were located in areas of sparse development where service by PCRWRD would be economically infeasible. Flow was then calculated for five year increments using the sewered population and multiplying by the gallon per capita per day factor of 85.

Facility influent flows are currently increasing for nearly all the Non-Metro facilities. Projected flow increases at these facilities range from 250 to nearly 3,000 percent. Many of the Non-Metro facilities will be treating over one mgd by 2010 with all facilities (excluding Mt. Lemmon WRF) treating more than one mgd by 2020. 2030 flow projections for these Non-Metro facilities range from 2.1 to 10.5 mgd (excluding Mt. Lemmon WRF). The future dry weather flow projections calculated from the population projections are presented in **Table 9-1**.

Table 9-1
Non-Metro Facility Average Daily Dry Weather Flow Projections (mgd)[1]

Facility	2006	2010	2015	2020	2025	2030	% Increase
Avra Valley WRF [2]	1.08	1.4	1.8	2.2	2.6	3.0	280
Corona de Tucson WRF [2]	0.14	0.5	0.9	1.3	1.7	2.1	1500
Green Valley WRF [3]	1.76	2.7	3.1	3.6	4.0	4.4	250
Marana WRF [2]	0.15	1.6	2.3	3.0	3.7	4.4	2900
Mt. Lemmon WRF [4]	0.013	0.013	0.013	0.013	0.013	0.013	-
Southlands WRF [2]	-	1.2	3.6	6.0	8.2	10.5	875

1. Flow from Arivaca Junction WRF, Pima County Fairgrounds WRF, and Rillito Vista WRF lagoon facilities' will be conveyed to Non-Metro facilities at a later date and future flow projections for these areas are included in the Non-Metro facilities' future flow projections
2. Future flows from PCRWRD's Facility Plan (TAZ)
3. Future flows from PAG
4. Future flow projection is assumed to be constant due to the agreement between PCRWRD, the County Department of Environmental Quality (DEQ), and the USFS

Future flow projections, developed in PCRWRD's Metro Area Facility Plan Update (Facility Plan) and discussed in Chapter 8, for Non-Metro facilities are summarized in **Table 9-2**.

Table 9-2
Non-Metro Facility Flow Projections (mgd)*

Facility	2010	2015	2020	2025	2030
Avra Valley WRF	1.4	1.8	2.2	2.6	3.0
Corona de Tucson WRF	0.5	0.9	1.3	1.7	2.1
Green Valley WRF	2.7	3.1	3.6	4.0	4.4
Marana WRF	1.6	2.3	3.0	3.7	4.4
Southlands	1.2	3.6	6.0	8.2	10.5

Determination of future Non-Metro influent design wastewater characteristics allows for the selection of a treatment alternative with the capabilities of properly treating the range of loadings the wastewater treatment facility may experience.

For purposes of wastewater treatment system evaluation for the Non-Metro facilities, influent wastewater characteristics were developed based on the Roger Road WRF, Ina Road WRF and Non-Metro facility influent wastewater characteristics. The influent wastewater characteristics used for evaluation of the Non-Metro facilities are listed in **Table 9-3**.

Table 9-3
Non-Metro Facility Influent Wastewater Characteristics

Characteristic	Non-Metro Facility Influent Concentrations (mg/L)
BOD_5	300
$sBOD_5$	125
COD	590
TSS	270
VSS	220
TKN	57
TP	10

9.2.2 Biosolids Handling, Treatment, and Disposal

The Non-Metro facilities store their biosolids before transporting it to one of the regional facilities, except Green Valley WRF provides on-site biosolids treatment and disposal. At Green Valley WRF sludge from the secondary clarifiers is sent to two gravity thickeners before being dried on sludge drying beds to produce Class A biosolids. Class A biosolids can be used for a number of different options, including cover material for landfills or for mine tailings reclamation. Currently, Green Valley WRF, Pima County,

and the University of Arizona have entered into an agreement with Asarco Mines to use biosolids for reclamation of its mine tailings.

Biosolids from Mt. Lemmon WRF and Marana WRF are stored and transported to the influent of the Ina Road WRF. Biosolids from Avra Valley WRF is mixed with the sewage tributary to Roger Road WRF to be treated and digested before being transferred to Ina Road regional processing facility for transfer to a disposal site. Biosolids from Rillito Vista WRF, Corona de Tucson WRF, and Pima County Fairgrounds WRF are dried, scraped, and hauled to a landfill as necessary.

Non-Metro facility biosolids production is approximated by assuming 2,800 dry pounds per day of raw biosolids produced per mgd flow treated. Current tpd produced and handling, processing, and disposal methods for each Non-Metro facility are shown in **Table 9-4**.

Table 9-4
Current Non-Metro Facilities' Biosolids Production/Handling, Processing, Disposal

Current Biosolids		
Location	**Produced (tpd)**	**Handling, Processing, Disposal**
Arivaca Junction WRF	0.09	Dried, Scraped, Hauled to Landfill
Avra Valley WRF	2.20	Storage, hauled and transported to conveyance system
Corona de Tucson WRF	0.16	Dried, Scraped, Hauled to Landfill
Green Valley WRF	5.70	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana WRF	0.28	Storage, hauled and transported to conveyance system
Mt. Lemmon WRF	0.02	Storage, hauled and transported to conveyance system
PC Fairgrounds WRF	0.004	Dried, Scraped, Hauled to Landfill
Rillito Vista WRF	0.01	Dried, Scraped, Hauled to Landfill
Total	**8.46**	

Chapter 5: Biosolids provides information regarding existing Class B regional biosolids processing and disposal methods, Class B and Class A biosolids requirements, available markets, process alternatives for Class A production at the regional facilities, and biosolids processing recommendations in more detail.

The current recommendation for biosolids handling, processing, and disposal at the Non-Metro facilities is for thickening and hauling of biosolids to continue until an extensive market study is completed producing an optimal biosolids processing strategy as discussed in the biosolids chapter of this study. The future Non-Metro facilities' biosolids production and handling, processing, and disposal recommendation are shown in **Table 9-5**.

Table 9-5
Future Non-Metro Facilities' Biosolids Production/Handling, Processing, Disposal

Future Biosolids*						
Location	Produced (tpd)					Handling, Processing, Disposal (2030)
	2010	2015	2020	2025	2030	
Arivaca Junction WRF	-	-	-	-	-	Flow transferred to Green Valley WRF
Avra Valley WRF	1.96	2.52	3.08	3.64	4.20	Thicken/haul to interceptor for discharge
Corona de Tucson WRF	0.70	1.26	1.82	2.38	2.94	Store/haul to interceptor for discharge
Green Valley WRF	3.78	4.34	5.04	5.60	6.16	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana WRF	2.24	3.22	4.20	5.18	6.16	Thicken/haul to Ina Road Digester for processing
Mt. Lemmon WRF	0.003	0.003	0.003	0.003	0.003	Thicken/haul to interceptor for discharge
PC Fairgrounds WRF	Current practice until flow is transferred					Flow transferred to SEI
Rillito Vista WRF	Current practice until flow is transferred					Flow transferred to Marana WRF
Southlands WRF	1.68	5.04	8.40	11.48	14.70	Master plan is under development
Total	**10.36**	**16.38**	**22.54**	**28.28**	**34.16**	

*Market study will determine future plans for all facilities' biosolids handling, processing, and disposal

9.2.3 Effluent Quality and Water Reuse

Pima County's treated effluent is increasing in value. Due to the large population growth and a limit to the amount of available water, communities are interested in water reuse programs as a means to augment their potable water consumption. Some Non-Metro communities have shown interest in obtaining the rights to their wastewater via purchase and operation of the local wastewater treatment facility and this could be a future trend in Pima County. Current and future effluent quality and water reuse for the area is discussed below to assist in determination of the optimal Non-Metro system configuration.

Quality

Determining the desired effluent quality is an important component for selection of a proper treatment technology. Effluent quality is determined by government regulations, existing permits, and the County's desired level of treatment. Government regulations have become increasingly more stringent with respect to effluent quality. The Non-Metro areas are required to follow the regulations set forth in the AAC Title 18 Chapter 9 Part B and the rules of the individual facility's respective permits. An evaluation of the

Non-Metro facilities' current permits has been summarized in Chapter 2. PCRWRD desires wastewater treatment quality standards for all facilities that will meet current and future regulations at each facility.

The recommended Non-Metro treatment alternative must comply with future government regulations, improve the discharged effluent quality, and standardize wastewater effluent quality for all facilities. Neither current nor future (2014/2015) PCRWRD Pima County AZPDES Permits require phosphorus removal. However, PCRWRD's commitment to provide a higher quality effluent has prompted PCRWRD to include the goal of a total phosphorus (TP) limit of < 1 mg/L as a part of the Regional Optimization Master Plan. Effluent quality parameters are summarized in **Table 9-6**.

Table 9-6
Effluent Quality Parameters

Parameter	Effluent Quality
BOD_5	< 6 mg/L
TSS	< 10 mg/L
Ammonium as Nitrogen (NH_4-N)	< 1 mg/L
TN	< 10 mg/L; Design <8mg/L
TP	< 1 mg/L
Pathogen removal	No detect in 4 of 7 samples per week. None exceeding 23 cfu/100ml
pH	6.8 – 7.2

Water Reuse

Currently, PCRWRD operated facilities have varying classes of treated effluent and various disposal and delivery methods. **Table 9-7** summarizes the current permitted effluent utilization for the Non-Metro facilities.

Table 9-7
Summary of the Non-Metro Facilities' Current Permitted Water Reuse*

Current Water Reuse		
Facility	**Permit**	**Use**
Arivaca Junction WRF	Class C	Reventone Ranch (Agriculture)
Avra Valley WRF	Class B+	Spray Field Disposal
Green Valley WRF	Class A+	Robson/Quail Creek, Inc. (Turf Irrigation)
Marana WRF	Class B+	Santa Cruz River Discharge and Plant Turf Irrigation
Mt. Lemmon WRF	USFS Permit	Spray Field Disposal

*Non-Metro facilities not mentioned here do not currently utilize effluent

Future prediction of water reuse begins by identifying the type(s) of uses that will be pursued and the types of customers. A reclaimed water system may grow as a way to augment the potable water supply with non-potable water. As Pima County's Non-Metro population continues to grow and the supply of potable water stays constant or possibly diminishes, water reuse will become necessary. Popular water reuse ideas for this area include turf irrigation and riparian restoration.

Turf Irrigation

Turf irrigation includes irrigation for areas such as golf courses and public/private parks. The Water Conservation in Pima County document states City of Tucson, Pima County, Marana, and Oro Valley have ordinances requiring the use of reclaimed water on new golf courses where feasible. The ability to use reclaimed water depends on the ability to connect to the reclaimed water distribution system. An existing reclaimed water piping system delivers reclaimed water to many areas of the eastern Pima County region. Golf courses outside of the existing reclaimed water distribution area would need to connect to the system at their cost.

Riparian Restoration

An element of the Sonoran Desert Conservation Plan includes riparian restoration. The City of Tucson and Pima County have come to the agreement to reserve up to 10,000 acre-feet of treated effluent per year for approved riparian projects.

9.3 Current Treatment Technologies and Future Requirements

Treatment technologies for the existing Non-Metro facilities include lagoons, oxidation ditches, closed loop reactors, and package plants. PCRWRD desires to replace primary wastewater treatment via land intensive lagoons and shift towards a technology that will comply with BADCT rules and relieve pressures due to population growth and loadings exceeding those acceptable for the lagoon technologies (BADCT rules are discussed further in Chapter 2 of this study).

Marana WRF, Avra Valley WRF, Corona de Tucson WRF, and Mt. Lemmon WRF are typically operated and maintained by a staff only present from Monday through Friday on either eight or ten hour daily shifts. Arivaca Junction WRF, Pima County Fairgrounds WRF, and Rillito Vista WRF have operations staff visits each facility approximately once per week. The projected increase in wastewater flow at Marana WRF, Avra Valley WRF, and Corona de Tucson WRF locations has prompted PCRWRD's desire for a highly efficient, low maintenance treatment technology.

Where the Non-Metro areas are experiencing rapid population expansion, populations are encroaching upon these historically remote treatment facilities driving up the price of available land. In an effort to eliminate odor complaints, eliminate potential community eye-sores, meet setback requirements, and eliminate additional land purchases, the selected treatment technology must have odor control technology implementation capabilities, be aesthetically pleasing, and be able to fit within setback buffers on PCRWRD's currently owned parcels.

Below the 0.5-mgd design capacity, treatment needs can be met by package or pre-engineered plants when operated properly. Package plants at Marana WRF used to meet the Non-Metro facility treatment needs. When capacities grow beyond 0.5 mgd, the addition of extra package plants can create a

cumbersome treatment operation and an alternative treatment facility should be determined. Marana WRF and Corona de Tucson WRF currently fall into the small capacity range (0 – 0.5 mgd) but are projected to transition into the medium capacity range (0.5 – 10 mgd) by 2010. In this range, package plants are generally no longer appropriate because as flows increase, the complexity of treatment increases significantly, well beyond the simplistic designs typical of package plants. All 2030 projected flows for the Non-Metro facilities are greater than 2.5 mgd. The proposed Southeast Non-Metro plant is projected to treat over 10 mgd by 2030.

Under the U.S. Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (PL 107188), drinking water utilities serving more than 3,300 customers were required to conduct vulnerability assessments (VAs) of their water systems. While similar requirements for wastewater utilities have yet to be promulgated, similar approaches have been promoted by the USEPA for the protection of wastewater facilities. During the design and retrofitting of PCRWRD's infrastructure, PCRWRD is encouraged to refer to the guidelines presented in *Guidelines for the Physical Security of Wastewater/Stormwater Utilities* "in an effort to delay or detect malevolent parties whose actions may otherwise defeat the mission of the utility."

9.4 Non-Metro Treatment Technology Options and Recommendations

There are many wastewater treatment technologies available. PCRWRD is interested in providing its customers and the environment with the highest quality treated effluent practical through the use of enhanced nutrient removal processes in addition to removals of the conventional pollutants of oxygen-demanding organics, suspended solids and ammonia. This chapter aims at examining and evaluating five treatment technology alternatives believed to provide a high quality effluent at reasonable cost and provide recommendations for the Non-Metro facilities.

9.4.1 Evaluation Criteria

Various treatment alternatives exist and must be analyzed using both monetary and non-monetary criteria. Monetary criteria include capital, operations and maintenance, and life cycle costs. Monetary and non-monetary criteria are analyzed using weighted rankings. This chapter discusses the evaluation criteria used to assist in treatment technology selection.

Monetary Criteria

Monetary criteria consider construction, operations and maintenance, and life cycle costs for each treatment alternative for comparative purposes only.

It is assumed that all treatment processes will need screening and grit removal and disinfection and that these costs are equally applicable to all alternatives and thus do not influence comparisons of alternatives.

Non-Monetary Criteria

Non-monetary criteria are described below. The values in parenthesis adjacent to the criteria indicate the weighting factor for that criterion (A weighting factor of 1 being low and 5 being high).

- ***Environmental Impact***: The treatment process introduces little or no negative environmental impacts during construction, start-up, regular operations, maintenance, expansion, etc. and has the potential to constantly meet and exceed current and future regulations regarding ground and surface water quality and quantity discharges. (4)

- ***Feasibility***: The treatment process meets the feasibility criteria for converting from the existing facilities to a preferred alternative process and following conversion is readily and reliably operable. (3)

- ***Operational Capability***: The treatment process meets the operational capability requirement by having the ability to modify process configurations during operations to accommodate abnormal conditions such as radical changes in influent wastewater characteristics, major maintenance activities, changes in permit requirements, changes in appropriate technology, requirements for expansion, discharge and reuse requirements and biosolids handling regulations. (4)

- ***Land Required***: The treatment process meets the land required criteria efficiently utilizes the available land. (2)

- ***Maintenance***: The treatment process meets the maintenance criteria of requiring a minimum amount of time and frequency of on-site operator attention, and that the routine preventative maintenance activities are easy to perform. (4)

- ***Public Acceptability***: The treatment process meets the public acceptability criteria in being aesthetically unobtrusive and provides effective odor and noise control. (5)

- ***Reliability***: The treatment process meets the reliability criteria by providing dependable, uninterrupted compliant service during construction, startup, operations and maintenance, and throughout its service life. (4)

- ***Sludge Production***: Current sludge processing for many of the Non-Metro facilities occurs at Ina Road WRF (a more detailed discussion of sludge processing occurs in Chapter 5). This requires transporting the sludge via pipeline or truck to a drop-off point along the conveyance system or to Ina Road WRF itself. Shipment by truck requires sludge holding facilities at the site of biosolids generation and shipment by pipeline requires construction of a pipeline specifically for the sludge produced. The treatment process would ideally produce the least amount of sludge to be processed. (1)

- ***Water Reuse Potential***: The treatment process meets the water reuse potential criteria by constantly providing the quantity and quality of reuse water demanded. (4)

- ***Odor Control***: The treatment process meets the odor control criteria by eliminating or reducing odor emissions through process components or additional external odor control structures could be added in a simple cost effective manner. (5)

9.4.2 Alternative Treatment Method Examination

This chapter reviews the five most likely treatment processes needed by PCRWRD to meet the regulatory effluent requirements for the existing Non-Metro facilities, which are:

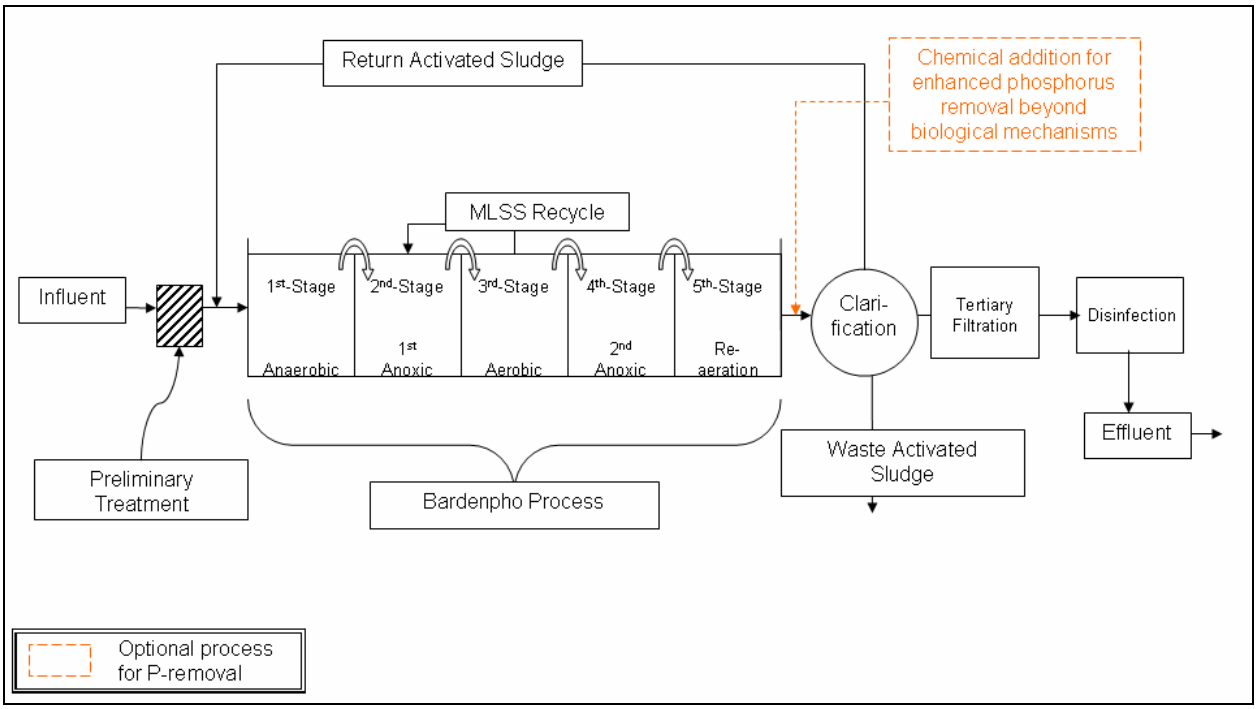
- Bardenpho (five stage)
- Biological nutrient removal oxidation ditch
- Membrane bioreactor
- Moving bed bioreactor
- Sequencing batch reactor

9.4.2.1.1 Bardenpho (Five Stage)

Process

The five stage Bardenpho process is a modification of the activated sludge process consisting of a multi-stage biological reactor. The mixing of influent with activated sludge and passing the mixture through a sequence of alternating environments of variable oxygen concentration allows removal of nitrogen from the wastewater. These alternating environments are termed anoxic and aerobic depending on the amount of oxygen available for metabolism. The five-stage process adds an anaerobic zone ahead of the anoxic/aerobic sequences of the four-stage process to create conditions amenable for the removal of phosphorus. Nitrogen is removed by metabolic processes performed by the active bacteria present in the bioreactor tanks, while phosphorus is removed by accumulating in specific species of bacteria in amounts in excess of metabolic requirements and removed from the system as these bacteria are removed from the system as part of the sludge wasting procedures. The general process flow for a typical five stage Bardenpho is shown on **Figure 9-1**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-1
Five-Stage Bardenpho Process Diagram



Benefits and Drawbacks

The five-stage Bardenpho process is capable of consistent high levels of BOD removal, suspended solids, nitrogen, and phosphorus with little or no use of chemicals. Compared to other biological nutrient removal processes, the five-stage Bardenpho provides excellent nitrogen removal and good phosphorus removal. Nitrogen is removed via anoxic, aerobic, anoxic stages of the process. Though biological nitrogen removal is generally capable of meeting total nitrogen (TN) levels less than 5 mg/L, reaching very low levels could require the addition of a supplemental carbon source such as methanol or some other highly degradable source to drive the denitrification reactions to completion. The removal of phosphorus biologically is a sensitive process. The efficiency of removal of the phosphorus is dependent on the quantity and quality of the readily degradable carbon in the anaerobic zone. To improve reliability, the inclusion of primary clarification with the concomitant fermentation of settled primary sludge to supplement the amount of readily degradable carbon can be very effective. A metal salt addition will most likely be required in order to reduce total phosphorus levels to below one mg/L.

Additional Components

The five-stage Bardenpho process requires five separate tanks followed by final clarifiers. The return activated sludge, mixed liquor suspended solids, and waste activated sludge requires piping and pumps for operation. All stages require mixing equipment and oxygen must be introduced in the third and fifth stages of the Bardenpho sequence.

9.4.2.1.2 Biological Nutrient Removal Oxidation Ditch (BNROD)

Process

An oxidation ditch is a modified activated sludge biological treatment process that utilizes long solids retention times to remove biodegradable organics and ammonia. Multiple reactors can be operated in series or parallel, depending on configuration, also allowing a reactor to be taken out of service for inspection or repairs. Oxidation ditches are designed to carry mixed liquor suspended solid concentrations of 3000-8000 mg/L. HRT is generally between 18-30 hours. Design SRTs can be selected for a high degree of nitrification. PCRWRD currently uses BNROD at its Avra Valley and Green Valley facilities. Additionally, an anoxic tank is currently being installed ahead of the BNROD at Avra Valley WRF to enhance total nitrogen removal.

Benefits and Drawbacks

The oxidation ditch is considered an economical, highly efficient, and simple waste treatment process. Oxidation ditches are able to withstand shock and peak loads, and can be operated continuously or intermittently. The BNROD system is noted as being "operator-friendly" according to PCRWRD staff and is currently in use at the Avra Valley and Green Valley WRFs for reduction of total nitrogen concentrations in effluent. It has been reported by PCRWRD staff that Avra Valley WRF's BNROD is treating approximately 1.3 mgd to a TN below 3 mg/L. This is being achieved by alternating aerators on and off, creating alternating aerobic and anoxic environments. Large areas of level land are needed for facility construction and to meet setback requirements set in the AAC Title 18 Chapter 9. This process can not meet phosphorus limits without addition of chemicals or construction of additional anaerobic tankage volume in front of the oxidation ditch.

Additional Components

liminary treatment usually precedes the oxidation ditch but primary settling prior to the oxidation ditch is rare. Influent is aerated and mixed with return activated sludge from the final clarifiers. An anaerobic tank may be added prior to the oxidation ditch to enhance biological phosphorus removal. An anoxic tank may be added upstream of the oxidation ditch for enhanced nitrogen removal (known as the Modified Ludzack-Ettinger or MLE process) along with mixed liquor recirculation from the aerobic zone to the anoxic tank. Tertiary filters may be required after clarification to polish the effluent prior to disinfection. Tertiary filtration is effective for reducing the effluent suspended solids significantly allowing the effluent turbidity goal to be achieved consistently. The general process flow sheet for a typical BNROD process is shown on **Figure 9-2** and the MLE on **Figure 9-3**. These figures also show where additional components would be added for enhanced nitrogen and phosphorus removal and where disinfection would be located.

Figure 9-2
Biological Nutrient Removal Oxidation Ditch

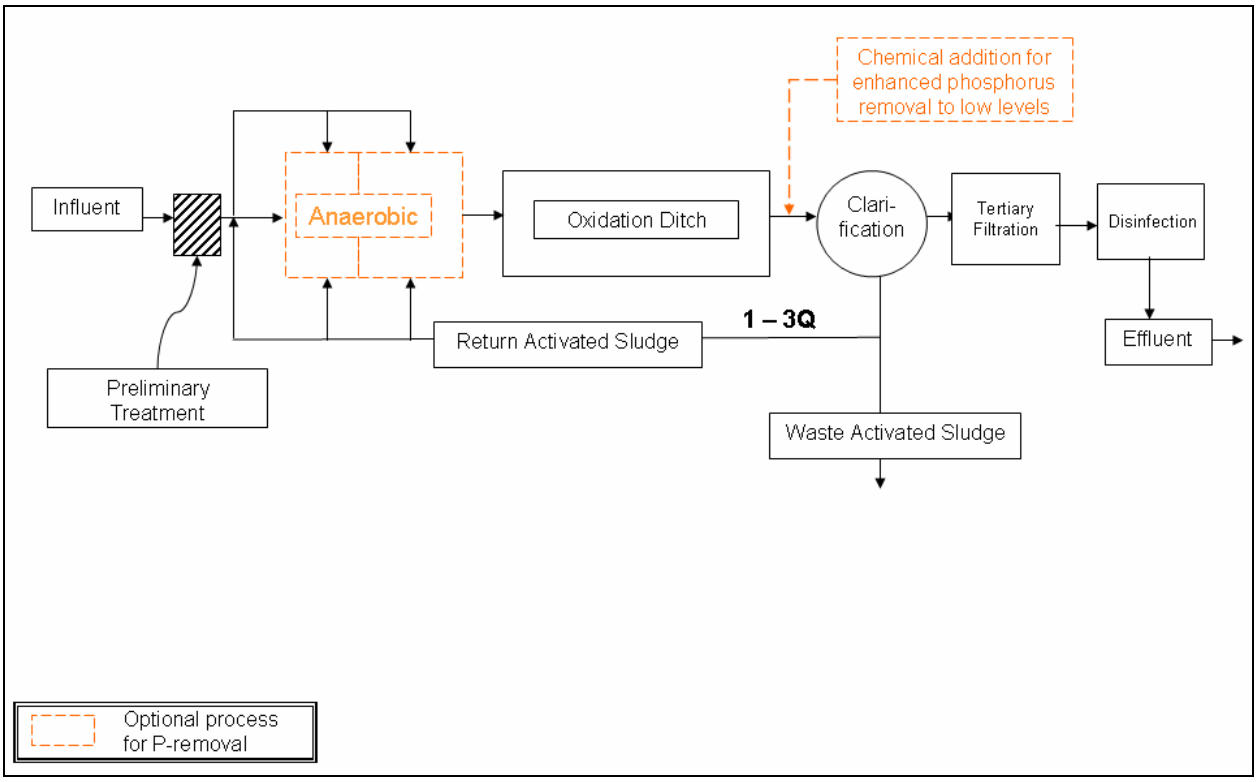
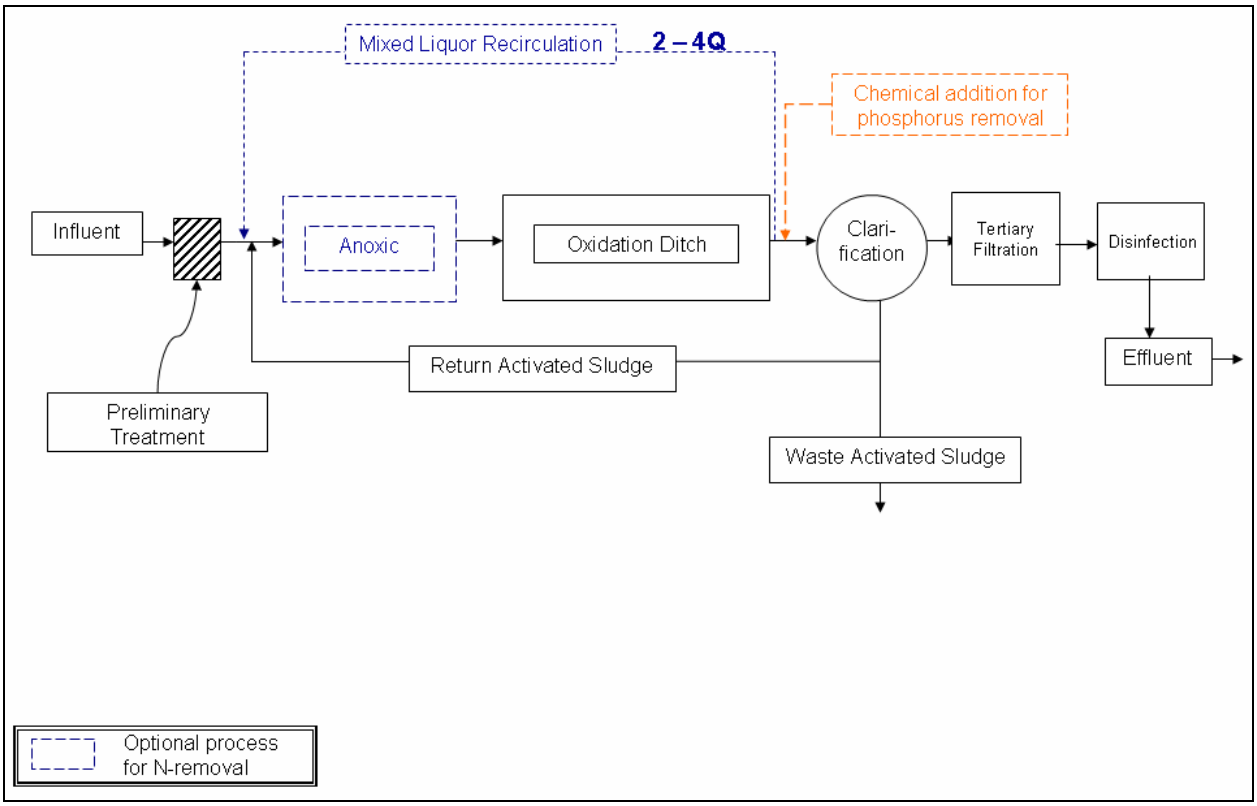


Figure 9-3
Modified Ludzack-Ettinger



9.4.2.1.3 Membrane Bioreactor (MBR)

Process
The MBR is an activated sludge process in which microfiltration through a synthetic membrane is used in place of secondary clarification. The membrane separation occurs in a separate, final stage activated sludge tank. Essentially all suspended solids and bacteria are retained in the aeration tank due to the small pore size of the separation membrane. The membrane provides both solids removal and filtration. Sludge is directly wasted from the aeration tank to maintain the desired Solids Retention Time. With membrane separation a much higher MLSS concentration (7-15,000 mg/L) can be used in the activated sludge process, reducing tank volume requirements. The MLSS concentration that can be achieved is limited by the oxygen transfer capacity of the aeration system and the fouling properties of the membranes.

Benefit and Drawbacks
A major advantage of this process is a smaller footprint and increased capacity for existing aeration tanks. Disadvantages are high energy demand, high capital and operation and maintenance costs and an unknown life expectancy of the membranes. There is the possibility for the need of a high dose of methanol as a

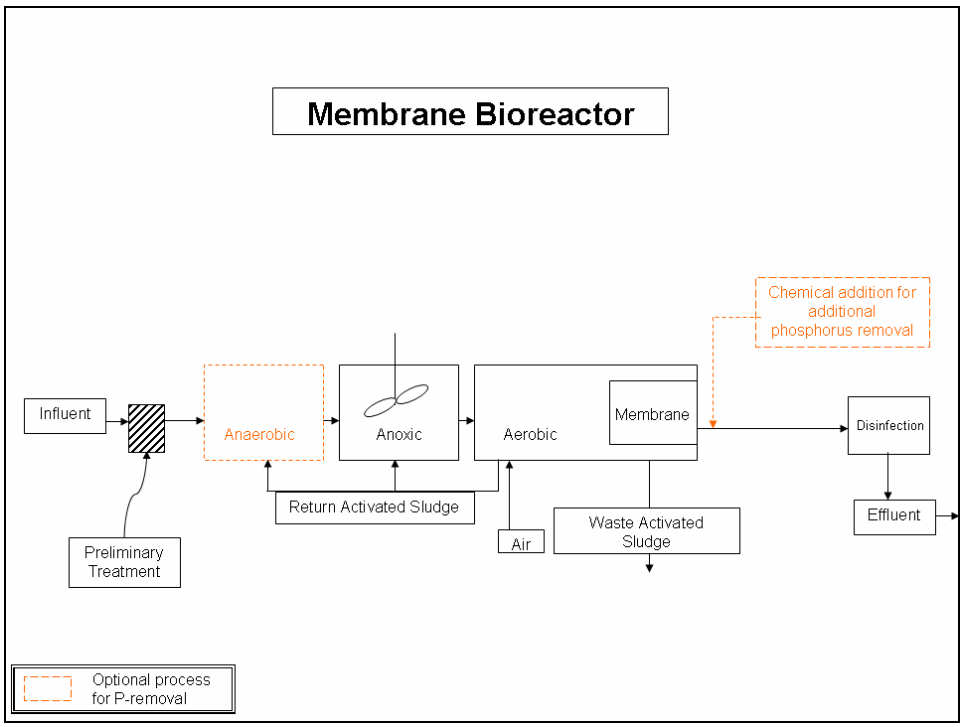
carbon source. In addition there would be no commonality of the processes at the other Non-Metro treatment plants which could require more operational training and a higher inventory of spare parts.

This process combines an ultrafiltration membrane system for solids separation with an activated sludge reactor eliminating the need for separate clarification. Wastewater is screened before entering the biological treatment tank where aeration within this aerobic zone provides the oxygen required for biological respiration and maintains solids in suspension. MLSS in the bioreactor are maintained at high levels (1% - 3%) allowing high levels of organic loading to the reactor. All solids are retained within the reactor, thus requiring no return activated sludge system. The process runs at a high solids retention time and nitrifiers are easily maintained within the system. The process is capable of achieving low levels of effluent BOD, suspended solids, nitrogen, and phosphorus.

Additional Components

Aggressive preliminary treatment usually precedes MBR. Influent is mixed with return activated sludge from the aerobic tank in an anoxic zone. An anaerobic tank may be added prior to the oxidation ditch to enhance biological phosphorus removal. Tertiary filters are not required prior to disinfection due to the membranes ability to produce very low turbidity effluent. The general process flow sheet for a typical MBR process is shown on **Figure 9-4**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-4
Membrane Bioreactor



9.4.2.1.4 Moving Bed Bioreactor (MBBR)

Process

The MBBR system is a modification of the activated sludge process. It utilizes an attached growth or fixed film biological process instead of the suspended growth process in the conventional activated sludge systems. The MBBR includes small, plastic (usually polyethylene) carrier elements placed in a continuously mixed basin to provide surface area for the growth of attached biomass. The MBBR system does not incorporate return sludge flow nor backwashing of the screens used to retain the plastic media within the continuously mixed basin. As with other processes, the MBBR can be configured with alternating environments to gain efficiencies in nutrient removals. Either coarse bubble aeration or a mechanical mixer can be used for continuous mixing depending on whether the zone is anoxic, anaerobic, or aerobic. The media can be provided by a number of manufacturers and a 2000 Water Environment Research Foundation (WERF) report concluded that the media's effective surface area is a key design parameter and the shape and size of the media is of less importance.

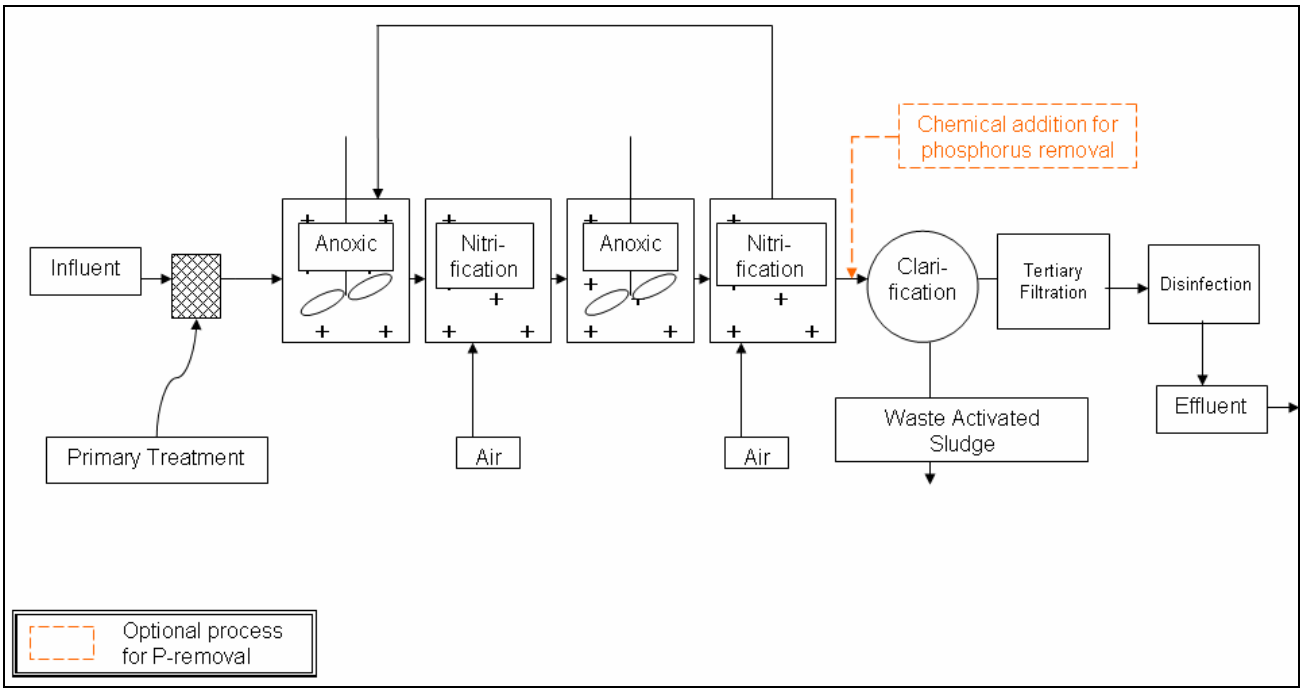
Benefits and Drawbacks

MBBR systems are less operationally complex than an activated sludge system because the MBBR system does not include return activated sludge.

Additional Components

The MBBR system requires screens, grit chambers, primary clarifiers, a reactor basin, plastic media, continuous mixing devices, a screen or sieve installed at the effluent end of the reactor basin to retain the media within the basin, and final clarifiers. The MBBR system can be retrofitted from an existing activated sludge reactor through the addition of baffle walls creating separated anoxic and aerobic zones. The amount of media required is dependent upon the organic and hydraulic loading, the temperature, oxygen transfer capability of the system, and the degree of treatment required. External chemical addition is necessary to provide a carbon source for denitrification. Retrofits of the oxidation ditches at the Avra Valley, Green Valley, and Corona de Tucson facilities to an MBBR are plausible options for PCRWRD to consider. The general process flow sheet for a typical MBR process is shown on **Figure 9-5**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-5
Moving Bed Bioreactor



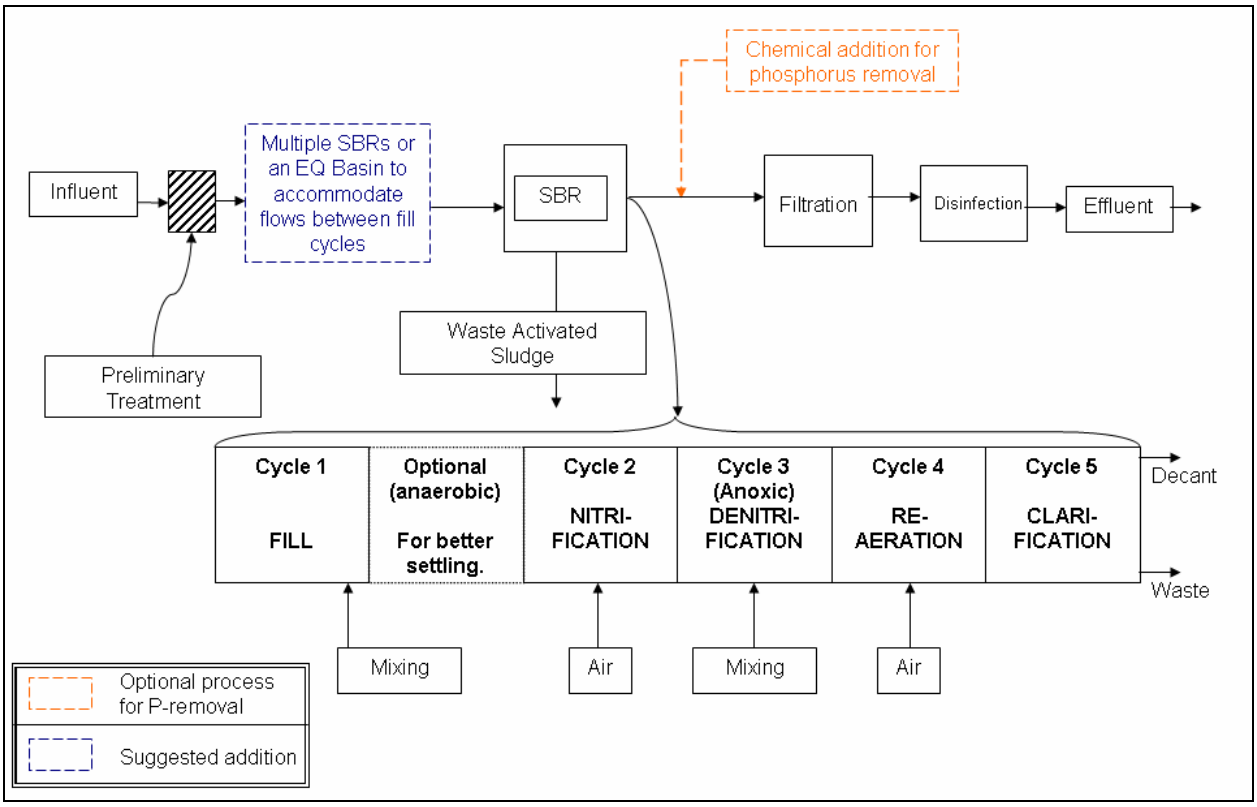
9.4.2.1.5 Sequencing Batch Reactor (SBR)

Process
Improvements in aeration devices and control systems have made sequencing batch reactors a competitive process to conventional continuous flow activated sludge systems. SBRs and conventional continuous flow activated sludge systems have essentially the same biological and physical processes, aeration and sedimentation/clarification are performed in both systems. SBRs allow these processes to be performed within in one tank, reducing the land area needed when compared to the conventional activated sludge processes. Hydraulic retention times between 21-24 hours are typical for SBRs.

Benefits and Drawbacks
SBRs need less land for reactors, but often require equalization (EQ) basins for volume balance; can be easily automated; can be operated for BNR with simple modifications to the sequencing logics; have limited capability to handle high hydraulic peaks;

Additional Components
An oxidation ditch could be retrofitted to an SBR by installing gates and a decanter mechanism and some aeration equipment in lieu of rotors. Also, mixers would be needed in order to develop anoxic/react conditions and anaerobic conditions. The general process flow sheet for a typical SBR process is shown on **Figure 9-6**. This figure also shows where additional components would be added for enhanced phosphorus removal and where disinfection would be located.

Figure 9-6
Sequencing Batch Reactor



9.4.3 Evaluations

Weighted ranks are used for evaluating treatment process alternatives with respect to the chosen criteria. A weighted rank is the product of the criteria's weighting factor (WF) and value. A weighting factor (1-5, with 5 being the highest) is given to each criterion; the higher the weighting factor, the more important the criteria. A rank (1-5, with 5 being the highest) is given to each treatment process; the higher the rank the better that treatment process satisfies the evaluation criteria. Each criterion is then given a score for a particular alternative; the weighted rank. The higher the weighted rank, the better the treatment process meets the evaluation criteria. The weighted values for each treatment process alternative are then summed and compared with the other alternatives. The highest sum of weighted ranks equates to a better treatment process alternative for the selected criteria.

Table 9-8 shows the weighted ranks for each criteria and treatment process alternative.

Table 9-8
Monetary and Non-Monetary Criteria Treatment Process Alternative Weighted Ranks

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBR	MBBR	SBR	Bardenpho	BNROD	MBR	MBBR	SBR
Cost	5	4	4	2	3	5	20	20	10	15	25
Environmental Impact	4	4	4	3	3	3	16	16	12	12	12
Feasibility	3	3	5	3	4	3	9	15	9	12	9
Operation Compatibility	4	4	4	4	3	2	16	16	16	12	8
Land Required	2	4	3	5	4	4	8	6	10	8	8
Maintenance	4	5	5	2	3	3	20	20	8	12	12
Public Acceptability	5	3	3	5	3	5	15	15	25	15	25
Reliability	4	3	4	2	3	3	12	16	8	12	12
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	4	16	16	16	16	16
Odor Control	5	4	3	4	4	3	20	15	20	20	15
Sum of Weighted Ranks							**155**	**160**	**137**	**137**	**145**

9.5 Non-Metro Facility Layout Recommendation

Application of the weighted rank method reveals BNROD and Bardenpho as the top two treatment alternatives. This chapter discusses the recommended expansion plan for each Non-Metro facility through the year 2030.

This chapter examines the general process, benefits and drawbacks, additional components necessary to meet treatment requirements, and a graphical representation of the process flow sheets of the five Non-Metro area treatment alternatives. These flow sheets reflect processes only. They are not intended to illustrate how the processes would be physically configured within the layouts of existing facilities or how a new facility would appear physically.

9.5.1 Northwest Region

Future flow projections for Marana WRF (includes Rillito Vista WRF flows) project wastewater flows of 4.4 mgd, well within BNROD's proven treatment range. PCRWRD currently has a completed 1.5 mgd BNROD system design and selecting a different process requires additional time and money investment. Therefore, Marana WRF's treatment process selection is BNROD.

Figure 9-7 presents the projected influent flow.

Figure 9-7
Marana WRF

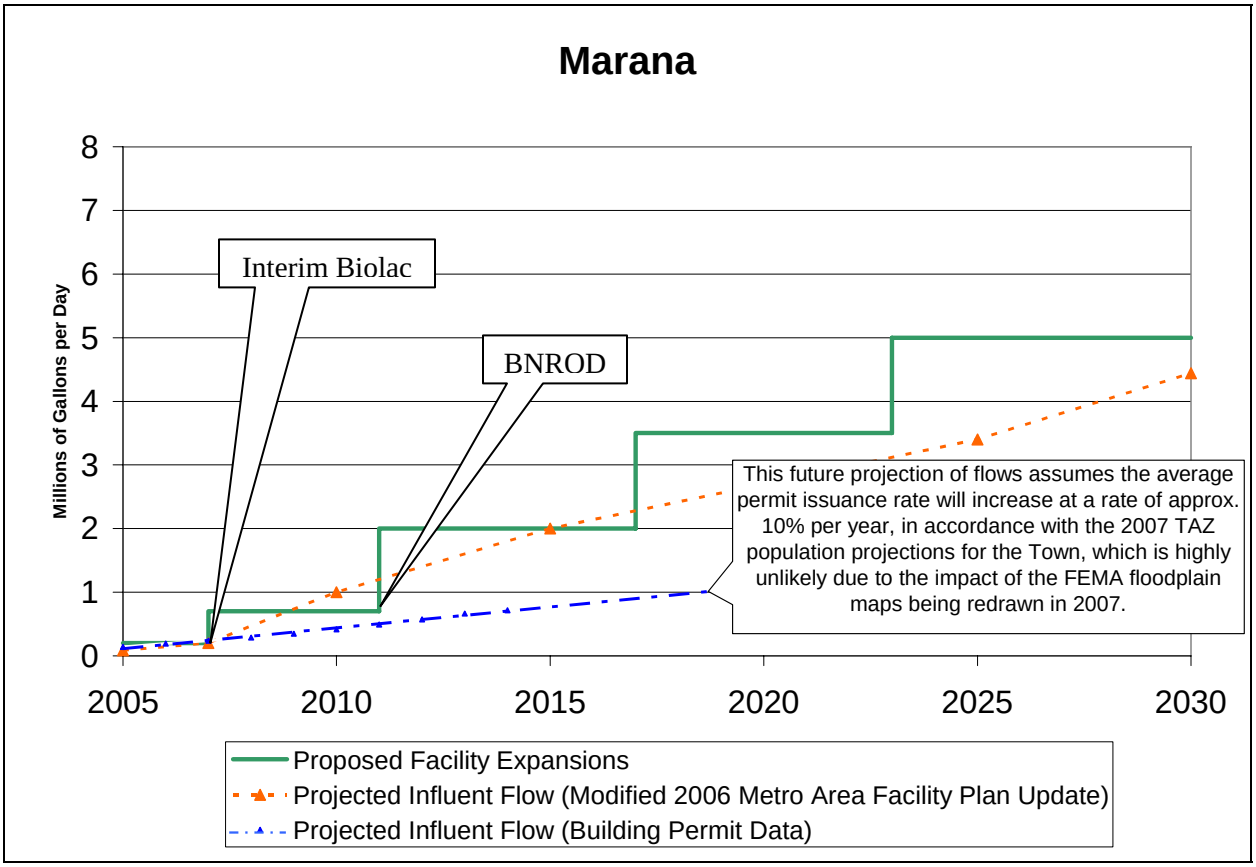
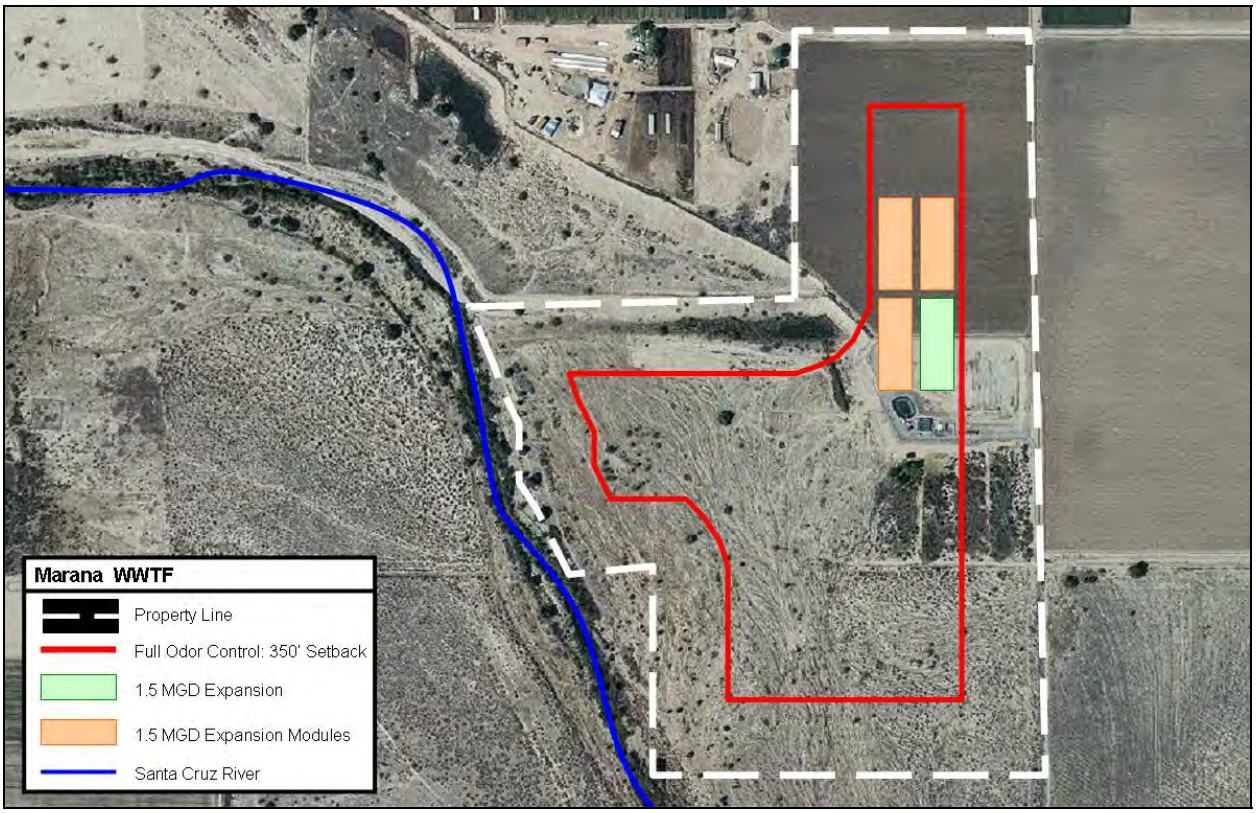


Figure 9-8 shows the possible location for siting 1.5 mgd BNROD modules within PCRWRD property and setback boundaries.

Figure 9-8
Marana WRF – 1.5-mgd Expansions without CRRPS Flow



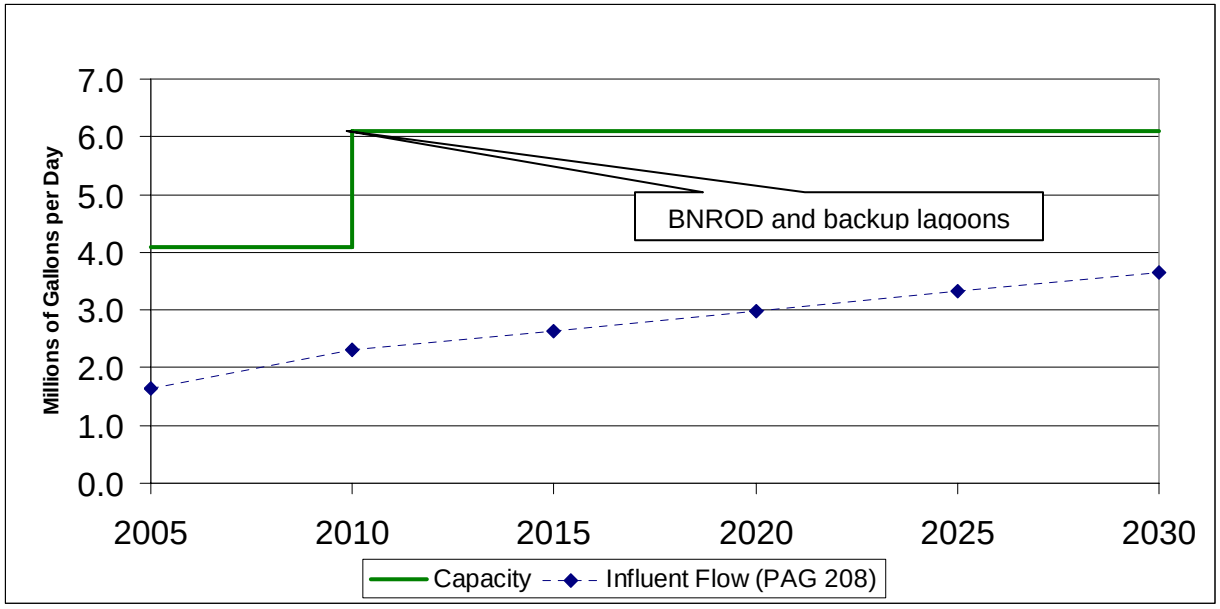
Marana WRF flow projections do not include flows originating within the Continental Ranch Regional Pump Station (CRRPS) service area. The CRRPS resides within the boundaries of the town of Marana and is located up-gradient of the Marana WRF and would best be served by the Marana WRF if economically feasible. On June 23, 2005 a Continental Ranch Regional Pump Station Strategic Plan Memorandum was issued. The memorandum determined that construction of an additional 24" force main is not required to handle flows through the 20-year planning period. The CRRPS Strategic Plan stated the long range plan (2005-2015) is to convey flow from the pump station to the Marana WRF via gravity within the 2012-2015 timeframe. This would give the County adequate time to complete the project before flows approach the pumping station's capacity and to relieve the emergency back-up pumping system. The CRRPS Strategic Plan projects a peak wet weather flow of 6.7 mgd by 2025. Ultimately, if the CRRPS flow is conveyed to the Marana WRF, the facility will need to be expanded to accept CRRPS flow.

An economic evaluation should be conducted before the pipeline capacity is modified determining the feasibility of phasing out the pump station and conveying the flow to the Marana WRF or constructing a parallel pump station/pipeline to continue to pump flow up-gradient to Ina Road WRF. Additionally, an economic evaluation determining the feasibility for Marana WRF's processing of the CRRPS's flow as opposed to pumping this flow to Ina Road WRF should be performed before expansion at Marana WRF occurs. It should be noted that allowing wastewater to flow by gravity from Continental Ranch to the Marana WRF will require expansion of the facility's capacity to accommodate the additional hydraulic loading.

9.5.2 South Region

Future flow projections for Green Valley WRF predict wastewater influent flows slightly above 3.5 mgd and are well within BNROD's proven treatment capability. Current combined BNROD/aerated lagoon capacity can provide sufficient treatment for flows through the year 2030. PCRWRD's environmental stewardship and foresight of residential encroachment includes in its CIP elements the construction of an additional 2.0-mgd BNROD facility in 2010 increasing its total capacity to 4.0 mgd. Introducing a different process to the Green Valley facility introduces complexity and therefore BNROD is the recommended treatment process for this Non-Metro facility. Green Valley WRF's projected flow and expansion are shown on **Figure 9-9**.

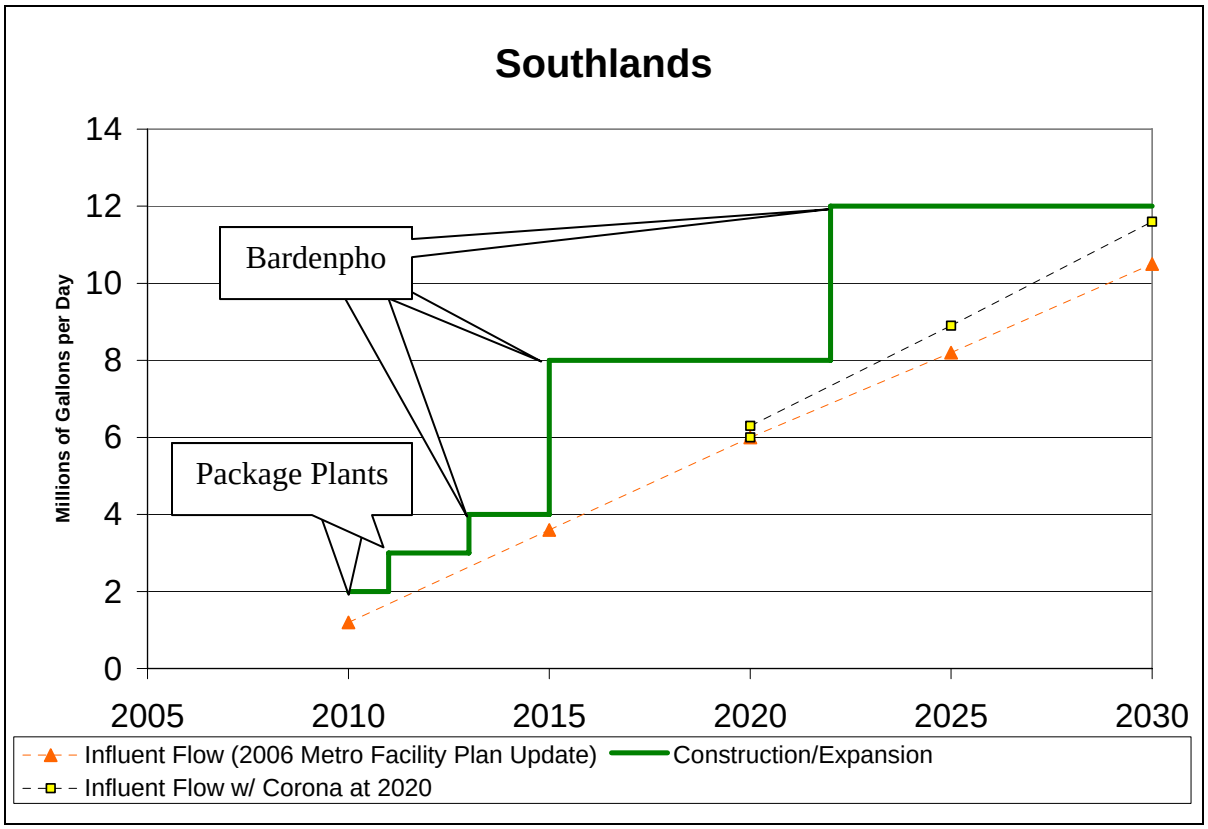
Figure 9-9
Green Valley WRF



9.5.3 Southeast Region

Future flow projections for the Southlands facility (excluding Corona de Tucson WRF flows) forecast flows greater than 10 mgd by 2030. Inclusion of Corona de Tucson WRF's flow, Southlands projected flows are above 13 mgd by 2030. At these capacities, the Bardenpho treatment process is recommended over a BNROD process. The Southlands flow projection (including Corona de Tucson WRF by 2020) and proposed construction/expansion are shown on **Figure 9-10**.

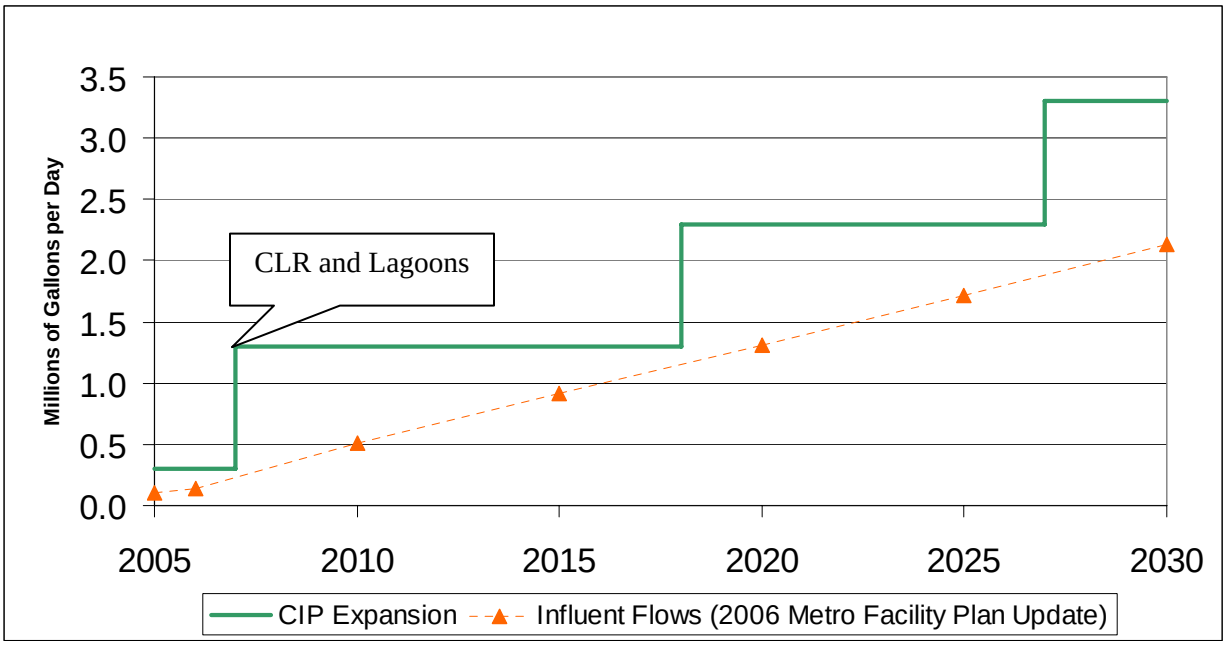
Figure 9-10
Southlands



While flow projections suddenly show influent flows of 1.2 mgd in 2010, no Southlands facility or expansion plan exists. Facility siting, design, and construction of this facility must start now to provide treatment service for the rapid population growth projected for this area. In an effort to provide treatment as rapidly as possible, package treatment plants provided by developers should be permitted and located to treat the flow until design, construction, and startup of a 4.0 mgd Bardenpho can be completed. Concurrent to package plant selection, siting, permitting, and startup, design of the Bardenpho module should begin. Construction of additional 4.0 mgd Bardenpho expansion modules will need to be completed by 2015 and 2022 providing the Southlands area with a total capacity of 12.0 mgd by the year 2030.

Investment in Corona de Tucson WRF's 1.0 mgd closed loop reactor and 0.3 mgd aerated lagoon system will provide sufficient capacity through the year 2020. The facility should continue with its 1.3 mgd total permitted capacity until a Southlands facility and conveyance structure transporting flows beyond Corona's 1.0 mgd closed loop reactor capacity can be sited, designed, and constructed. Flow beyond Corona de Tucson WRF's capacity can then be conveyed to Southlands for treatment and Corona de Tucson WRF could continue as a wastewater treatment facility or be upgraded to provide reclaimed water service. Converting Corona de Tucson's wastewater treatment facility to a facility that provides reclaimed water would require a feasibility study be completed. The Corona de Tucson WRF projected flow and expansion without diverting flow to Southlands WRF is shown on **Figure 9-11**.

Figure 9-11
Corona de Tucson WRF



Expansion at the Corona de Tucson facility should only occur if the Southlands Non-Metro facility and conveyance structure are not constructed to accept flow beyond Corona de Tucson WRF's 1.3 mgd capacity. Flows beyond Corona de Tucson's 1.3 mgd capacity should be conveyed to the Southlands facility for treatment.

9.5.4 Southwest Region

PCRWRD's Avra Valley WRF Expansion Plan recommends having a dual oxidation ditch online and permitted to treat 4.0 mgd by January 2008. **Figure 9-12** and **Figure 9-13** show the projected flow and expansion for Avra Valley WRF, respectively.

Figure 9-12
Avra Valley WRF

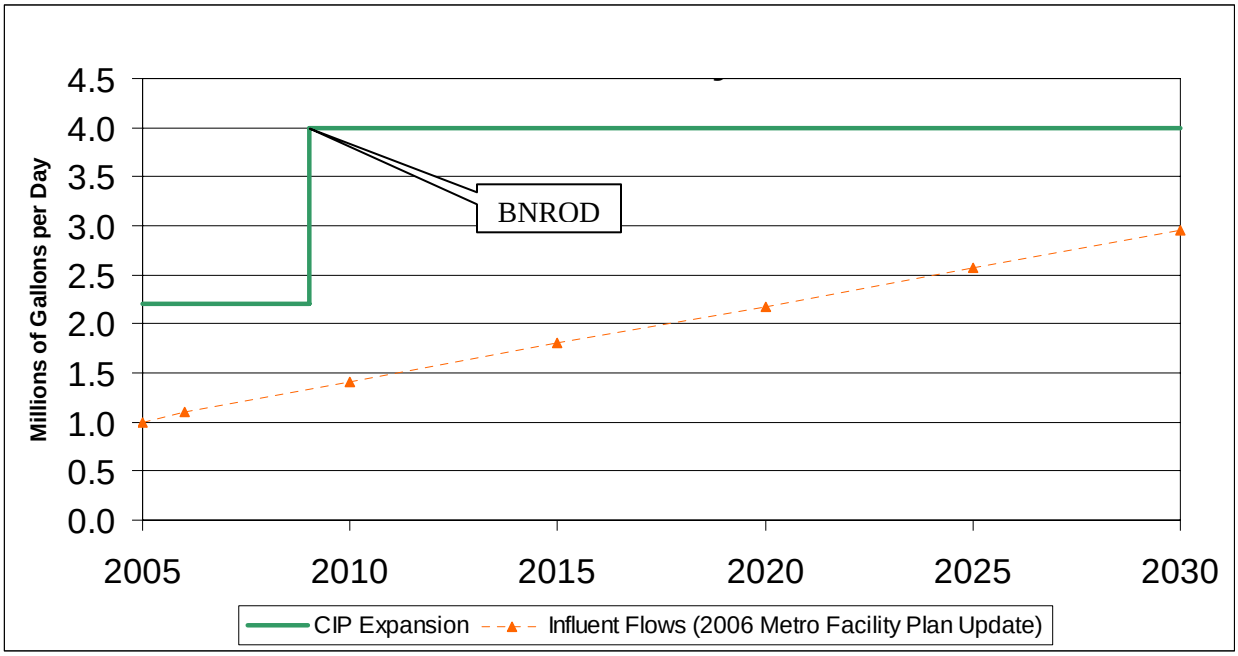


Figure 9-13
Avra Valley WRF

9.5.5 Mount Lemmon Region

The Mount Lemmon WRF is currently in the process of negotiating service area expansion with the USFS. Future flow projection should refer to the agreement contracted between PCRWRD and the USFS. Future recommendation for this facility includes the development of a contingency plan for emergencies due to weather, facility malfunction, or routine maintenance.

9.6 Summary

Establishing regional treatment facilities does carry some pragmatic challenges. Obviously, large tracts of undeveloped land exist throughout the Non-Metro area and are significant distances from the any PCRWRD facility. Development in some separated areas would require long conveyance structures to transport sewage from the new developments to regional treatment plants. These lines would have significant excess capacity for years to come until build-out is achieved. Additionally, demand for water in these Non-Metro areas is likely to require the availability of treated effluent to supplement other water sources. (A satellite facility could ultimately be converted to a water reclamation plant to help relieve local water demands.) Such conditions generally pose significant economic disincentives for establishing centralized wastewater treatment on a regional level, and solutions, such as satellite plants constructed within the newly developed area typically result.

However, satellite facilities may not be an appropriate solution for the long term. Owning multiple facilities would require Pima County to budget annually for operations and maintenance for several different facilities. Critical to successful operation of several satellite facilities is finding and retaining skilled operators and maintenance personnel. Secondly, multiple facilities require multiple operating permits, none of which will remain static in respect to their regulatory compliance standards. Thirdly, as populations increase in these areas, there will be needs for upgrading and expanding these satellite facilities. Finally, as development progresses, on-going public acceptance of the treatment facilities in their neighboring areas cannot be guaranteed.

Aligning regional treatment facilities provides Pima County with an opportunity to establish a model for how it will support development for years to come. This model incorporates the interests of stakeholders ranging from developers to environmental groups to local residents. It promotes Pima County as a proactive leader in managing rapid growth pressures to improve quality of life for generations.

Balancing the economics necessary to shape the Non-Metro facilities into regional facilities will require some type of mechanism for generating a consistent revenue stream to fund the conveyance and treatment infrastructure. Since many facilities are already under design and/or expansion, these revenues would initially focus on the installation of regional interceptor sewers that tie the developing areas to the Non-Metro facilities. Options include development reimbursement agreements, impact fees on new residential and commercial construction, revenue bond sales, general obligation bonds, economic development income tax revenues, or tax incremental financing districts.

CHAPTER 10

CIP Elements

Chapter 10 - . CIP Elements

10.1 Introduction

The ROMP includes a coordinated Capital Improvement Design and Construction program including, at a minimum, cost estimates, schedules and a recommended project delivery and funding strategy for implementation of resulting projects and integration with the PCMWD Capital Improvement Program (CIP). ROMP capital projects are primarily regulatory driven and include specific costs associated with meeting more stringent requirements for effluent discharges into the Santa Cruz River from the WRC and the Ina Road WRF. Other capital projects include various wastewater treatment and conveyance projects necessary to repair and replace existing infrastructure, as well as wastewater treatment and conveyance projects to provide the capacity to serve forecasted demand in the PCRWRD's Non-Metro service area This chapter discuses the major construction elements and cost of the PCRWRD CIP including:

ROMP Projects

- Santa Cruz Interceptor Phase IV
- Water Reclamation Facility (32-mgd total)
- Ina Road WRF (50-mgd total)

Other Capital Projects (Non-ROMP)

- Electrical System Modifications
- Conveyance System Augmentation
- Outlying Facilities Expansions
- Support Facilities

Construction and labor costs are on the basis of the year 2006 and must be escalated to the cost when the services or construction is provided.

The following assumptions provided in the ROMP Study were incorporated to accomplish the evaluation of the engineering alternatives.

- Both plants achieve regulated nutrient removal utilizing the Bardenpho treatment process.
- The Water Reclamation Campus consists of four independent 8 MGD Bardenpho trains.
- Design Bid Build is used as a basis for scheduling. Scheduling may change if another method is selected.
- Construction costs do not change regardless of project delivery method.
- Base costs were based upon tankage volumes, blower requirements and pumping sizes that were determined and rolled up to a process level in the ROMP Study.
- Design and construction procurement requires 6 months and includes the following components.
  - Develop Request for Proposal
  - Advertising
  - Selection
  - Award
- The Water Reclamation Campus construction contract must be awarded by December 2010.

- The Ina Road facility construction contract must be awarded by January 2011.
- Startup and testing for both facilities requires 6 months and must begin no later than 6 months prior to the respective facility's compliance date.
- The Water Reclamation Campus is to be online and compliant no later than January 30, 2015.
- The Ina Road facility is to be online and compliant no later than January 30, 2014.

10.2 Base Case

At an estimated cost of $501 million (2006 dollars), an initial alternative, termed the Base Case, included concurrent construction of a 32-mgd Water Reclamation Campus near the existing Roger Road facility and 50-mgd expansion/upgrade of the current Ina Road WRF. Disinfection for the Base Case alternative was achieved via filtration and ultraviolet technology. The estimated $501.6 million included the following elements.

- Santa Cruz Extension Phase IV – $22.4M
- Water Reclamation Campus – $235.2M
- Ina Road WRF – $244.0M

A general description of the facility, elements that make up the facility and the costs of the elements for the Base Case are summarized below.

10.2.1 Santa Cruz Extension Phase IV (ROMP)

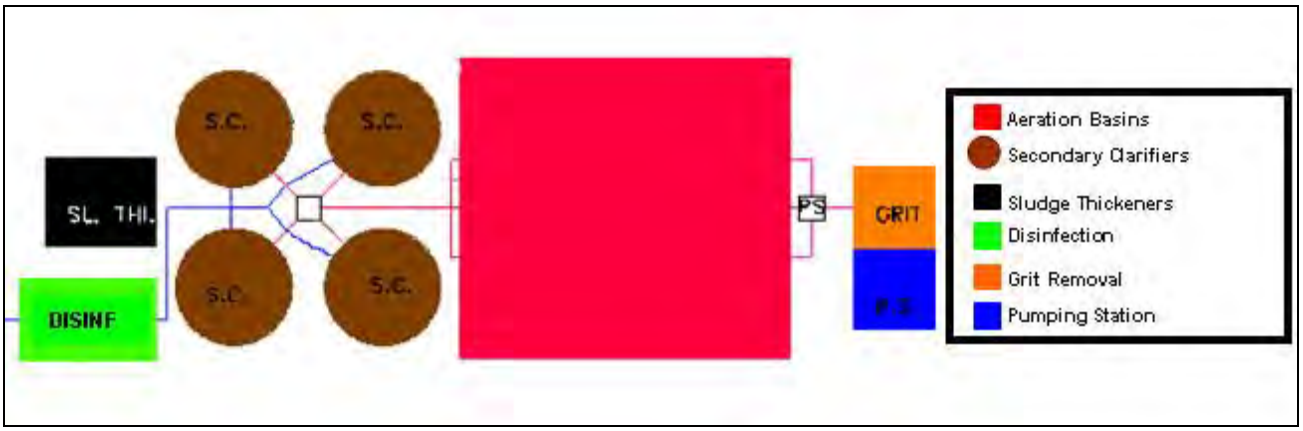
The recommended route for the plant interconnect pipeline is approximately 5 miles in length and varies in size from 54 inches to 66 inches in diameter. Costs developed for the Santa Cruz Extension do not include right-of-way acquisition or easement costs, or any cost to relocate existing utilities during construction segments of the sludge force main, which may be in the pipeline alignment.

Project Element	Costs (in 2006 $)
Santa Cruz Extension Phase IV (1 or 2 projects)	$ 19.0 million
Engineering Services (design and office/field services during construction)	$ 3.4 million
Total	$ 22.4 million

10.2.2 Water Reclamation Campus (ROMP)

Recommendations for the WRC are to construct a new 32-mgd wastewater treatment facility using Bardenpho technology to meet the stringent standards imposed by the Arizona Department of Environmental Quality. The existing facilities would be demolished after commissioning the new operation. A conceptual layout of the proposed WRC is shown in **Figure 10-1**.

Figure 10-1
Water Reclamation Campus Conceptual Layout



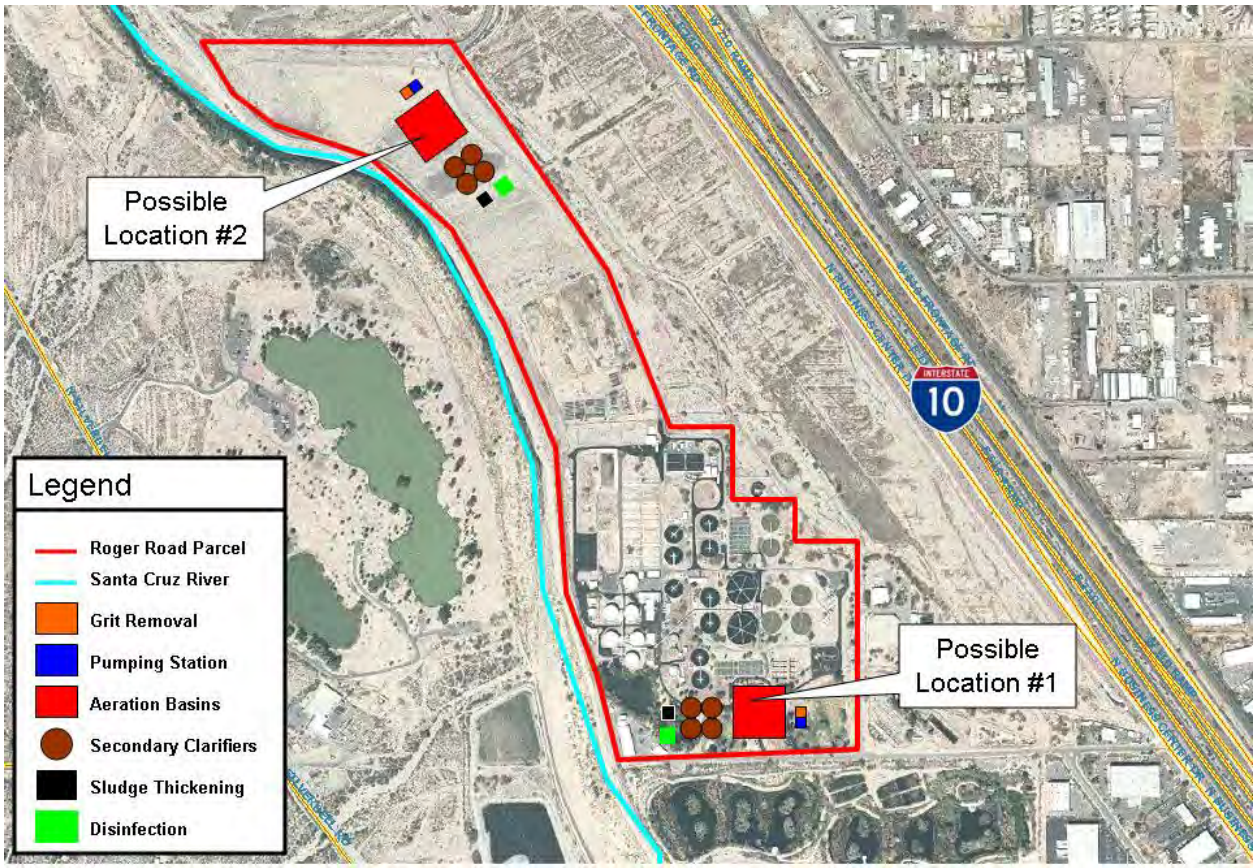
10.2.3 Treatment Processes/Systems

The new WRC is comprised of the major construction elements and estimated costs below. Costs are based on 2006 labor and construction dollars.

Project Element/System	Costs (in 2006 $)
Demolition and Removal	$ 17.3 million
Influent Screening Facilities	$ 3.1 million
Influent Grit Facilities	$ 2.1 million
Odor Control	$ 11.6 million
Aeration Tanks	$ 73.4 million
Final Clarifiers	$ 20.3 million
Disinfection (UV + Filtration)	$ 23.1 million
Sludge Thickening and Dewatering Facilities	$ 2.3 million
Sludge Transfer Pump Station	$ 2.1 million
Site Work	$ 0.7 million
Paving	$ 0.8 million
Architectural	$ 14.0 million
Fence	$ 0.2 million
Irrigation/Landscaping	$ 0.5 million
Engineering	$ 25.7 million
Contingency	$ 38.1 million
Total	$ 235.2 million

Two possible locations for siting the new WRC in a location allowing the existing Roger Road facility continued operation until the new facility is in operation are shown in **Figure 10-2**.

Figure 10-2
Two Future Possible Locations for the New Water Reclamation Campus



A third possible location parallels the Santa Cruz River at the northeastern most edge of PCRWRD's parcel.

10.2.4 Ina Road WRF (ROMP)

Ina Road WRF will have onsite facilities upgraded and expanded to meet the regulatory and growth needs of Pima County over the next 25-years. The wastewater treatment process will be based on Bardenpho technology to meet the stringent standards imposed by the Arizona Department of Environmental Quality. The plant will be expanded to 50-mgd by adding a new Bardenpho treatment train. This expansion will occur by replacing the current 25-mgd HPO process with two new 12.5-mgd Bardenpho trains utilizing the existing clarifiers to their greatest ability, and converting the 12.5-mgd BNRAS train to the Bardenpho process.

The plant will handle and treat the solids from both the WRC and the Ina Road WRF. In the near-term, Pima County wastewater treatment operations will process a Class B biosolids. These solids will be distributed from the Ina Road plant. In the future, the plant may produce a Class A biosolids which also would be distributed from Ina Road. Cost and space requirements for Class A biosolids is based on the thermophilic anaerobic digestion technology. The new wastewater treatment plant facilities at Ina Road WRF are shown on **Figure 10-3.**

Figure 10-3
Ina Road WRF Conceptual Layout

Legend:

1. Existing Warehouse
2. Existing Administration Building
3. Existing Primary Clarifiers
4. Existing Blower Building
5. New Primary Clarifiers
6. New Aeration Tanks
7. Existing Aeration Tanks
8. New Sludge Thickeners
9. Existing Secondary Clarifiers
10. New Secondary Clarifier
11. Existing Headworks
12. Existing Chlorine Contact Basin
13. Existing Energy Recovery Building
14. Existing Training Center
15. Existing Chlorination Buildings
16. Existing Digesters
17. New Digesters
18. Existing Sludge Thickeners
19. Existing Vacuum Filtration Building
20. Existing Activated Sludge Reactor
21. Existing Oxygen Production
22. Existing Centrifuge Building
23. Extension to Centrifuge Building
24. New GBT Thickening Building
25. Existing Sludge Storage Basin
26. New Disinfection Facilities
27. Pima County Industrial Waste
28. Tucson Water Facilities (not shown)

10.2.5 Treatment Processes/Systems

The expanded and upgraded Ina Road WRF is comprised of the major construction elements and estimated costs below. Costs are based on 2006 labor and construction dollars.

Project Element/System	Costs (in 2006 $)
New Influent Screening Facilities	$ 0.9 million
Odor Control	$ 13.3 million
Primary Clarifiers	$ 10.5 million
Aeration Tanks	$ 62.1 million
Final Clarifiers	$ 9.2 million
Disinfection	$ 43.1 million
Sludge Thickening and Dewatering Facilities	$ 10.2 million
Sludge Digestion Facilities	$ 15.0 million
Site Work	$ 0.5 million
Paving	$ 0.6 million
Architectural	$ 12.1 million
Irrigation/Landscaping	$ 0.2 million
Engineering	$ 26.6 million
Contingency	$ 39.7 million
Total	$ 244.0 million

10.3 Electrical Service Modifications (Non-ROMP)

The electrical service to the Ina Road facilities consists of multiple feeds from the local power utility and from onsite power generation which utilize biogas and/or natural gas. The existing 37.5 mgd is powered from Tucson Electric Power. The waste heat is utilized for digester and heat cooling requirements. Cost to unify the utility power services and upgrade the onsite power generation systems are to be included in the upgrade and expansion of the facilities at the Ina Road WRF.

In addition, costs to provide back-up power service to the new WRC are required by regulations and will need to be included with the construction of the new facilities.

Costs for the electrical utility power systems modifications at the WRC and Ina Road WRF are:

Ina Road WRF Project Elements	Costs (in 2006 $)
Ina Road Power Unification	$ 3.0 million
Ina Road Power Upgrade & Expansion	$ 5.0 million
Ina Road Power Generation Upgrades	$ 16.0 million
Engineering for Ina Road Electrical	$ 4.0 million
WRC Project Elements	
Back-up Power	$ 6.0 million
Engineering for Electrical	$ 1.0 million
Total	$ 35.0 million

10.4 Conveyance System Augmentation (Non-ROMP)

The conveyance system serving the Roger Road WRF and Ina Road WRF were evaluated for capacity augmentation over the next 25-years. This does not include costs for conveyance system rehabilitation based on recent condition assessments or the costs for odor control enhancements required in the conveyance system.

Based in forecast population growth and per capita contribution, there are a number of sewer segments within the existing conveyance network that will require augmentation. The augmentation is not required immediately, but will be required over time. The forecast for sewer augmentations and the year by which the work should begin are provided below. Costs are based on 2006 labor and construction dollars, and include an engineering allowance of 15 percent and a contingency of 30 percent.

Project No.	Project Year	Description (Manhole to Manhole)	Total Costs (in 2006 $)
1	2020	4636-30A to 4190-05A	$4.35 million
2	2015	6036-21 to 3979-101	$0.74 million
		3919-101 to 8031-01	$1.32 million
3	2020	8635-11 to 8635-10	$0.31 million
4	2010	5627-08A to 9907-49	$2.76 million
5	2015	8130-01 to 1779-02	$0.45 million
		9917-20 to 9910-21	$3.95 million
		5667-01 to 5662-01	$3.31 million
		1779-02 to 5667-01	$1.21 million
		9910-21 to 9910-19	$0.40 million
6	2010	8149-05 to 1726-29	$2.30 million
		3983-05 to 8149-05	$0.48 million
		1726-29 to 1726-26	$0.87 million
		1726-26 to 1726-19	$2.35 million
7	2015	4630-09 to 4630-02	$0.73 million
8	2010	1751-09 to 1751-01	$2.57 million
9	2010	8626-01 to 6804-15A	$0.04 million
10	2020	9521-02 to 9549-05	$0.46 million
11	2010	1708-22 to 6804-15A	$1.57 million

Costs of sewer augmentation by 5-year periods are:

Year	Construction Costs	Engineering Costs	Contingency Costs	Total Costs (in 2006 $)
2010	$8.93 million	$1.34 million	$2.67 million	$12.94 million
2015	$8.36 million	$1.25 million	$2.50 million	$12.11 million
2020	$3.54 million	$0.53 million	$1.05 million	$5.12 million

10.5 Non-Metro Facilities Expansion (Non-ROMP)

Service areas owned and operated by the County in Non-Metro facilities are experiencing rapid population growth. Many of these facilities will require expansion over the next 25 years. Lagoon treatment systems will remain providing the County with backup treatment capabilities. The expansion program is summarized below. Estimated costs for these facilities are not provided in the summary below.

Non-Metro Facility

Siting, land procurement, and design must be completed before construction of a new Southland WRF and the existing Non-Metro facilities will be expanded to meet the increasing wastewater flows. The project delivery method for the new construction of the Southland WRF will be CMAR, while all the Non-Metro facility expansions will be Design/Build. The Non-Metro facility expansions and new construction phases are listed by each region below.

- Southwest Region
  - Avra Valley WRF
    - 2006/2007 Expansion 1 (from 1.2 to 2.2 mgd)
    - 2008/2009 Expansion 2 (Phase out existing BNROD and start up two new BNROD trains providing a total treatment capacity of 4.0 mgd)

- Southeast Region
  - Corona de Tucson WRF
    - 2006/2007 Expansion 1 (from 0.3 to 1.3 mgd)
    - 2018/2019 Expansion 2 (from 1.3 to 2.3 mgd)
    - 2027/2028 Expansion 3 (from 2.3 to 3.3 mgd)
  - Southland WRF
    - 2009/2010 New Construction (from 0.0 mgd to 2.0 mgd)
    - 2010/2011 Expansion 2 (from 2.0 mgd to 3.0 mgd)
    - 2012/2013 Expansion 3 (from 3.0 mgd to 4.0 mgd)
    - 2014/2015 Expansion 4 (from 4.0 mgd to 8.0 mgd)
    - 2022/2023 Expansion 5 (from 8.0 mgd to 12.0 mgd)

- South Region
  - Green Valley WRF
    - 2011/2012 Expansion 1 (from 4.1 mgd to 6.1 mgd)

- Northwest Region
  - Marana WRF
    - 2010/2012 Expansion 1 (from 0.5 to 2.0 mgd)

- Mt. Lemmon WRF
  - No change unless changes in area restrictions.

10.6 Support Facilities (ROMP)

The recommendation is to construct a new centralized laboratory for PCRWRD. Based on the existing limited operating space at Ina Road WRF and the ever increasing load on laboratory services to provide operational and regulatory laboratory tests, the centralized laboratory will be constructed at the WRC. Cost of the new centralized laboratory in 2006 construction dollars is estimated at $10 million. An additional $2 million dollars (2006 dollars) are provided for engineering and architectural services to provide design and office and field services during construction. One million dollars (2006 dollars) is provided for contingency.

10.7 Expression of Interest

PCRWRD recognizes the value of engaging the "market" to explore alternative, optimal solutions and delivery methods as a means of implementing portions of the PCRWRD's Capital Improvement Program. PCRWRD further recognizes that it is through collaboration with those entities that can make available to PCRWRD "world class" innovative solutions that may result in the real cost and time savings while implementing the Capital Improvement Program. To that end, a Request for Expression of Interest was developed.

For those responding to the Request for Expression of Interest, PCRWRD receives certain knowledge that will provide long-term benefits and value to the customers and citizens of Pima County. The submissions shared provided PCRWRD a better understanding of how public private partnership can be used to meet long-term community benefits.

The Request for Expression of Interest and the summary responses to this request are presented in **Appendix J**.

10.8 Summary

Costs of the project elements outlined in the ROMP were developed on the basis of 2006 labor and construction costs. The total cost of the ROMP, which includes the Santa Cruz Extension Phase IV, the WRC and the Ina Road WRF with support facilities, exceeds $500 million in 2006 dollars. Element costs will be packaged into projects that will be procured, designed, constructed and placed into service over the next 10 to 20 years. In an effort to reduce the capital burden, various engineering alternatives were discussed and six were chosen for further analysis. The construction sequence for the chosen alternatives was reviewed and a modified construction phasing schedule was determined as an option to reduce the capital burden. A summary of the economic analysis of the ROMP engineering alternatives and the packaging and phasing of these projects is presented in Chapter 10. Chapter 12 presents the implementation and financial impacts of the entire PCRWRD CIP.

CHAPTER 11

Analysis of ROMP Engineering Alternatives

Chapter 11 - Analysis of ROMP Engineering Alternatives

11.1 Introduction

Numerous engineering construction scenarios have been examined in an attempt to reduce the Base Case capital burden. Six of the scenarios were selected as the CIP Engineering Alternatives for further examination to compare their financial impacts to the Base Case. These analyses were required to determine the most advantageous financial pathway for the implementation of the ROMP program.

The following six engineering alternatives differ from the Base Case in several ways. However, the greatest common difference between the Base Case, from an economic perspective, and these six alternatives is the utilization of chlorine technology rather than ultraviolet radiation to achieve the required level of pathogen removal.

All scenarios incorporate assumptions provided in Chapter 10 with the following exception: the Ina Road facility construction contract must be awarded 6 months prior to the start-no-later date of January 2011. In review of the construction cost analysis, it was determined that there may be some construction phasing issues at Ina Road relating to concurrent construction of the wastewater treatment trains and the conversion of existing BNRAS facilities to the new arrangement. This phasing may impact construction scheduling, but it was assumed for this analysis that it could be completed within allotted construction time. Because of this phasing, construction cost may be slightly different than what is developed in this construction cost estimate.

11.2 Engineering Alternatives

The six ROMP Engineering Alternatives are described below.

Alternative 1: All at Once – Chlorine Technology WITHOUT Filtration

Concurrent construction of a new 32 mgd capacity Water Reclamation Campus (WRC) and expansion/upgrade of a 50 mgd capacity Ina Road WRF. Initial construction for the Water Reclamation Campus will consist of sitework and facility construction will be delayed for the first year. Disinfection will occur without a preceding filtration step and will be accomplished via a chlorination technology process similar to the current disinfection method utilized by the two facilities. Demolition and removal of the existing Roger Road WRF occurs after the new Water Reclamation Campus is completed.

Alternative 2: All at Once – Chlorine Technology WITH Filtration

Concurrent construction of a new 32 mgd capacity WRC and expansion/upgrade of a 50 mgd capacity Ina Road WRF. Disinfection will be accomplished via a chlorination technology process similar to the current disinfection method utilized by the two facilities including a preceding filtration step. Demolition and removal of the existing Roger Road WRF occurs after the Water Reclamation Campus is completed.

Alternative 3: 8-mgd WRC Delay – Chlorine Technology WITHOUT Filtration

Concurrent construction of a new WRC at 24 mgd and repair/expansion of Ina Road WRF to 50 mgd and delayed construction of additional 8 mgd at the new WRC upon completion of initial 24 mgd. Disinfection will be accomplished via a chlorine technology process similar to the current disinfection method utilized by the two facilities. Demolition and removal of the existing Roger Road WRC occurs after the new Water Reclamation Campus is completed.

Alternative 4: 8-mgd WRC Delay – Chlorine Technology WITH Filtration

This scenario includes all components from the previous alternative, ***8-mgd WRC Delay – Chlorine Technology WITHOUT Filtration***, and only differs from the addition of a filtration system prior to chlorine disinfection.

Alternative 5: 8-mgd WRC Delay – Utilize Roger Road WRF's Existing Sludge System

Concurrent construction of a new WRC at 24 mgd and repair/expansion of Ina Road WRF to 50 mgd and delayed construction of additional 8 mgd at the WRC upon completion of initial 24 mgd. Disinfection will be accomplished via a chlorine technology process similar to the current disinfection method utilized by the two facilities including a preceding filtration step. Demolition and removal of the existing Roger Road WRF will be delayed to a later date. This scenario retains current biosolids processing facilities at Roger Road WRF and improves current biosolids processing facilities at both Roger Road WRF and Ina Road WRF as needed while deferring new construction of sludge facilities at Ina Road WRF's centralized processing until a later date.

Alternative 6: All at Once – Chlorine Technology WITHOUT Filtration

Concurrent construction of a new 32 mgd capacity WRC and expansion/upgrade of a 50 mgd capacity Ina Road WRF. Facility construction for the new WRC will occur throughout the duration. Disinfection will occur without a preceding filtration step and will be accomplished via a chlorination technology process similar to the current disinfection method utilized by the two facilities. Demolition and removal of the existing Roger Road WRF occurs after the new Water Reclamation Campus is complete.

11.2.1 Treatment Capacity

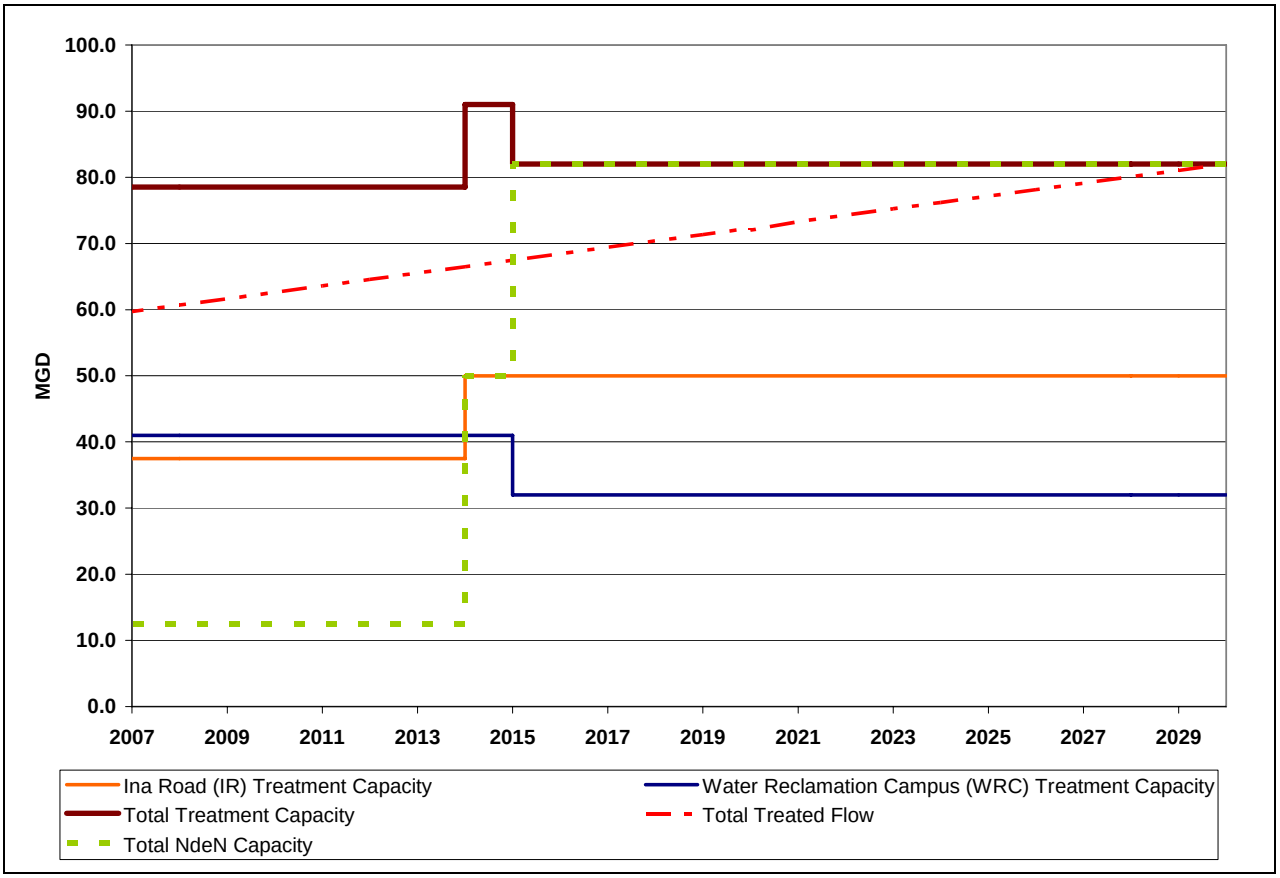
Each scenario must provide adequate NdeN treatment capacity for the projected influent flows. A NdeN treatment capacity analysis has been completed for each of the five engineering alternatives and all alternatives meet the required NdeN capacity for this study. Provided below are The CIP Engineering Alternatives "All at Once" and Alternatives "8-mgd WRC Delay".

All at Once – Chlorine Technology WITH & WITHOUT Filtration

Figure 11-1 shows the treatment capacity flow chart for both Ina Road WRF and the WRC facilities through the year 2030. The green dashed line represents the total NdeN treatment capacity. The NdeN capacity by 2014 is 50 mgd represented by completion of the expansion/upgrade of Ina Road WRF.

Completion of the new 32 mgd WRC by 2015 provides 84 mgd total NdeN treatment capacity, which is a sufficient amount of capacity for treating the total flow (red dashed line).

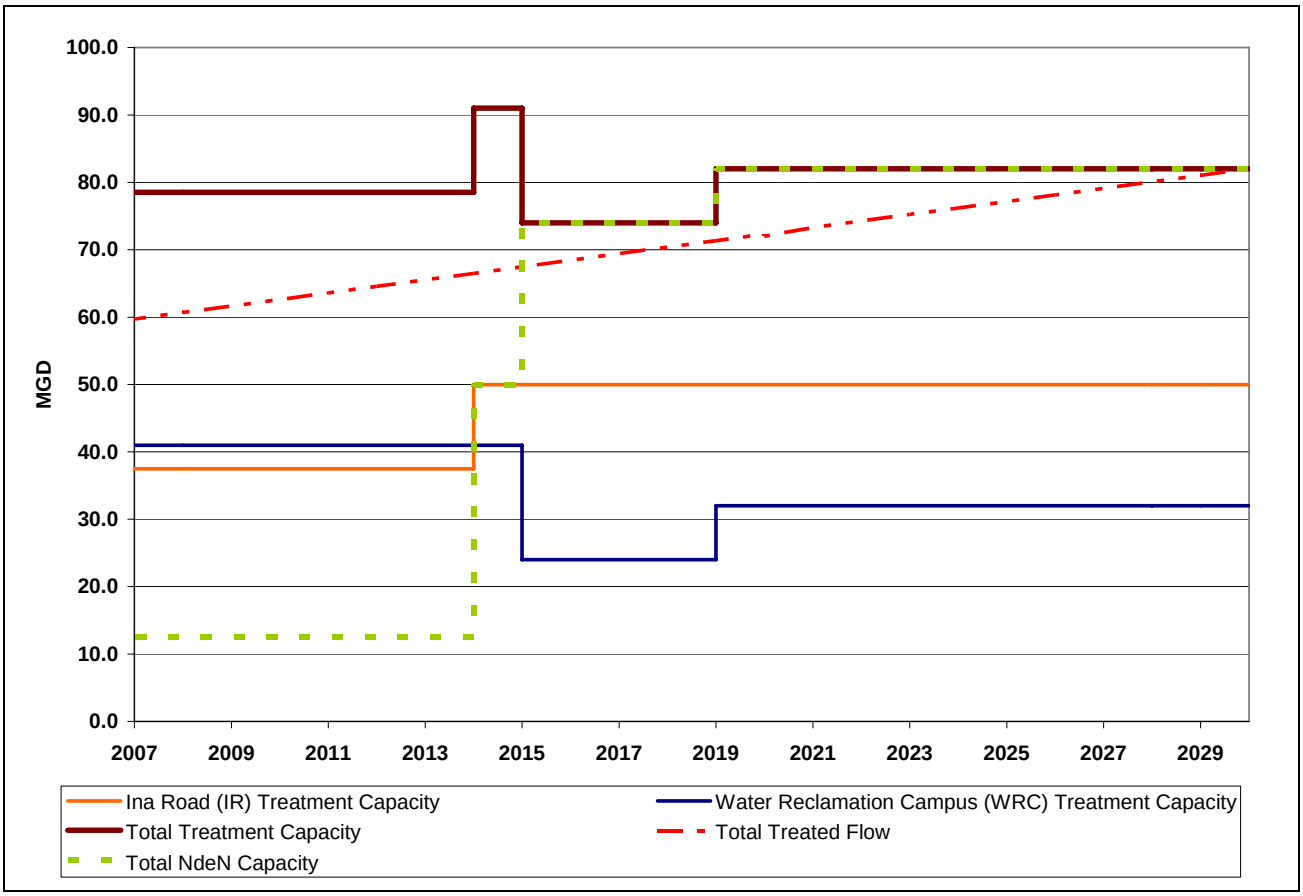
Figure 11-1
ROMP Engineering Alternatives "All at Once" Flow Capacity Analysis



8-mgd WRC Delay – Chlorine Technology WITH & WITHOUT Filtration and Utilize Roger Road WRF's Existing Sludge System

Figure 11-2 shows the treatment capacity flow chart for both Ina Road WRF and the new WRC facilities through the year 2030. The green dashed line represents the total NdeN treatment capacity. The NdeN capacity by 2014 is 50 mgd as represented by completion of the expansion/upgrade of Ina Road WRF. Completion of the new 24 mgd WRC by 2015 provides 74 mgd total NdeN treatment capacity and the additional 8 mgd completed by 2019 provide a sufficient amount of capacity for treating the total flow (red dashed line).

Figure 11-2
ROMP Engineering Alternative "8-mgd WRC Delay" Flow Capacity Analysis



11.2.2 Construction Flow Charts

Construction flow charts were created to illustrate the preliminary construction schedule for each alternative. Key dates and durations were used to determine whether sufficient time was available for the various alternatives. These dates provide sufficient time for completion of each alternative to meet the NdeN regulatory requirements and are included in **Appendix D**.

The following preliminary construction flow charts have been created to determine the plausibility for the various CIP Engineering Alternatives to provide treatment capacity meeting the ammonia toxicity regulatory requirement dates set in each facility's respective permit. Enough time must be allotted for the Ina Road WRF to be online by January 30, 2014 and for the new WRC by January 30, 2015. **Table 11-1** shows the duration and start date for each component for Ina Road WRF and the new WRC.

Table 11-1
Components Required for the CIP Engineering Alternative Completion

Project Component	Start Date		Duration	
	Ina Road WRF	New WRC	Ina Road	New WRC
Design Procurement	August 2007	January 2008	6 Months	6 Months
Design	January 2008	July 2009	24 Months	18 Months
Construction Procurement*	January 2010	January 2010	6 Months	6 Months
Construction Contract Award	January 2011	January 2011	-	-
Construction	July 2010	January 2011	37 Months	42 Months
Start-Up & Testing	August 2013	August 2014	6 Months	6 Months
Must be Online No Later Than	January 2014	January 2015	-	-

***Selection of an alternative delivery method may reduce the time for selection of contractor after development of plan, longer engineering time, or long construction time.**

11.2.3 Construction Costs

Construction costs for each alternative were developed initially from the yearly construction costs presented in the Base Case. Alternatives "8-mgd WRC Delay" constructs 24 mgd of the WRC's treatment capacity and delays completion of an additional 8 mgd until 2016. Of these three scenarios, the costs for the 24 mgd portion (Phase I) were calculated by taking 75% of the Master Plan's yearly budgeted amount for the duration of that phase of construction. The 8 mgd portion (Phase II) costs were calculated by taking 25% of the Master Plan's yearly budgeted amount for the duration of that phase of construction. An additional 10% of Phase II's yearly cost has been added to each year of Phase II's duration. This additional 10% accounts for costs associated with beginning a new construction phase,

administration, mobilization, demobilization, legal contract development, procurement, etc. Each of the five engineering alternatives costs are shown in **Table 11-2**.

Table 11-2
ROMP Engineering Alternative Cost Comparisons

Alternative	Description	Total Cost* (2006 dollars in Millions)
1	All at Once – Chlorine Technology **WITHOUT** Filtration	**$450**
2	All at Once - Chlorine Technology **WITH** Filtration	**$480**
3	8-mgd WRC Delay – Chlorine Technology **WITHOUT** Filtration	**$455**
4	8-mgd WRC Delay – Chlorine Technology **WITH** Filtration	**$485**
5	8-mgd WRC Delay – Utilize Roger Road WRF's Existing Sludge System	**$485**
6	All at Once – Chlorine Technology **WITHOUT** Filtration	**$450**

***Total Cost includes $22.3M for Santa Cruz Extension Phase IV, costs associated with the 50 mgd upgrade/expansion of Ina Road, and new construction of the 32 mgd WRC.**

11.3 Economic Analysis

The financial implications of the ROMP Base Case and the selected alternatives were evaluated over a 15-year planning period. (FY 2007 – FY 2022). A planning period of this length was selected as it provides sufficient time to address the construction requirements for meeting regulatory compliance schedules, while allowing for sufficient time to incorporate the costs of specific funding assumptions that are identified in the Baseline Financing Plan (see Chapter 10). Capital project costs for each alternative were escalated annually by 5.0% to reflect the anticipated increase in costs over the forecast period. **Table 11-3** provides a projection of the annual ROMP project costs for the Base Case and each of the selected engineering alternatives. **Figure 11-3** summarizes the total ROMP project costs over the planning period.

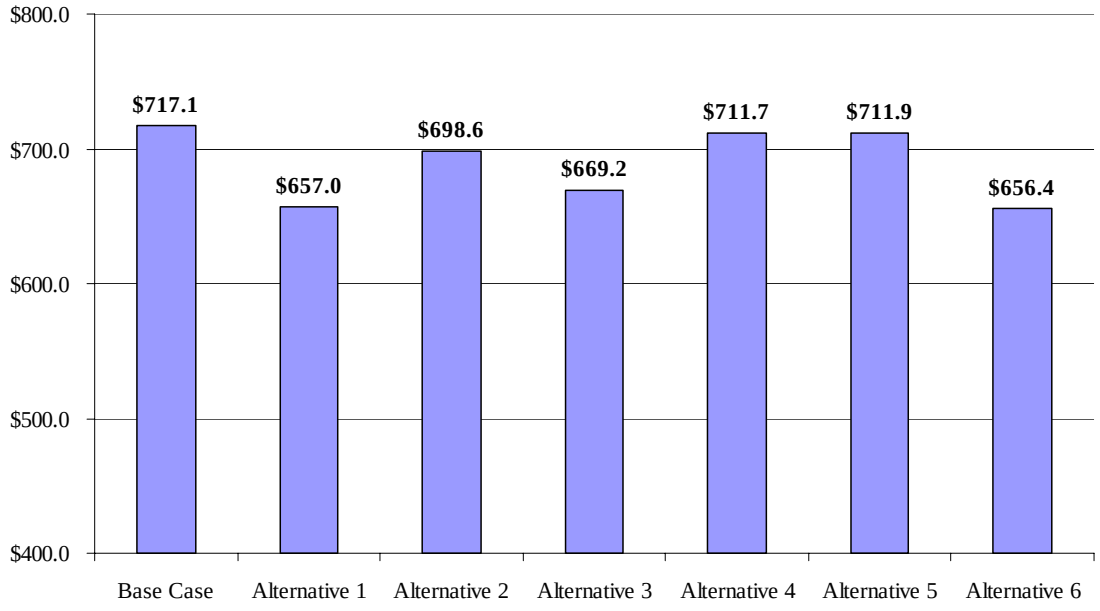
Table 11-3
ROMP Engineering Alternatives ($ Millions by Year)

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
ROMP Project Costs (1)								
Base Case	$ 0.35	$ 8.10	$ 51.92	$ 66.42	$ 102.31	$ 140.97	$ 156.84	$ 107.45
Alternative 1	$ 0.35	$ 8.10	$ 21.21	$ 28.97	$ 71.21	$ 153.42	$ 165.03	$ 111.84
Alternative 2	$ 0.35	$ 8.10	$ 21.21	$ 28.97	$ 77.24	$ 167.08	$ 179.10	$ 119.47
Alternative 3	$ 0.35	$ 8.10	$ 21.21	$ 28.97	$ 70.60	$ 147.10	$ 146.04	$ 89.99
Alternative 4	$ 0.35	$ 8.10	$ 21.21	$ 28.97	$ 76.63	$ 160.20	$ 158.52	$ 95.91
Alternative 5	$ 0.35	$ 8.10	$ 21.21	$ 28.97	$ 74.82	$ 157.01	$ 154.59	$ 93.76
Alternative 6	$ 0.35	$ 8.10	$ 22.52	$ 29.73	$ 102.24	$ 144.06	$ 175.93	$ 81.50

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
ROMP Project Costs (1)								
Base Case	$ 36.22	$ 24.14	$ 7.39	$ 7.18	$ 7.82	$ -	$ -	$ -
Alternative 1	$ 23.74	$ 37.06	$ 8.72	$ -	$ 14.59	$ 12.77	$ -	$ -
Alternative 2	$ 23.91	$ 37.06	$ 8.72	$ -	$ 14.59	$ 12.77	$ -	$ -
Alternative 3	$ 46.97	$ 72.31	$ 10.18	$ -	$ 14.59	$ 12.77	$ -	$ -
Alternative 4	$ 49.38	$ 74.84	$ 10.18	$ -	$ 14.59	$ 12.77	$ -	$ -
Alternative 5	$ 48.92	$ 74.35	$ 10.18	$ -	$ 21.29	$ 18.39	$ -	$ -
Alternative 6	$ 22.89	$ 2.77	$ -	$ -	$ 43.45	$ 22.87	$ -	$ -

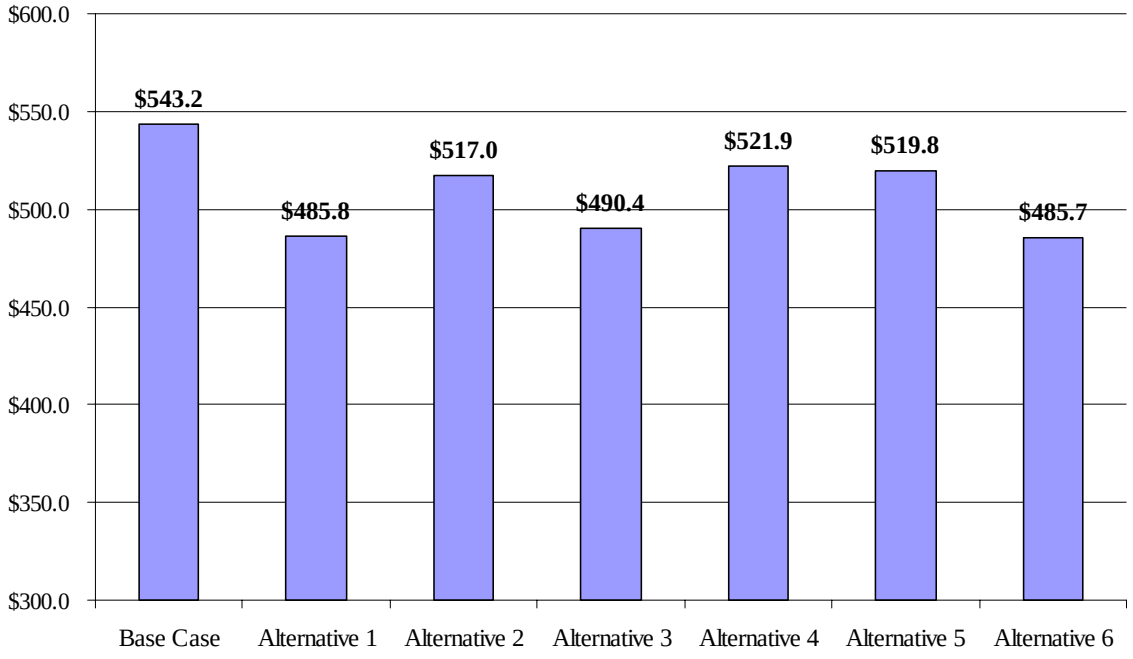
(1) ROMP project costs are escalated annually at a rate of 5.0%.

Figure 11-3
ROMP Engineering Alternatives - Total Cost ($ Millions)



It was determined that the most appropriate metric to serve as basis for comparing the economic impacts of the Base Case and the selected alternatives was a net present value (NPV) calculation. The NPV calculation is an effective tool that is designed to capture the difference in the timing of future investments, which provides a meaningful basis for comparing alternatives. For each alternative, the projected capital costs identified above were discounted back to a present value term based on a discount rate of 4.5%. The discount rate of 4.5% was chosen as it represented a reasonable proxy for the average cost of capital associated with PCRWRD's most recent revenue bond issuance. **Figure 11-4** presents the NPV Calculation for the Base Case and the selected alternatives.

Figure 11-4
ROMP Engineering Alternatives - NPV of Total Costs ($ Millions)



11.4 Summary and Recommended Alternative

The NPV calculation identified Alternative 6 as the most cost-effective ROMP engineering alternative. As described previously, Alternative 6 represents the concurrent construction of a new 32 MGD WRC and expansion/upgrade of a 50 MGD Ina Road WRF, with both facilities utilizing chlorination disinfection without a preceding filtration step.

While it is apparent that Alternative 6 would be the most cost effective approach to delivering the ROMP projects, both in terms of total cost and NPV, the feasibility of Alternative 6 has not been fully evaluated.

As is the case with the "All at Once" scenarios, Alternative 6 achieves a significant portion of its cost savings from the concurrent construction of the full 32 MGD Water Reclamation Campus at Roger Road WRF and the upgrades and expansion to 50 MGD at Ina Road WRF. Concurrent construction phasing may introduce some issues at Ina Road WRF that could potentially result in delays in the construction schedule at that facility. The feasibility and constructability of concurrent construction needs to be evaluated, as well as any potential cost increases due to this method. Therefore, it needs to be determined that concurrent phasing assumptions are feasible and will not result in significant cost increases..

Additionally, it should also be noted that the Base Case scenario, which has been presented to ADEQ, utilizes UV disinfection while many of the alternatives utilize chlorine for disinfection. While it is likely that the use of a chlorination process is indeed feasible, its feasibility has not been positively determined.

Therefore, until the feasibility of Alternative 6 is positively confirmed, the Base Case scenario is considered to be the most probable course of action with respect to the implementation of the ROMP projects and the economic analysis presented in Chapter 10 is based on the Base Case scenario.
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CHAPTER 12

CIP Implementation and Financing Plans

Chapter 12 - CIP Implementation & Financing Plans

12.1 Introduction

The master plan utilizes a strategic financial analysis to identify the most appropriate and cost effective capital program for implementation, while assessing the potential impact on PCRWRD customers. As discussed in Chapter 11, the PCRWRD CIP includes both ROMP capital projects and Non-ROMP capital projects. ROMP capital projects are designed to address PCRWRD's requirement to meet more stringent effluent discharge standards, while Non-ROMP capital projects address infrastructure repair and replacement and capacity expansion needs within the PCRWRD service area. The master plan identifies several engineering alternatives to address the capital requirements associated with ROMP, including a Base Case scenario and 6 alternatives that are each capable of meeting the new effluent regulatory requirements by ADEQ's compliance date. However, in order to provide a conservative forecast of capital costs over the planning period, the financing plan includes the ROMP project costs identified in the Base Case rather than the engineering alternative identified in the economic analysis summarized in Chapter 11.

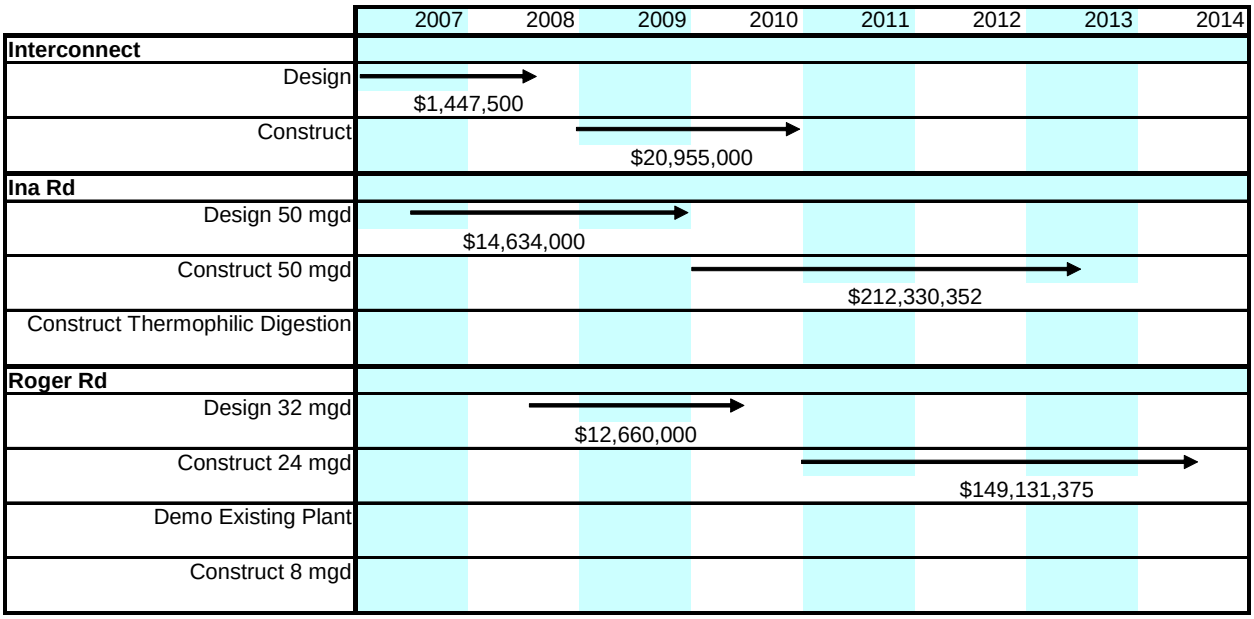
This chapter begins with an overview of the components of an effective strategic financial plan and discussions related to alternative capital funding options, and follows with a recommendation of the most appropriate funding strategy that will meet PCRWRD's financial objectives.

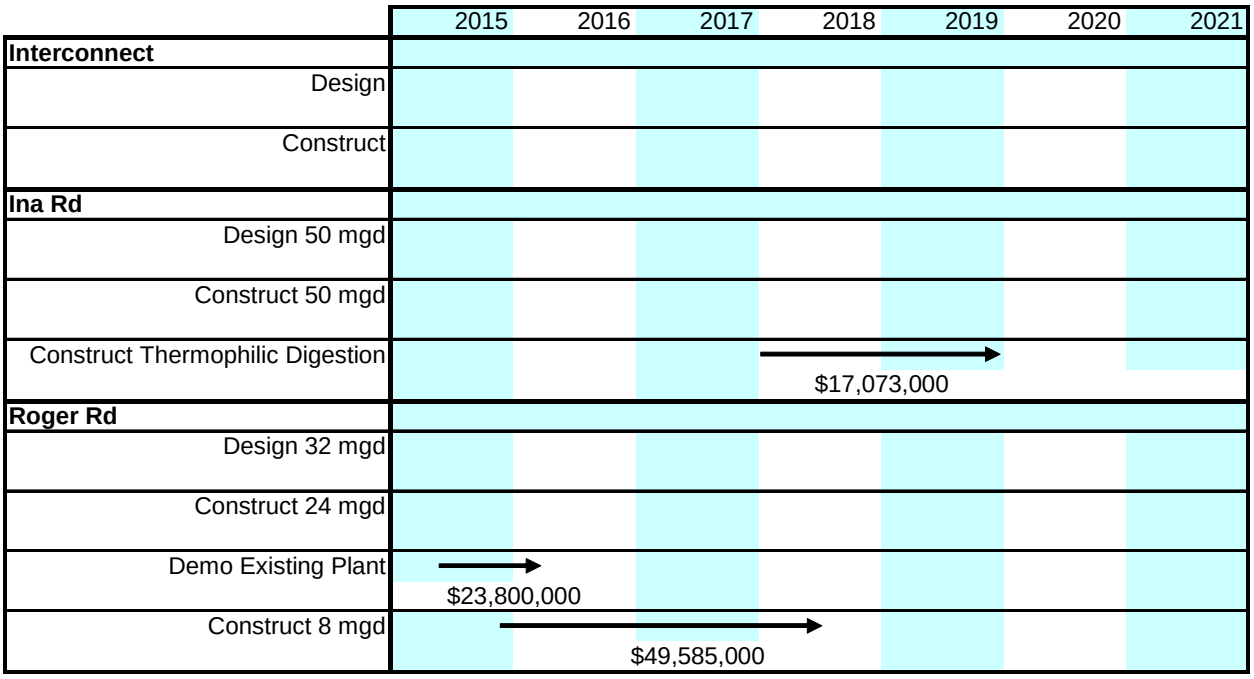
12.2 CIP Implementation Plan

12.2.1 ROMP Project Phasing

Phasing of the projects to meet the regulatory requirements for ammonia toxicity and growth needs of the community will be required across the 15-year planning horizon. Some projects are immediate, such as the plant interconnect pipeline, while other projects will be delayed, such as the demolition of Roger Road WRF, which can not occur until the new WRC is constructed and are placed into service. A project timeline driven by regulatory compliance for the new plant interconnect pipeline, new WRC and upgrade/expansion at Ina Road WRF, and conveyance system augmentation related to the regional optimization master plan is shown below. Concurrent with the expansion and upgrade projects are the projects related to the conveyance system and pump station rehabilitation and the expansion of the Non-Metro facilities to match rapid growth needs.

Figure 12-1
ROMP Project Timeline





The project timeline has been coordinated with the project financing and customer rate impacts described later in this chapter

12.2.2 Water Reclamation Campus (WRC) Projects

The construction of the facilities will be phased to meet the needs for regulatory compliance and to match the needs of population growth. In most cases, the phasing will require the completion of Phase 1 before the commencement of Phase 2. Project delivery is listed in preferential order if more than one alternative is indicated. A description of the various project delivery methods available under Arizona law is provided in **Appendix K**. Instrumentation & Control for the WRC are assumed to be included with the Ina Road Instrumentation & Control contracts (see Ina Road Projects). Dates are given in fiscal years.

Project elements for the Roger Road wastewater facilities by phases are:

- Phase 1: Engineering, permitting and procurement services for Phases 2 and 5 to begin 2007/08 and be completed by 2010.
  Project Delivery: Professional Services Procurement

- Phase 2: Facilities to be under construction by 2011 and completed by 2015 are:
  - Incoming Power service/standby power generation
  - Site preparation (temporary administration building)
  - Headworks
  - 24-mgd Bardenpho treatment (includes clarifiers, blowers/mixers)
  - Solids thickening/pumping
  - Disinfection facilities
  - Administration/control building

  Project Delivery: Construction Manager at Risk (CMAR) or Design/Build (D/B)

- Phase 3: Engineering, permitting and procurement services for Phase 4 to begin in 2014 and be completed by 2015
  Project Delivery: Professional Services Procurement

- Phase 4: Facilities to be under construction by 2015 and completed by 2017 are:
  - Existing Roger Road WRF demolition

  Project Delivery: D/B or Design-Bid-Build (D-B-B)

- Phase 5: Facilities to be under construction by 2017 and completed by 2020 are:
  - 8-mgd Bardenpho system (including clarifier)
  - Additional gravity belt thickeners

  Project Delivery: Construction Manager at Risk (CMAR) or Design/Build (D/B)

12.3 Ina Road WRF Projects

Project elements for the Ina Road wastewater facilities upgrades and expansions by phases are:

- Phase 1: Engineering, permitting and procurement services for Phases 2, 3, 4 and 7 to begin 2007/08 and be completed by 2010.
  Project Delivery: Professional Services Procurement

- Phase 2: Power facilities to be under construction by 2010 and completed by 2012 are:
  - Power unification/biogas power generation

  Project Delivery: Construction Manager at Risk (CMAR) or Design/Build (D/B) or (biogas power could be constructed under a public/private partnership arrangement)

- Phase 3: Wastewater reclamation facilities to be under construction by 2010 and completed by 2014 are:
  - Site preparation
  - Primary clarifier
  - Bardenpho treatment (including clarifiers, blowers/mixers)
  - Disinfection facilities
  - Demolish HPO and oxygen system

  Project Delivery: CMAR or D/B or D-B-B

- Phase 4: Biosolids facilities to be under construction by 2010 and completed by 2014 are:
  - Mesophilic digestion (4 new, 4 existing)
  - Gravity thickening (primary sludge)
  - Gravity belt thickening (WAS sludge)
  - Centrifuge dewatering
  - Sludge storage

  Project Delivery: CMAR or D-B-B

- Phase 5: Engineering, architectural, permitting and procurement services for Phase 6 to begin 2007/08 and be completed by 2010.
  Project Delivery: Professional Services Procurement

- Phase 6: Support facilities to be under construction by 2010 and completed by 2012:
  - Centralized laboratory

  Project Delivery: Design/Build (D/B) or Construction Manager at Risk (CMAR)

- Phase 7: Biosolids facilities to be under construction by 2017 and completed by 2020 to coincide with additional wastewater facilities at Roger Road WRF are:
  - Additional mesophilic digester
  - Additional centrifuge thickener

  Project Delivery: D/B or CMAR

- Phase 8: Engineering, permitting and procurement services for Phase 9 to begin 2018/19 and be completed by 2020.
  Project Delivery: Professional Services Procurement

- Phase 9: Future biosolids facilities to be under construction after completion of system-wide biosolids management plan and 2020 are:
  - Thermophilic digesters or heat drying or other (Class A) process

  Project Delivery: Design/Build/Operate (D/B/O) or D/B or CMAR or (could be constructed earlier under a public/private partnership arrangement)

12.3.1 Conveyance System Projects

The plant interconnect pipeline is a critical part of the upgrade and expansion of the treatment facilities at Roger Road WRF and Ina Road WRF. The need for the construction of the pipeline is immediate. The conceptual route layout has been developed and a fatal flaw and preliminary development analysis is nearing completion. Procurement of professional services for the design and permitting is underway. A construction manager at risk will be selected shortly after the selection of the professional services firm to commence the construction process. The goal of the procurement process is to have the pipeline in service as quickly as possible, but not later than 2010.

In addition to the ongoing series of rehabilitation projects in the conveyance system, there are several sewer segments that will require augmentation to be able to carry the increased capacity cause by population growth in the service areas. The projects are describe in Chapter 6 and are listed below.

Project No.	Description (MH to MH)	Project Cost (in 2006 $)
Year 2010		
■ 4	5627-08A to 9907-49	$2.76 million
■ 6	8149-05 to 1726-29	$2.30 million
	3983-05 to 8149-05	$0.48 million
	1726-29 to 1726-26	$0.87 million
	1726-26 to 1726-19	$2.35 million
■ 8	1751-09 to 1751-01	$2.57 million
■ 9	8626-01 to 6804-15A	$0.04 million
Year 2015		
■ 2	6036-21 to 3979-101	$0.74 million
	3919-101 to 8031-01	$1.32 million
■ 5	8130-01 to 1779-02	$0.45 million
	9917-20 to 9910-21	$3.95 million
	5667-01 to 5662-01	$3.31 million
	1779-02 to 5667-01	$1.21 million
	9910-21 to 9910-19	$0.40 million
■ 7	4630-09 to 4630-02	$0.73 million
Year 2020		
■ 1	4636-30A to 4190-05A	$4.35 million
■ 3	8635-11 to 8635-10	$0.31 million
■ 10	9521-02 to 9549-05	$0.46 million
■ 11	1708-22 to 6804-15A	$1.57 million

Costs of sewer augmentation by 5-year periods are:

YEAR	TOTAL COSTS (IN 2006 $)
2010	$12.94 million
2015	$12.11 million
2020	$5.12 million

12.3.2 Non-Metro Facilities Projects

Population growth in the Non-Metro regions is creating pressure to expand wastewater facilities at a rapid pace. The goal is to provide the needed facilities when required, but not sooner. The projected expansion(s) of the facilities are provided below.

Non-Metro Facilities

Siting, land procurement, and design must be completed before construction of a new Southland WRF and the existing Non-Metro facilities will be expanded to meet the increasing wastewater flows. The project delivery method for the new construction of the Southland WRF will be CMAR, while all the Non-Metro facility expansions will be Design/Build. The Non-Metro facility expansions and new construction phases are listed by each region below.

- Southwest Region
  - Avra Valley WRF
    - 2006/2007 Expansion 1 (from 1.2 to 2.2 mgd)
    - 2008/2009 Expansion 2 (Phase out existing BNROD and start up two new BNROD trains providing a total treatment capacity of 4.0 mgd)

- Southeast Region
  - Corona de Tucson WRF
    - 2006/2007 Expansion 1 (from 0.3 to 1.3 mgd)
    - 2018/2019 Expansion 2 (from 1.3 to 2.3 mgd)
    - 2027/2028 Expansion 3 (from 2.3 to 3.3 mgd)
  - Southland WRF
    - 2009/2010 New Facility Construction (from 0.0 mgd to 2.0 mgd)
    - 2010/2011 Expansion 1 (from 2.0 mgd to 3.0 mgd)
    - 2012/2013 Expansion 2 (from 3.0 mgd to 4.0 mgd)
    - 2014/2015 Expansion 3 (from 4.0 mgd to 8.0 mgd)
    - 2022/2023 Expansion 4 (from 8.0 mgd to 12.0 mgd)

- South Region
  - Green Valley WRF
    - 2011/2012 Expansion 1 (from 4.1 mgd to 6.1 mgd)

- Northwest Region
  - Marana WRF
    - 2010/2012 Expansion 1 (from 0.5 to 2.0 mgd)

- Mt. Lemmon WRF
  - No change unless changes in area restrictions.

12.4 CIP Financing Plan

12.4.1 Financial Planning Overview

When developing a financing plan for a major capital program, a utility must take into account a number of key considerations. These factors are:

- ***Risk/Reward Relationship***: Typically, the lower the costs associated with a particular financing model, the greater the risks associated with that model. Therefore, a utility must carefully weigh financial rewards associated with a particular financing mechanism against the levels of risk associated with that mechanism. For example, while short-term debt offers lower interest rates, the interest-rate risk that results from the need to refinance as the debt matures is greater. In this case the utility must decide whether the lower costs justify the increased risks.

- ***Multi-year Planning Horizon***: When developing a financing plan, a utility must take into consideration future capital needs and the financial circumstances that may exist in the future. This will ensure that financing capacity is available for future needs as well as current needs.

- ***Rate Stability***: A primary goal of any County utility is rate stabilization. Therefore, when developing a financing plan, the impact of the financing plan on rates should be examined carefully. A low-cost financing plan that causes dramatic rate volatility may not be as desirable as a more expensive plan that allows debt service to be structured in a way that will reduce rate volatility.

- ***Equitable Distribution of Costs***: It is commonly agreed that each utility customer should pay a fair share of the costs associated with providing service. Therefore, when developing a financing plan for a specific capital project, a utility must take great care to ensure existing customers are not forced to pay an inordinate share of the costs of a project that will actually be of more benefit to future customers. Forcing future customers to recover too much of a project's costs should also be avoided. This intergenerational equity can be achieved in a number of ways, including the use of system development charges or structuring debt service, or both, to be spread in such a way that current and future customers end up paying for the portion of the project that benefits them.

After considerable discussion with PCRWRD staff, it was determined that the most appropriate strategy for evaluating different financing approaches and assessing customer impacts is to establish a baseline financing plan that uses traditional public financing instruments, and then evaluate non-traditional financing alternatives, both public and private, that could provide a more cost-effective strategy for funding certain components of the CIP. In each case, only the financing options that were relevant to

PCRWRD and its capital planning initiatives were evaluated. An analysis was then performed whereby each financing tool considered was evaluated with respect to ten key criteria that were developed to assess each financing tools adherence to the to the previously described financial planning considerations and the PCRWRD's financing objectives. These criteria are:

- ***Applicability***. Indicates relevance or practicality of using a particular financing tool for PCRWRD's capital planning initiatives. Financing options that are inappropriate or not relevant for these types of projects are eliminated upfront. Therefore, this criterion is used to assess each option relative to the other options being evaluated for consideration.

- ***Legality***. Is a broad characterization as to whether the financing tool under consideration is in adherence with federal, state and local legal guidelines. This characterization was developed based on conversations with Pima County's legal advisors; Hawkins, Delafield & Wood; representatives of state financing agencies and various financial advisors and bond counsels. One of the major factors considered when applying this criterion was whether the financing tool had been utilized before on similar projects in the United States.

- ***Administrative and Compliance Requirements***. Deals with the level of effort that must be undertaken to administer and provide proof of compliance with applicable requirements in order to take advantage of the financing tool being considered.

- ***Issuance Costs***. Is a relative evaluation of the level of costs, exclusive of interest rate costs, associated with being able to utilize the financing tool under consideration. Among the many costs that were considered are costs associated with preparing and printing official statements, loan closing costs, and professional advisory fees.

- ***Effective Interest Rate***. Is a relative evaluation of the effective interest rate costs associated with each financing option. Interest rate costs are the main component of financing costs and therefore, to a great extent, determine the economic attractiveness of a particular financing tool.

- ***Attractiveness to Vendors***. Is a relative measurement of the willingness of private water service contractors to participate in projects that utilize the financing tool under consideration. Obviously, this criterion is particularly important with respect to those alternative project delivery methods that require the participation of private contractors.

- ***Rate Stability***. Is a relative evaluation of the rate stabilizing capabilities that the financing tool under consideration offers to the County utility. Of primary importance is the degree to which creative structuring of debt service schedules are possible when using the financing tool under consideration. Another important consideration is the practicality of using the tool being evaluated in conjunction with other financing tools.

- ***Off Balance Sheet Financing Effects***. Is a broad characterization of how each financing option might impact a County utility's apparent financial strength. It is important since the financing used on one project can affect a County utility's ability to obtain financing for future projects.

- ***Economic Risk of Tax Requirement Non-Compliance***. Different financing tools are viewed in different ways by the Internal Revenue Service (IRS). Use of some financing tools brings with it a greater risk of non-compliance with IRS guidelines. In some cases, the economic impact of non-compliance may be quite large in other cases, non-compliance ramifications may be acceptable. This criterion is a relative evaluation of the economic impact that may ensue if the County utility were to fail to adhere to IRS rules and regulations.

12.4.2 Capital Financing Options and Alternatives

The baseline financing plan described in Section 12.3 was designed to provide a reasonable assessment of the financial and customer impacts of the PCRWRD CIP. In order to evaluate all possible funding alternatives, more non-traditional financing sources and strategies, both public and private, which have been used successfully by municipalities across the country were also considered. Portions of these descriptions have been adapted from the following sources:

- *Comprehensive Guide to Water and Wastewater Finance and Pricing* by George Raftelis
- Government Finance Review, August 2005 Issue, "Understanding Municipal Derivatives"

12.4.2.1 Traditional Public Financing

In the United States, wastewater utilities are typically financed using some type of public funding. Sources of public funding include debt, internal/reserve funds, and federal or state grants. Debt can either take the form of a bond or a loan. A bond, which is the primary instrument of County utility debt, is a written promise to repay borrowed money on a definite schedule usually at a fixed rate of interest for the life of the bond. The key element of utility bonds for Pima County is that they are tax-exempt, meaning that investors do not pay taxes on the interest proceeds from the bonds. As a result, utilities are able to set much lower interest rates on their bonds and still have them be attractive to investors. These lower interest rates represent a significant savings to the issuing government when compared to the interest rates they would be required to offer if their bonds were not tax-exempt.

A loan differs from a bond in that it is a temporary provision of the specific amount of funds for an expenditure that must be repaid in a set amount of time, typically with interest.

A number of typical public financing options and their advantages and disadvantages are described below. Portions of these descriptions have been adapted from the following sources:

- *Comprehensive Guide to Water and Wastewater Finance and Pricing* by George Raftelis;
- AWWA Manual M29, "Water Utility Capital Financing";
- "A Guidebook of Financial Tools: Paying for Sustainable Environmental Systems" prepared by the U.S. EPA's Environmental Financial Advisory Board, dated April 1999; and

Short-Term Tax-Exempt Debt. Short-term tax-exempt debt consists primarily of short-term municipal bonds and short-term securities known as notes. These instruments generally have maturities ranging

from a few months to a few years, have fixed interest rates, and are issued in anticipation of a bond issue, grant proceeds, or tax collections. Examples include bond anticipation notes (BANs) which are issued in anticipation of the sale of long-term bonds; grant anticipation notes (GANs), issued in anticipation of receipt of state or federal grants; tax anticipation notes (TANs), issued in anticipation of the receipt of taxes; revenue anticipation notes (RANs), issued in anticipation of revenues to be generated by the issuing County utility; and tax and revenue anticipation notes (TRANs).

Tax-exempt variable-rate demand notes differ from the traditional fixed-rate notes in that their interest rate is tied to market conditions. These instruments are sold to investors who, after some time, have the right to "demand" payment of the face value of the notes. Because of the high liquidity of variable-rate demand notes, they are very attractive to investors and tend to carry a lower rate of interest than less flexible, more traditional fixed-rate financing instruments.

Tax-exempt commercial paper is another short-term financing tool. These instruments are short-term, unsecured promissory notes, backed, for liquidity purposes, by a line or letter of credit from a commercial bank. Maturities normally range from one to 270 days.

Short-term debt markets are easily accessed and the interest rates associated with these instruments are typically low. As a result, short-term instruments are commonly used to meet short-term capital needs for design and initial construction while waiting for long-term financing. The use of several consecutive short-term debt issues to fund projects with a long useful life can be risky in that interest rates could rise significantly meaning that the next short-term issue could be significantly more expensive.

General Obligation Bonds. General obligation bonds are secured by the full faith and credit of the issuing entity. Typical issuers of general obligation bonds include municipalities, counties, special service districts with taxing authority, and other government entities. General obligation bonds have a major advantage in that they are backed by the full taxing capacity of the government entity, and consequently this credit is usually regarded as having the strongest security pledge available and therefore, the lowest available net interest cost.

There are, however, disadvantages to general obligation bonds. Since the issuance of general obligation debt typically requires legislative or voter approval, project funding can be delayed significantly particularly when the project being funded has a high cost or is politically sensitive. In addition, municipalities typically have a limit on the amount of general obligation debt that they can hold at any one time. Therefore, it is important to take long-term capital needs into account when considering the use of general obligation bonds.

Revenue Bonds. Revenue bonds are debt instruments for which interest and principal are payable solely from the revenue generated from a specific project or utility. In most states, the holders of revenue bonds do not have recourse to have taxes levied to pay required debt service. A major advantage of revenue bonds is that they preserve the issuer's general obligation debt capacity for other projects. Revenue bonds are generally tax-exempt and would be issued at interest rates lower than taxable debt but higher than general obligation debt. PCRWRD has historically utilized revenue bonds to fund the majority of its significant capital projects. The current rate on AAA rated, tax exempt insured revenue bond is approximately 4.5%.

Revenue bonds can have greater flexibility in market timing, and reduced risk if they are presold and can have greater flexibility in timing the repayment of principal. One disadvantage of revenue bonds is that they are often encumbered with indentures or ordinances, such as the requirement to establish reserve funds and debt coverage ratio requirements. In addition, in Arizona, revenue bonds also require the prior approval of the issuing agency's voters.

Double Barrel Bonds. A "double barrel bond" can be viewed as a hybrid of revenue bonds and general obligation bonds. These bonds are secured in a two-tiered manner: (1) the first source of funds used in the debt service payments on the bonds is derived from a designated revenue source generated by the project, such as user fees; and (2) if the revenue stream is inadequate to pay debt service, ad valorem taxes, or the general tax revenue of the government entity, is used. The double barrel bond will have almost the same credit ratings as a general obligation bond and will have interest rates close to if not the same as the general obligation bond.

Zero Coupon Bonds and Capital Appreciation Bonds. Zero coupon bonds are securities that have a zero interest rate. They are typically issued at a fraction of their par value and investors receive par value when the bonds mature. Capital appreciation bonds (CABs) are similar to zero coupon bonds in that no periodic interest payments are made. Instead, the investor receives a lump sum payment of interest and principal when the bond matures. These instruments are attractive to long term investors in that there is no need to reinvest periodic interest payments and the return is guaranteed. From a County utility's standpoint, these securities are often used as a means of structuring debt service in a way that will minimize the short-term impact on rate payers and are often used in conjunction with other debt instruments. The current implied interest rate for zero coupon bonds depends on the terms of the bonds.

State Revolving Funds. The 1996 Safe Drinking Water Act Amendments authorized the funding of Drinking Water State Revolving Loan Funds (SRFs) to assist drinking water systems in financing the infrastructure costs of complying with the Act and to protect the public health. SRFs provide low-cost loans to publicly and privately owned water and wastewater systems, as well as nonprofit community ones, for periods up to 20 years. Many states, including Arizona, leverage funds provided from the federal and state government by issuing SRF revenue bonds.

SRF revenue bonds are issued to expand, or leverage, loan funding sources for local projects that meet the eligible project criteria under the Drinking Water SRFs. In Arizona, the Water Infrastructure Finance Authority (WIFA) serves as an independent agency of the state and is authorized to issue SRF revenue bonds (WIFA revenue bonds) to finance the construction of water, wastewater, wastewater reclamation, and other water quality projects. WIFA's main source for providing funding for wastewater systems is the Clean Water Revolving Fund, which is capitalized by contributions from both the federal and state level. WIFA revenue bonds are issued under the bond leveraging approach and are secured first by local general obligation or revenue bond pledges as collateral on loan repayments, and then by debt reserve funds underlying the WIFA revenue bond.

In Arizona the interest rate for SRF loans is indexed to the average current tax-exempt bond interest rate with the actual interest rate being a fraction of this index. The current index is approximately 4.5%. The fraction of the current tax-exempt bond rate that the SRF will charge an individual County utility is determined based on evaluation of the fiscal capacity of County utility. Specifically, the SRF looks at a

County utility's mean annual income, current wastewater rates and charges, credit rating and the cost-effectiveness of the particular project for which the loan is being obtained.

SRFs probably represent the lowest cost funding for capital projects; however, there are a number of administrative hurdles that must be overcome before this financing tool can be utilized. In addition to a fairly stringent application process, voter approval is required before a County utility can access SRF funds. Also, the amount of SRF funds is fairly limited and competition for these funds has been relatively intense. In addition, the decision as to whether a County utility is eligible for SRF funds is to a certain extent based on need. Although recently the County has been successful securing SRF funds for certain capital projects, it may be difficult for a utility like Pima County, which is financially sound, to continue to have access to these funds.

Current Revenues/Reserve Funding. Internal funding involves a utility using reserve funds as a source of funding for a project. Reserve funds are cash, or cash equivalents, that the utility has accumulated over a period of time, either for the purpose of funding specific projects or to be used on an as needed basis. Utility reserve funds are typically funded through contributions from user charge revenues and supplemented with earnings derived from investing. Reserve funds can also be acquired through the use of system development charges, which require new customers of the system to pay for their proportional share of the costs to provide available capacity to serve these customers. It should be noted, however, that revenues derived from system development charges can be restricted for use on only the projects that will provide capacity to serve growth. PCRWRD currently assesses system development charges, or "connection fees", with the revenue derived from these fees being accounted for through a System Development Fund and used solely for growth related projects.

Typically, reserve funding can be a very low cost means of financing capital projects since the only cost associated with this type of funding is the opportunity cost associated with not being able to earn a return on these funds though investing. Since most municipalities restrict their reserve fund investing to relatively low risk and therefore low yield investments, this opportunity cost can be quite low. However, internally funding fund capital projects can put significant pressure on user rates and charges and/or system development fees. Therefore, utilities must carefully balance the use of current revenues and reserve funds with the short-term and long-term implications on customers.

One disadvantage of reserve fund financing is that any depletion of reserve funds hinders a utility's ability to access these funds in the case of an emergency. To address this issue, PCRWRD has recently instituted a policy whereby their goal for an Emergency Reserve Fund balance is 50% of annual O&M expenditures. As of June 30, 2006, the balance in the PCRWRD's Emergency Reserve Fund was approximately $10 million, which represents approximately 14.3% of budgeted operating expenditures in FY 2007.

Leasing/Lease-Purchase. Under lease financing, one party owns a capital item and leases it to a "using" party. The party owning the capital item is called a lessor, and this party leases the item to a lessee. The lessor retains tax advantages of asset ownership with the lessee paying a rent or lease payment to the lessor. In some cases, there is a purchase provision in the lease. This provision allows the lessee to purchase the capital item during or at the end of the lease period for some predetermined amount, based on an agreed-on formula. This scenario is known as a lease-purchase agreement.

Leasing and lease-purchase financing is particularly relevant in Arizona where municipalities can establish tax-exempt entities that have the capacity to issue debt. These entities, called municipal property corporations (MPCs), issue debt, with the proceeds used to purchase or construct capital facilities. These facilities are then leased back to the sponsoring utility. In this way, municipalities are able to circumvent the voter approval process for both general obligation and revenue bonds that is required in Arizona.

Interest rates on debt issued by an MPC are usually similar to the interest rates on municipal revenue bonds.

Certificates of Participation. Certificates of participation (COPs) are used in conjunction with a leasing or rental arrangement. COPs are securities that are backed by an interest in a stream of rental or lease payments. The issuer is typically a governmental entity such as an MPC. COPs are typically only used in situations where the issuing entity is unable to issue bonds, since the interest rates on COPs are usually somewhat higher.

Federal/State Grants. Federal and state grants are another potential funding source for County utility capital projects. A grant is a sum of money awarded to an eligible entity without a demand for repayment. Typically, grants are awarded by the federal government to State or local governments, or by States to local governments, for the purpose of financing a particular activity or facility.

Grant funding, particularly for wastewater facilities, used to be much more prevalent. In fact, a large portion of the country's sewer infrastructure was financed with Clean Water Act grants. However, over the past several years, the federal government has all but eliminated its grant programs reflecting the philosophy that utilities should be self-sustaining.

Since there are no requirements for the repayment of grants, these are very low cost financing tools. However, there is intense competition for a very limited supply of grant funding and typically these grants are reserved for municipalities that are unable to utilize other financing tools. In addition, grant funds often have conditions that affect the scope, intent, nature or cost of the project or program in question, therefore, by accessing these funds, a County utility may have to forfeit a significant amount of control over the project.

Government Loans. There are a number of government agencies that offer loans to municipalities to fund infrastructure improvements. In fact, the SRFs discussed previously are a form of government loan. The U.S. Department of Agriculture has a number of loan programs designed to aid communities in need of funds to construct utility improvements; however, most of these programs are designed for use by rural utilities and therefore are typically not available to large municipalities. As with SRF funds and government grants, competition for these funds is fierce and priority is generally given to municipalities that are disadvantaged in some way.

Direct Source. Direct source is a financing mechanism whereby the supplier of a piece of equipment provides financing. The utility then makes regularly scheduled payments to the supplier. This financing tool is generally not appropriate for large scale projects and is typically only used to finance individual components of a project. However, some of the private financing methods described later in this report

are, in a sense, forms of direct source financing whereby the private contractor that builds a facility is the direct source supplier and the utility agrees contractually to make regular payments to the contractor.

12.4.2.2 Non-Traditional Public Financing Options

12.4.2.2.1 Interest Rate Swaps, Synthetic Fixed or Variable Rate Debt, and other Derivative Products

The municipal derivatives market has grown significantly over the past decade. A number of state and local governments are now executing derivative transactions to reduce borrowing costs, hedge existing assets and liabilities, and improve strategic timing for market access, among other reasons.

Most common use for derivatives in the municipal market is the execution of interest rate swaps. An interest rate swap is a contractual agreement between two parties, generally the issuer and a counterparty (usually a bank or investment bank), to exchange interest rates for a set period of time. In a typical interest rate swap transaction one party agrees to pay a fixed rate in exchange for a floating rate from the other party. Interest payments are calculated based on a "notional" amount and include only interest; no principal is exchanged. Another form of interest rate swap, referred to as a "basis swap", involves the two parties making payments to each other based on separate floating rates. Basis swaps are less common with municipal issuers.

An interest rate swap often can be used to achieve financing objectives at a cost lower than with more traditional financing methods. For example, an issuer considering long-term financing may issue fixed rates bonds and then enter into a *variable payer swap* for the construction period. In a variable payer swap the issuer agrees to make floating payments and receive fixed payments over the swap term. In doing so, the issuer has established the equivalent of variable rate construction period financing and has avoided the costs associated typically with issuing variable rate debt (e.g. letter of credit fees, remarketing fees). Conversely, in a *fixed payer swap* the issuer pays a fixed rate and receives a variable rate. Issuers typically enter into a fixed payer swap to hedge against the interest rate volatility of variable-rate debt. Floating rate payments received by the issuer will effectively cancel out the issuer's variable rate debt exposure, which essentially converts the issuer to a net fixed rate payer. These types of bond related swaps provide what is known as *synthetic rate debt*.

Synthetic rate debt may be either fixed or variable, and it may provide some significant advantages. As discussed above, synthetic variable rate debt can be used as an alternative to other types of short-term variable tax-exempt debt (VRDOs, notes, commercial paper, etc.) to avoid the additional costs associated with a securing a liquidity facility, credit facility, and/or remarketing services. Additionally, at times the swap market may yield opportunities in which fixed rate synthetic debt or variable rate synthetic debt could actually provide lower rates than what is available through traditional sources of financing.

Another common type of derivative used by municipal issuers is called a *swaption*. A swaption provides a means of synthetic bond refunding by allowing an issuer to sell a counterparty an option to enter into a future swap. The premium paid by the counterparty is an upfront payment, which results in an immediate savings to the issuer. A swaption may be attractive to an issuer that is considering an advanced refunding of existing fixed rate debt. An advanced refunding means that the issuer will actually issue new bonds

prior to the call-date on the existing bonds in an effort to invest the proceeds at a rate higher than what will be paid on the new bonds. An effective advanced refunding provides the issuer a positive carry, or arbitrage opportunity, as it will be earning the incremental return above its new cost of money. However, at certain times conditions will not facilitate an opportunity for arbitrage, as the interest rate an issuer could earn on newly borrowed funds is not sufficient to cover the interest rate on the existing bond; this is known as negative arbitrage. For example, an issuer with fixed rate debt contemplating an advanced refunding finds that negative arbitrage prohibits an effective refunding. As an alternative, the issuer sells to a counterparty the option to enter into a swap at some future date, which is usually the call date of the existing fixed rate bonds. The swap would require the issuer to pay the counterparty a fixed rate while receiving a variable rate. The agreement can usually be structured such that the issuers continuing payments under the swap agreement, if exercised, would be virtually the same as its existing fixed payments. If the swap is exercised the issuer would call the old bonds and issue variable rate refunding bonds. The variable rate received by the counterparty would offset the variable rate payments due by the issuer, and the issuer would continue to make fixed rate payments at the same level as before. Savings to the issuer would be the premium it retained for entering into the swaption, which could be quite large depending on the market rates of interest at the time of the option sale.

Although interest rate swaps can be an attractive mechanism to lower borrowing costs they are not without risk. An issuer considering an interest rate swap or similar transaction needs to fully understand the obligations of the agreement, as well as the associated risks which generally include:

- *Interest Rate Risk* – Risk that rates will increase or decrease affecting the interest rate swap's cash flow and market value.
- *Basis Risk* – At times, there can be a mismatch between the interest rate received by the issuer and the interest rate payable on the issuer's related debt service obligation. For example, in a fixed payer swap the floating rate received by the issuer may not exactly equal the floating rate payable by the receiver on the variable rate bonds it is hedging.
- *Termination Risks* – An interest rate swap could be terminated prior to its scheduled termination date as a result of various circumstances outlined in the agreement. The termination could be related to either party for reasons such as payment default, bankruptcy, covenant default, or certain ratings downgrades. Upon an early termination, a substantial mark-to-market payment could be due or payable based on the current value of the transaction.
- *Amortization Risk* – Risk of a mismatch between the principal value and notional amount of the related interest rate swap.

It is important for a utility to consider all of these risks prior to entering into a derivative transaction. If a utility is considering the use of derivatives, it should first determine whether it has the legal authority to engage in such a transaction. Should legal authority exist, bond counsel should be consulted to determine whether the existing indenture requires revision to cover these types of transactions.

12.4.2.2.2 Alternative User Fees and Charges

Many utilities develop alternative user fees or charges when operating and capital costs related to a specific purpose are readily identifiable and can be determined with reasonable accuracy. When this is the case, it can make sense for a utility to un-bundle the specific costs associated with a particular cost-category or driver, and develop an alternative fee or charge as a method of cost recovery. Although

specific user fees usually require that customers only be assessed the fee if they exercise the option to use the service, a number of utilities have developed alternative fees or charges that apply to all customers as a result of specific utility initiatives, such as meeting regulatory requirements. For example, a utility faced with significant capital costs to meet environmental regulations may consider recovering these costs through an "Environmental Fee". Environmental Fees should be based on cost of service principles and be assessed proportionately to all customers. It is important to remember, however, that although costs associated with an Environmental Fee would not be recovered through general user rates, the ultimate impact on customers would be essentially the same.

12.4.2.3 Private Financing

As discussed in Section 12.3, tax-exempt public financing offers to local government wastewater utilities in the United States the opportunity to finance wastewater capital facilities at extremely low costs. Nowhere else in the world do utilities have the ability to borrow at rates that are at tax-exempt levels. As a result, there has to be persuasive reasons why a government utility eligible for tax-exempt financing would consider private financing for wastewater utility assets. This section discusses the background of private sector financing and evaluates private financing as an alternative for water and wastewater utility facilities in the United States and internationally.

12.4.2.3.1 Overview of Private Financing

Globally, private sector capital has become commonplace in supporting water and wastewater utility construction and permanent financing. At one time, industrialized and newly developing countries primarily used host country governmental funds to finance utility assets. In disadvantaged, developing countries, it is challenging, if not impossible, to generate adequate funds to support environmental, as well as other public works infrastructure. As a result, international lending organizations were established as a response to an overwhelming infrastructure need worldwide. Prominent "nonprofit" lenders that were created to address these needs include the World Bank, the Inter-American Development Bank, and the Asian Development Bank.

The private sector has emerged as a major force in institutionalized financing of global water and wastewater infrastructure. In addition to serving industrialized countries, sophisticated international private contractors have developed a strong understanding of the role of worldwide lending institutions and have assisted needy countries in gaining access to low interest loans and grants to build water and wastewater facilities. Particularly over the last ten years, international private contractors have become more sophisticated in understanding the risks of providing water service in various international locations. At the same time, international lending institutions have become more sophisticated in developing relevant financing products that have been used creatively to finance worldwide infrastructure at affordable costs. Increased financing sophistication of private contractors and improved financing methods offer attractive alternatives to countries that may not otherwise be able to afford or construct needed water improvements.

In the United States, a different approach to financing water and wastewater facilities has evolved in addressing environmental requirements and public demands. As Americans have become aware of the health requirements to have safe, potable water supplies for public and commercial purposes, the water industry emerged as a major force in public works in the United States. Americans have prioritized water

quality as a major public policy issue, and through its political representatives, passed laws to mandate improved water supply and delivery systems.

In the 1900s a two-tiered approach to providing water service emerged. In many cases, government utilities were formed to address water service requirements of growing communities. Many times these utilities took the form of water departments of city and county governments. As an alternative, stand-alone government utility authorities were created. Given the priority placed on water quality, grant and low interest loans became available to assist government agencies in building needed infrastructure. At the same time, private water companies took the initiative to build water infrastructure to address existing residential, commercial, and industrial consumer requirements. In some cases, developers built and operated water facilities to support property and housing sales. As a result, water service by the private sector also became a well-established institution in the United States.

To protect the public from the potentially monopolistic position of investor-owned water companies, public service commissions were established. The objective of these commissions was primarily to insure through regulation, affordable, cost-effective, and environmentally safe water supply to the public. Today, major investor-owned water utilities (IOUs) that are regulated by public service commissions, such as Arizona Corporation Commission, include:

- American Water Works Company
- Aqua America (Philadelphia Suburban Water Company)
- Elizabeth Town Water Company
- California Water Company
- Middlessex Water Company
- United Water Services

To assist government agencies in providing water service, tax laws were passed which allowed government agencies to borrow at attractive tax-exempt interest rates. An entire financing industry developed around the planning, structuring, and delivery of tax-exempt debt to government agencies. Tax-exempt instruments such as revenue bonds and general obligation bonds (described in Section 13.3), have become commonplace in offering low cost, tax-exempt financing to government utilities. Major investment banking firms that specialize in issuing tax-exempt debt on behalf of their government utility clients include:

- Paine Webber
- Bank of America
- Merrill Lynch
- Bear, Stearns
- Morgan Stanley
- Goldman Sachs
- J.P. Morgan
- Citigroup

Initially, public policy limited tax-exempt financing to only governmental agencies. Private water companies were not eligible for these favorable financing instruments. As a consequence, private water companies have had to borrow at levels historically two to three percentage points higher than tax-exempt

debt. Financing methods of the private sector have therefore been more expensive with additional interest rate costs being passed to consumers, typically through water rates.

Today, private activity bonds (PABs) and state revolving funds (SRFs) have become available to the private sector under certain circumstances for financing needed water facilities. These long-term debt instruments carry with them interest rates comparable to tax-exempt debt, and provide additional opportunities to the private sector to compete with public financing approaches.

In general, public tax-exempt financing is the "method of choice" for government agencies, such as Pima County, for financing major water and wastewater infrastructure. This option is appealing, primarily because of easy access to low cost, tax-exempt debt. There are instances, however, when private financing offers an attractive alternative to public financing. Approaches have been developed internationally as well as in the United States to provide competitive financing alternatives. In this section, private financing approaches within the United States will be discussed, as will the merits of private financing to Pima County.

12.4.2.3.2 Private Financing within the United States

As discussed earlier, the private sector's entry into the water industry was primarily through IOUs or as private water companies supporting a real estate development, industrial operation, or commercial activity. In the United Sates, there are over 80,000 private water service providers. The vast majority of these providers serve very small systems.

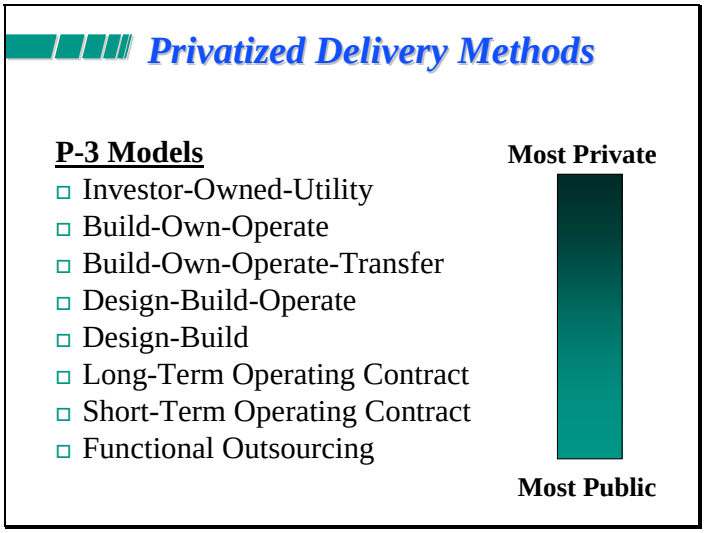
In the last twenty years, however, a paradigm shift has taken place in the water and wastewater industry. Smaller service providers are being purchased by government utilities or larger water companies. At the same time, private contractors are taking a more aggressive role in providing contract operations to government utilities. Even though there are some exceptions, (e.g., Houston, New Orleans, Atlanta, etc.) the vast majority of privatized operations are for small to medium size communities. Furthermore, contract operations have focused primarily on treatment plants rather than distribution systems, customer services, and administrative support. Major private contractors providing contract operations around the United States include:

- US Water (Bechtel Enterprises)
- AnglianAmerican Environmental Technologies (American Water Works Company and Anglian Water Company)
- United Water Resources (Suez Lyonnaise)
- Operations Management International (CH2M Hill)
- Earthtech (TYCO International Limited, LTD)
- Aqua Alliance – Veolia Water

Most of these organizations have legal and financial affiliations with larger worldwide international private contractors. (These affiliated larger firms are indicated above in parentheses.) As a result of the evolution of the water industry in the United States, the major private service providers are investor-owned water utilities and large private contractors with international affiliates. As depicted in **Figure 12-2** these companies provide a wide variety of privatization services ranging from functional outsourcing

(contracting out functional activities of the utility) to full privatization (investor-owned utility ownership and operations).

Figure 12-2
Privatized Delivery Methods



The alternative delivery study currently being performed for Pima County has focused on assessing privatization delivery methods (with certain variations) with traditional build-own operate approaches.

12.4.2.3.3 Private Financing Approaches in the United States

There are several methods used by IOUs and private contractors in financing capital facilities in the United States. These financing methods are discussed below.

Short-term Taxable Debt. Short-term notes, commercial paper, and commercial loans are used extensively by private contractors to finance smaller capital items (vehicles, equipment, capitalized repairs, etc.). In addition, these sources are used, along with equity, to provide bridge financing for permanent long-term financing. Many times the short-term market is used when long-term lending rates are unfavorable, and the private contractor would like to "buy some time" before the permanent financing is used.

The short-term market has the advantage of being relatively simple to access with little issuance and administrative costs. The major disadvantage of short-term financing is that it does not offer a long-term, permanent solution to a utility's financing needs. When short-term borrowing is used (less than five years), attractive taxable interest rates of 5 ½ to 6% can usually be realized by preferred borrowers in today's market.

Private Activity Bonds (PABs). PABs are the creation of Congress and the Internal Revenue Service whereby private developers can borrow at tax-exempt rates to build facilities used for specific public purposes. Each state is authorized to issue PABs based on a ceiling of $50 per capita in the state.

Each state has specific rules for the use of PABs. In Arizona, the PABs are distributed accordingly:

- 35% – Single-family mortgages
- 20% – Student loans
- 15% – Manufacturers
- 15% – Director's discretion
- 15% – All others

Only 30% of the PABs are available for water and wastewater related projects. According to Arizona Department of Commerce staff, the director's allocation is used to promote manufacturing jobs, which leaves only 15% of the PABs available for water and wastewater projects, as well as other needs. As a result, very few PABs have been used for public water and wastewater projects. There is a move to explore removing the PABs cap for water and wastewater projects, but it is unlikely this will occur in time to potentially benefit the PCRWRD.

PABs have the advantage of being tax-exempt and can compete at interest rates comparable to public finance. There are several administrative steps that are required before PABs can be issued. Typically, an economic agency of the government is required to sponsor PABs. In the case of Pima County, it is the Arizona Department of Commerce. PABs are popular to private contractors because they allow them to reduce their overall cost of capital by using tax-exempt debt. It is highly unlikely, however, that PABs would provide a meaningful level of funding for PCRWRD's CIP.

Taxable Bonds. Historically, taxable debt has been used routinely by IOUs and private water companies in financing capital facilities. As with tax-exempt bonds, all of the major investment banking firms are heavily involved in structuring and issuing taxable bonds. In today's market, taxable bond interest rates are about 1½ to 2% higher than tax-exempt debt; this premium translates into taxable bond interest rates of 6½-7%. Many times, because of major corporate guarantees, taxable debt can be issued without specific credit enhancements such as bond coverage requirements, insurance, reserve fund requirements, and high issuance expense.

Equity. Equity is defined as investment of capital for the purpose of earning a return to owners or investors. For water IOUs, state public service commissions typically mandate that utility capital structures include a significant portion of equity. Even though the mandated percentage of equity varies from state to state, public service commissions usually require about 30-50% of the capital structure to be equity. While the ACC previously had a mandated percentage of equity, according to ACC staff, this requirement has been removed. Commercial lenders tend to be somewhat more flexible than public service commissions in allowing a lower percent of equity to be required in structuring a deal. In today's capital markets, lending institutions usually require a minimum requirement of about 20% equity.

The advantage of equity is that it is flexible, requires little administration to issue and to use, and can be accessed relatively easily. The major disadvantage of equity is that it requires a higher rate of return to reward stockholders for their investment in a specific project.

State Revolving Funds (SRFs). As discussed in Section II, SRFs are available for privately owned projects in Arizona. The major advantage of SRF financing is that it provides access to capital markets at interest rates somewhat lower than taxable debt. In Arizona, SRF interest rates for private projects are calculated at 75% of the prime commercial rate. In today's market, this calculation translates into a lending rate of about 5-6% interest. Private contractors have argued that the heavy administrative and compliance requirements to get SRF financing authorized for a project does not justify the interest rate differential over taxable debt. In Arizona, SRFs have been used by private contractors for smaller projects ($10,000-50,000). In summary, SRF funds will not likely be a strong alternative to private contractors for funding major aspects of the PCRWRD capital plan because:

- The amount of funding will likely be small;
- The County's recent use of SRF funds may limit the amount of SRF funding available for County projects;
- The availability of funds will be in competition with small priority projects in Arizona;
- The interest rate differential between SRFs (5-6%) and taxable bonds (6-7%) does not offer a significant financing cost advantage; and
- The administration to apply for and comply with SRF requirements adds cost and effort for the private contractor.

Tax-Exempt Corporation. It may be possible for a private company to use tax-exempt MPCs to secure project financing. This might be accomplished in much the same way that the Pima County could utilize the CIC, as described in the discussion on public financing options. The only difference would be that in this case the private company, instead of Pima County, would make lease payments to the CIC. However, conversations with bond counsel, financial advisors and representative of state financing agencies indicate that financing obtained in this way would be subject to the volume cap restrictions that apply to PABs. Therefore, there may not be any advantages to using a tax-exempt corporation when compared to traditional PABs.

12.4.2.3.4 Private Financing Case Studies in the United States

Historically, most IOU and private water company projects have been privately financed. Over the past ten years, these companies have been aggressive in seeking PABs at tax-exempt interest rates. Examples of water projects that have been financed through PABs include:

- Boise, Idaho
- Illinois American
- Tennessee American
- United Water New Jersey
- United Water New York

In addition, private capital has been used on projects that involved a partnership relationship with the local municipality and government utility. Successfully financed projects include:

- Town of Cranston, Rhode Island Wastewater Plant
- City of Franklin, Ohio Water Plant

- Design/Build/Operate Improvement and Operate Contracts with:
  - City of Wilmington, Delaware
  - Miami Conservancy District, Ohio
  - City of North Brunswick, New Jersey

12.4.2.3.5 Evaluation of Private Financing Options

The advantages and disadvantages of various finance methods available to the private contractor are summarized in **Figure 12-3.**

Figure 12-3
Evaluation of Private Financing Options

	Evaluation Criteria									
	Applicability	Legality	Administration and Compliance Requirements	Issuance Cost	Effective Interest Rate	Interest Rate Risk	Attractiveness to Vendors	Rate Stability	Off Balance Sheet Financing Effects	Economic Risk of Tax Requirement Non-Compliance
Short-Term Taxable Debt	3	5	4	3	2	3	4	3	5	5
Private Activity Bonds	4	4	2	3	4	4	5	4	4	2
Taxable Bonds	4	5	4	2	2	4	3	3	5	5
Investment Capital	4	5	5	5	1	5	1	5	5	5
State Revolving Funds	1	3	1	4	5	5	5	2	3	1
Tax-exempt Corporation	2	2	3	4	4	4	3	3	5	1

5 – Most effectively addresses the evaluation criteria
1 – Least effectively addresses the evaluation criteria

While private financing may have some benefits for PCRWRD, it does not appear that any of the private financing tools discussed above are applicable for inclusion in the Baseline Financing Plan for the PCRWRD. However, PCRWRD should continue to explore private financing opportunities that may be utilized in conjunction with the alternative project delivery methods discussed in Chapter 10.

12.4.3 Baseline Financing Plan

12.4.3.1 PCRWRD Long-term Capital Needs

The annual cash needed to construct the required facilities over the next 15 years is provided on **Figure 12-4** (ROMP Projects) and **Figure 12-5** (Non-ROMP Projects). The entire PCRWRD CIP is presented in **Figure 12-6**.

Figure 12-4
PCRWRD CIP - ROMP Projects ($ Millions)

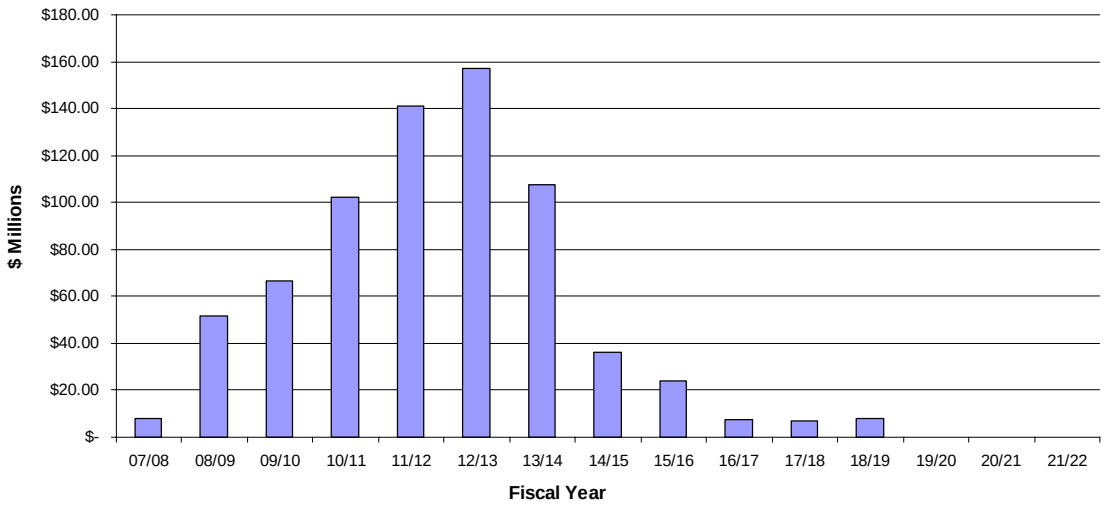


Figure 12-5
PCRWRD CIP – Non-ROMP Projects ($ Millions)

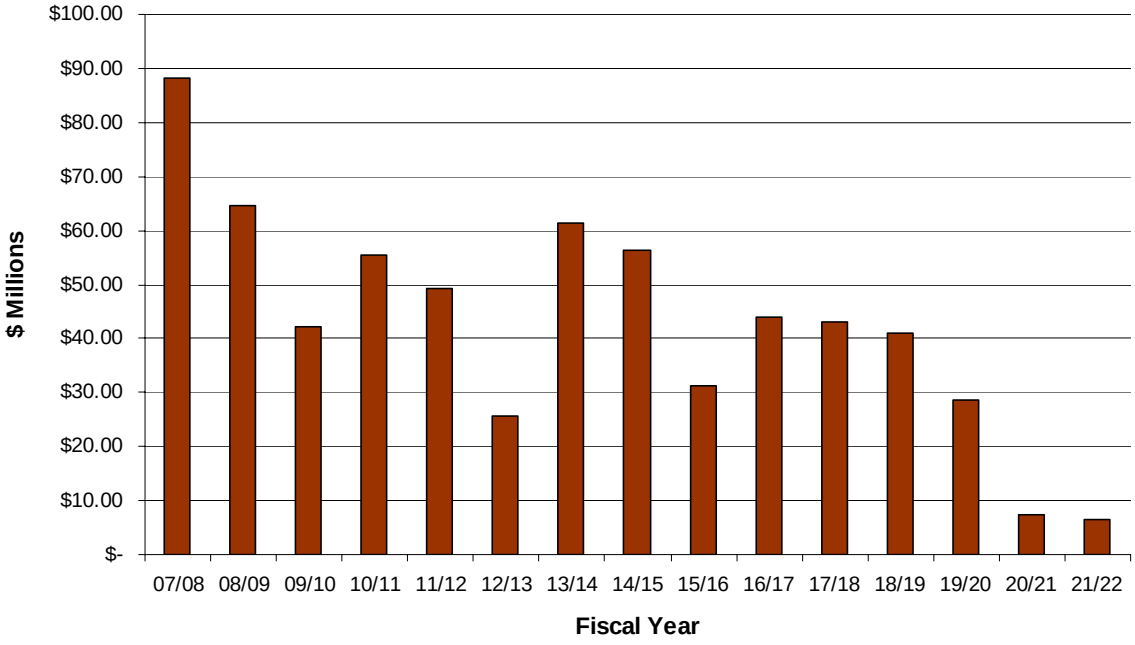
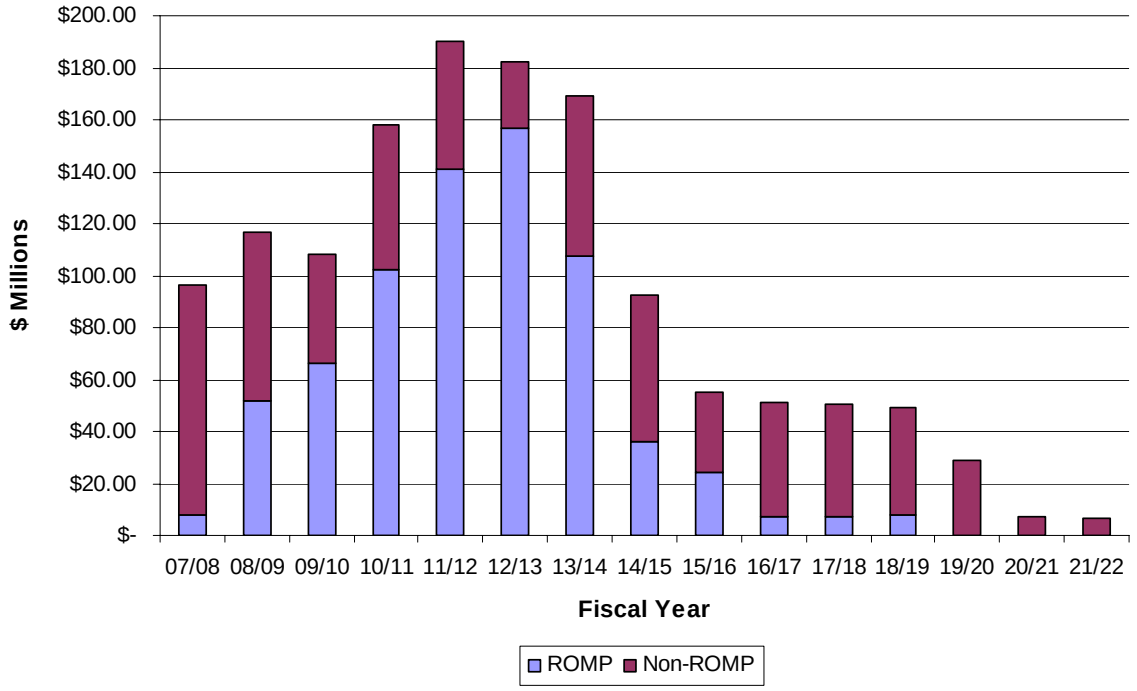


Figure 12-6
PCRWRD Capital Improvements Plan ($ Millions)



12.4.3.2 Identification of Funding Sources

No attempt was made to include the entire universe of financing options that are available in today's financial markets. However, a concerted effort was made to explore all financing tools that might be relevant to capital planning scenarios outlined for PCRWRD. Those financing tools that were considered to be relevant were described in the previous section of this report. After additional examination of each of these financing options, it was determined that while all of the listed tools had relevance to the PCRWRD's capital program, the probability that some of the options would or could be utilized was low. As a result, several of the financing tools were eliminated prior to final evaluation. Some of the financing options that were eliminated from consideration were disregarded because of marginal ratings with regard to several of the previously described evaluation criteria. For instance, direct source financing received low ratings for Effective Interest Rate, Applicability to a project of this size, and Attractiveness to Vendors. Other financing options were eliminated from consideration because they were rated extremely low in one particular category. For example, government loans received a very low Applicability rating because these loans are typically reserved for borrowers that are unable to access other funding sources and since PCRWRD is capable of receiving funding from a variety of other sources, it was decided that government loans were a very unlikely source of funding for the project.

Figure 12-7 presents the public financing tools that were included in the final evaluation and shows their ratings with regard to each of the different evaluation criteria. Each financing tool received a 1 to 5 rating

in each of the criteria, with a 5 indicating that the financing tool is most effective in addressing PCRWRD's financing objectives with regard to the corresponding criterion, and a 1 rating indicates that the tool is not effective in addressing the PCRWRD's objectives

Figure 12-7
Matrix for the Evaluation of Public Financing Options

	Evaluation Criteria									
	Applicability	Legality	Administration and Compliance Requirements	Issuance Cost	Effective Interest Rate	Interest Rate Risk	Attractiveness to Vendors	Rate Stability	Off Balance Sheet Financing Effects	Economic Risk of Tax Requirement Non-compliance
Short-Term Tax-Exempt Debt (notes, commercial paper, etc.)	4	5	2	3	4	2	4	3	1	3
Revenue Bonds/Double Barrel Bonds	5	5	4	4	3	4	4	5	1	4
General Obligation Bonds	2	5	3	4	4	4	4	5	1	3
Current Revenues/Reserve Funds	5	5	4	5	5	5	5	1	1	5
Lease-Purchase	2	4	3	4	3	2	4	3	3	3
State Revolving Funds	5	5	2	4	4	4	4	5	1	2
Miscellaneous (COPs, CABs, Zero Coupons, etc.)	4	4	3	4	3	2	4	3	2	3

5 – Most effectively addresses the evaluation criteria
1 – Least effectively addresses the evaluation criteria

Based on the results of the evaluation matrix, the two financing options that appear to be particularly effective for use in a baseline financing plan are revenue bonds and current revenues/reserve funds. These two financing options are discussed in more detail below.

Revenue Bonds. PCRWRD has utilized revenue bonds historically to fund the majority of its major capital initiatives. Although several of the alternatives identified above, such as general obligation bonds and SRF loans, could provide PCRWRD with a more cost-effective source of funding, certain non-economic issues related to each make revenue bonds a more attractive choice. Specifically, due to the size of the PCRWRD capital program, authorizing general obligation bonds to fund the majority of these projects could limit funding sources available for other services provided by Pima County. Even though it may be possible for PCRWRD to access a certain level of WIFA funds, the administrative hurdles would be significant and the amount of funds available would not likely be significant. Other short-term

financing alternatives could be considered initially during project construction phases as a means of lowering PCRWRD's overall cost of capital, but continuing to utilize short-term funds for long-term financing needs would place significant interest rate risk on Pima County. Since the purpose of a baseline financing plan is to provide PCRWRD a conservative estimate of the financial impacts of its capital planning initiatives, utilizing traditional financing vehicles such as revenue bonds provide a sound foundation to evaluate the potential impacts on Pima County wastewater customers.

Current Revenues – System Development Charges. As noted previously, PCRWRD assesses system development charges to new customers to offset the capital cost of growth. Since a number of the projects outlined in the CIP are related to system expansion to meet forecast demand, the baseline financing plan assumes that PCRWRD will continue to use system development charges to fund these types of projects.

Capital Funding Sources and Uses. Pima County approved $150 million in revenue bond funding in its 2004 Revenue Bond Program ("Series 2004 Bonds"). Based on the capital cost phasing plan described in Section 12.2, approximately $32.2 million of the Series 2004 Bonds will need to be used to fund ROMP projects with the remainder being used to fund other projects in the CIP. Also, Pima County would need to authorize an additional $565 million in bonds in its 2008 Revenue Bond Program ("Series 2008 Bonds"), approximately $399 million in its 2012 Revenue Bond Program ("Series 2012 Bonds") and approximately $153 million in its 2016 Revenue Bond Program ("Series 2016 Bonds"). The remaining funding requirements will be addressed with balances in the System Development Fund. **Figure 12-8** provides a summary of the baseline financing plan.

Figure 12-8
Capital Funding Sources and Uses

1997 Bonds		**$**	**3,945,440**
	Other CIP	*$*	*3,945,440*
2004 Bonds		**$**	**150,000,000**
	ROMP Projects	*$*	*32,283,125*
	Other CIP	*$*	*117,716,875*
SDF's		**$**	**144,964,660**
	Other CIP	*$*	*144,964,660*
2008 Bonds		**$**	**565,000,000**
	ROMP Projects	*$*	*445,000,000*
	Other CIP	*$*	*120,000,000*
2012 Bonds		**$**	**398,698,624**
	ROMP Projects	*$*	*227,228,957*
	Other CIP	*$*	*171,469,666*
2016 Bonds		**$**	**153,341,187**
	ROMP Projects	*$*	*1,767,905*
	Other CIP	*$*	*151,573,282*
Total ROMP Projects		$	706,279,987
Total Other CIP Projects		$	709,669,924
Total Capital Plan		**$**	**1,415,949,911**

As shown above, the CIP will, for the most part, be funded with a combination of the proceeds for revenue bonds, cash reserves and rate revenues. However, the County and the Project Team will continue to pursue financing options that will ultimately reduce the financial impact of the CIP on PCRWRD's customers.

12.4.3.3 Customer Rate Impacts

In order to assess the potential financial impact of the proposed CIP and financing plan, a model was developed to calculate the estimated impact on the bill of a typical customer. The model allowed for the input of project cost and project phasing/sequencing information, which was used to develop annual capital needs for each year of the planning period. These annual capital needs were then translated into capital revenue requirements based on the Baseline Financing Plan described in this chapter. These capital revenue requirements consist of debt service and cash needed to either fund projects or ensure that the PCRWRD would meet its debt service coverage requirements. These capital revenue requirements are then combined with O&M expenses to arrive at the utility's total revenue requirements for each year as shown in **Figure 12-9.** Total revenue requirements represent the amount of money that PCRWRD must generate each year from it various revenue sources, including User Charges and Connection Fees, to provide service and support the proposed CIP.

Figure 12-9
Revenue Requirements

	2007	2008	2009	2010	2011	2012	2013	2014
Revenue Requirements ($ Mil.)								
Operating & Maintenance (1)	$ 75.4	$ 77.9	$ 81.2	$ 84.3	$ 87.5	$ 90.8	$ 94.2	$ 99.0
Capital								
Debt Service	$ 15.5	$ 26.2	$ 26.2	$ 43.4	$ 43.4	$ 75.8	$ 75.3	$ 108.7
Direct CIP Funding (Cash)	$ 22.5	$ 22.9	$ 48.1	$ 9.2	$ 15.4	$ 6.8	$ 2.0	$ 2.0
Total Revenue Requirements	**$ 113.4**	**$ 127.0**	**$ 155.5**	**$ 136.9**	**$ 146.3**	**$ 173.4**	**$ 171.6**	**$ 209.6**
% Change		*12.0%*	*22.5%*	*-12.0%*	*6.9%*	*18.5%*	*-1.1%*	*22.2%*

	2015	2016	2017	2018	2019	2020	2021	2022
Revenue Requirements ($ Mil.)								
Operating & Maintenance (1)	$ 104.6	$ 108.7	$ 112.3	$ 116.1	$ 120.0	$ 124.0	$ 128.1	$ 132.4
Capital								
Debt Service	$ 109.3	$ 124.6	$ 116.3	$ 120.6	$ 120.6	$ 128.1	$ 128.1	$ 129.2
Direct CIP Funding (Cash)	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0
Total Revenue Requirements	$ 215.9	$ 235.3	$ 230.6	$ 238.6	$ 242.5	$ 254.1	$ 258.2	$ 263.6
% Change	*3.0%*	*9.0%*	*-2.0%*	*3.5%*	*1.6%*	*4.8%*	*1.6%*	*2.1%*

(1) Includes departmental capital outlays.

Also shown on the above figure is the percent change in revenue requirements from year to year. This number gives a general indication of the magnitude of the increase in rates and charges that will be required. **Figure 12-10** shows how the increases in revenue requirements might impact the bills that customers pay.

Figure 12-10
Impacts on Customer Bills

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Typical Customer Bill (1)	$ 18.98	$ 21.56	$ 25.21	$ 27.90	$ 30.89	$ 34.23	$ 37.33	$ 40.71
% Change		*13.6%*	*16.9%*	*10.6%*	*10.7%*	*10.8%*	*9.0%*	*9.1%*
Connection Fee (2)	$ 4,724	$ 5,308	$ 6,364	$ 7,151	$ 8,035	$ 9,028	$ 9,953	$ 10,973
% Change		*12.4%*	*19.9%*	*12.4%*	*12.4%*	*12.4%*	*10.3%*	*10.3%*

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Typical Customer Bill (1)	$ 40.71	$ 43.12	$ 43.12	$ 43.86	$ 46.05	$ 46.05	$ 46.05	$ 46.05
% Change	*0.0%*	*5.9%*	*0.0%*	*1.7%*	*5.0%*	*0.0%*	*0.0%*	*0.0%*
Connection Fee (2)	$ 10,973	$ 11,698	$ 11,698	$ 11,899	$ 12,494	$ 12,494	$ 12,494	$ 12,494
% Change	0.0%	*6.6%*	*0.0%*	*1.7%*	*5.0%*	*0.0%*	*0.0%*	*0.0%*

(1) Represents the monthly sewer bill for a 10ccf customer.
(2) Non-participating connection fees.

12.4.3.4 Financing Terms

PCRWRD typically uses 15-year bonds rather than 20-year or 30-years bonds to fund its major capital projects. The primary benefit of using 15-year bonds is that the overall cost of borrowing to the County is lower than if longer-term financing is selected. However, since principal repayment on 15-year bonds, as compared to 20-year or 30-year bonds, is required more quickly, there is additional pressure on revenue requirements over the short-term to meet debt service payments, including coverage. Although the continued use of 15-year bonds represents a reasonable, prudent funding strategy, in light of the significant size of the PCRWRD CIP, the financial analysis included an assessment of the potential impacts of extending the repayment terms in the Baseline Financing Plan beyond the traditional 15 years. **Figure 12-11** and **Figure 12-12**, respectively, present the potential customer impacts of using 20-year and 30-year bonds.

Figure 12-11
Impacts on Customer Bills (20-Year Bonds)

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Typical Customer Bill (1)	$ 18.98	$ 21.56	$ 25.21	$ 27.45	$ 29.90	$ 32.57	$ 34.91	$ 37.43
% Change		*13.6%*	*16.9%*	*8.9%*	*8.9%*	*9.0%*	*7.2%*	*7.2%*
Connection Fee (2)	$ 4,724	$ 5,308	$ 6,364	$ 7,017	$ 7,736	$ 8,529	$ 9,225	$ 9,977
% Change		*12.4%*	*19.9%*	*10.3%*	*10.3%*	*10.3%*	*8.2%*	*8.2%*

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Typical Customer Bill (1)	$ 37.43	$ 39.97	$ 39.97	$ 39.97	$ 42.73	$ 42.73	$ 42.73	$ 42.73
% Change	*0.0%*	*6.8%*	*0.0%*	*0.0%*	*6.9%*	*0.0%*	*0.0%*	*0.0%*
Connection Fee (2)	$ 9,977	$ 10,740	$ 10,740	$ 10,740	$ 11,483	$ 11,483	$ 11,483	$ 11,483
% Change	0.0%	*7.6%*	*0.0%*	*0.0%*	*6.9%*	*0.0%*	*0.0%*	*0.0%*

(1) Represents the monthly sewer bill for a 10ccf customer.
(2) Non-participating connection fees.

Figure 12-12
Impacts on Customer Bills (30-Year Bonds)

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Typical Customer Bill (1)	$ 18.98	$ 21.56	$ 25.21	$ 27.00	$ 28.91	$ 30.98	$ 32.63	$ 34.39
% Change		*13.6%*	*16.9%*	*7.1%*	*7.1%*	*7.1%*	*5.3%*	*5.4%*
Connection Fee (2)	$ 4,724	$ 5,308	$ 6,364	$ 6,884	$ 7,445	$ 8,053	$ 8,543	$ 9,064
% Change		*12.4%*	*19.9%*	*8.2%*	*8.2%*	*8.2%*	*6.1%*	*6.1%*

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Typical Customer Bill (1)	$ 34.39	$ 36.86	$ 36.86	$ 36.86	$ 39.85	$ 39.85	$ 39.85	$ 39.85
% Change	*0.0%*	*7.2%*	*0.0%*	*0.0%*	*8.1%*	*0.0%*	*0.0%*	*0.0%*
Connection Fee (2)	$ 9,064	$ 9,803	$ 9,803	$ 9,803	$ 10,597	$ 10,597	$ 10,597	$ 10,597
% Change	0.0%	*8.2%*	*0.0%*	*0.0%*	*8.1%*	*0.0%*	*0.0%*	*0.0%*

(1) Represents the monthly sewer bill for a 10ccf customer.
(2) Non-participating connection fees.

A longer term repayment structure reduces PCRWRD's annual debt service obligation and lowers the potential impacts on customers over the planning period. However, by extending the repayment terms the total cost of borrowing increases as bond principal is retired over a longer period of time. **Figure 12-13** summarizes total borrowing costs, both principal and interest, associated with using 15-year, 20-year, or 30-year bonds in the Baseline Financing Plan.

Figure 12-13
Total Cost of Borrowing

Term	Principal (1)	Interest	Total
15	$ 1,150,551,004	$ 540,364,603	$ 1,690,915,607
20	$ 1,150,551,004	$ 735,254,630	$ 1,885,805,634
30	$ 1,150,551,004	$ 1,159,189,348	$ 2,309,740,352

(1) Principal value represents funding needs in the 2008, 2012 and 2016 revenue bonds, plus 3% issuance costs.

12.4.4 Additional Financing Consideration

Our analysis of the PCRWRD's options for funding its capital program indicates that from a broad perspective, the Baseline Financing Plan, which uses a mix of revenue bonds and cash reserves to fund the PCRWRD CIP, is the most efficient and cost effective overall capital funding approach. However, the analysis also revealed several opportunities that should be pursued further during the implementation of the CIP.

Specifically, PCRWRD should:

- **Use alternative charges to increase revenues.** The use of alternative charges such as Environmental Fees or Repair & Rehabilitation Fees may be more politically attractive than simply increasing the current rates and charges by the amount needed to generate the cash needed to implement the Baseline Financing Plan. While the out-of-pocket cost for most customers will be the same if alternative charges are developed, the use of these charges can make the increased costs more palatable.

- **Optimize current rates and charges.** In general, current Connection Fees are designed to recover the costs associated with making capacity available to new customers and User Charges are designed to recover the costs associated with the day-to-day operation, maintenance, repair and replacement of the system. Ensuring that these charges are only recovering the costs they were designed to recover from the appropriate customers should help to increase customer acceptance of the rate increases that will be necessary to implement the CIP.

- **Issue bonds with terms consistent with the life of the assets they are being used to fund.** The use of bonds with terms of 20 to 30 years more closely approximates the useful life of the assets that are included in the CIP. While the total cost of borrowing associated with longer term bonds is greater, the matching of bond terms to asset useful life has multiple benefits

including increased intergenerational equity and greater rate stability as costs are amortized over longer periods.

- **Continue to investigate the use of WIFA funds for a portion of its CIP.** While the relative lack of availability of these funds and the more stringent administrative requirements that accompany their use reduces their attractiveness, the lower interest rates associated with WIFA funds could help to mitigate adverse rate impacts.

- **Utilize short-term instruments, interest rate swaps and other derivatives.** While the use of these creative financing techniques would change PCRWRD's risk profile, other utilities in Arizona and throughout the country have demonstrated that these techniques, if used responsibly, can significantly reduce financing costs without an inordinate increase in risk.

Explore private financing options. In terms of the cost of borrowing, it is very difficult to beat tax-exempt bonds; however, the costs associated with creative financing approaches that utilize private funds have been approaching the cost of tax-exempt funding. As implementation of the CIP progresses, PCRWRD should continue to explore financing options that may be offered by private funding sources, particularly in cases where private partners are already involved in the delivery of the project. Additionally, recent legislative efforts have sought to increase the availability of Private Activity Bonds. If these efforts are successful, private financing costs could decrease dramatically.

Pima County
Regional Optimization Master Plan

Regional Optimization Master Plan Final Report

Appendices

Pima County Regional Wastewater Reclamation Department

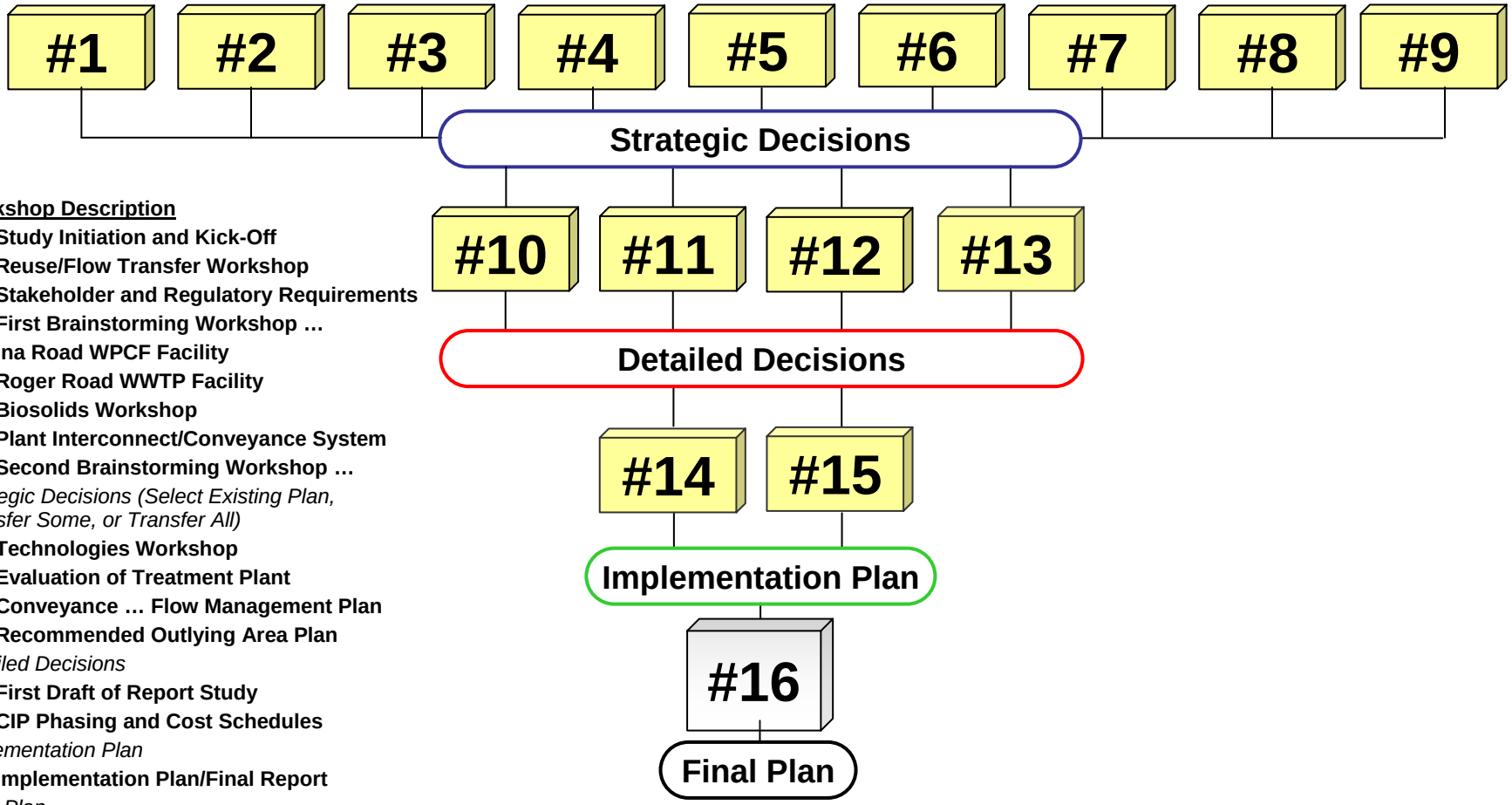
FINAL–November 2007

GREELEY AND HANSEN

APPENDIX A

Workshop Summaries

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

GREELEY AND HANSEN

Project Workshops

The goal of the master plan is to serve as a broad road map. It will identify potential roads, as well as obstacles to the implementation of Pima County Wastewater Management Department's (PCWMD) Capital Improvement Program (CIP). Through the appropriate level of evaluation, the best option will be identified and selected for implementation, without precluding changes in direction that may be prompted by future needs. This master plan will forecast needs for wastewater treatment capacity throughout the PCWMD service area and the facilities required to meet those needs through the year 2030.

The master plan will build upon several planning and engineering efforts previously performed for or by the PCWMD. The plan will identify how and when wastewater treatment facilities will be upgraded and expanded, as well as how existing facilities will be integrated into future expansions or decommissions through the year 2030. The plan will be based on current and potential future regulatory and PCWMD customer requirements. The plan will recommend a comprehensive CIP with treatment component and system alternatives, phasing schedules and cost apportionments for future implementation of PCWMD wastewater facilities.

To implement this study a series of facilitated workshops (consisting of PCWMD staff, consultants and other stakeholders) will be conducted. The workshops are central to the decision making process for the development of the master plan. All key decisions and the development of consensus will be through the facilitated workshop process.

Sixteen workshops are planned to cover the issues and concerns necessary to develop a comprehensive plan.

Project Workshops

- Workshop #1: Study Initiation and Kick-Off
- Workshop #2: Reuse/Flow Transfer Workshop
- Workshop #3: Stakeholder and Regulatory Requirements
- Workshop #4: First Brainstorming Workshop & Background Data Review
- Workshop #5: Ina Road WPCF Facility
- Workshop #6: Roger Road WWTP Facility
- Workshop #7: Biosolids Workshop
- Workshop #8: Plant Interconnect/Conveyance System
- Workshop #9: Second Brainstorming Workshop & Facility Oriented Workshop
- Workshop #10: Technologies Workshop
- Workshop #11: Evaluation of Treatment Plant
- Workshop #12: Conveyance System Alternatives/ Recommended Flow Management Plan
- Workshop #13: Recommended Outlying Area Plan
- Workshop #14: First Draft of Report Study
- Workshop #15: CIP Phasing and Cost Schedules
- Workshop #16: Presentation of Implementation Plan/Final Report

Workshop attendance will be based on a particular workshop's subject matter. Accordingly, not all will be required to participate, or attend, all scheduled workshops. Subject matters to be covered at the workshops include regulatory and customer requirements, key issues, preferences and constraints, process approaches, identification and evaluation of alternatives and other topics relative to the completion of the study.

Workshops will be conducted by a facilitator to direct the workshop process and focus workshop participants on making decisions and holding to those decisions.

- Mutual project goals that define "success" and an action plan to address potential barriers to success will be developed during these workshops.

Major Topics of Each Workshop

Each workshop will have a central theme and will build upon key decisions arrived from the previous workshops. Therefore, the sequence of workshops is important and the workshops are viewed as additive in building results. A brief summary of the major topics of each workshop follows.

- **Workshop #1: Study Initiation and Kick-Off (1-Day)**
  - Study Schedule Review and Workshop Schedule Review
  - Study Approach and Scope of Services Review
  - Study Expectations
  - Preliminary Project Implementation Schedule, Delivery Options/Funding Options
  - Identify and Review of Initial Study Alternatives
  - Opinion of Probable Cost Level
  - Background Information Available
  - Study Report Outline Review
  - Develop Evaluation Criteria
  - Identify Stakeholders

- **Workshop #2: Reuse/Flow Transfer Workshop (1-Day)**
  - Impacts of Continuation of Existing Water Reuse Plan
  - Impacts of "Transfer Some" Treatment Option
  - Impacts of "Transfer All" Treatment Option
  - Potential for "Combined Wastewater Treatment and Reuse Treatment" Reuse Option

- **Workshop #3: Stakeholder and Regulatory Requirements (1-Day)**
  - Overview of Stakeholder Discussions
  - Issue Identification – Including CMOM, GASB 34, Asset Management Overview
  - Reuse Impacts/Considerations
  - Impact of reduced discharge from Roger Road WWTP on the Santa Cruz River riparian habitats
  - Regulatory Review/Establish January 2007 ADEQ Compliance Reports
  - Review of Future Regulatory Requirements (Nutrient Control, Pharmaceuticals, Air Permits, etc.)
  - Study and Schedule Implementation

- **Workshop #4: First Brainstorming Workshop & Background Data Review (1 Day)**
  - Results of Background Data Review
  - Results of Facility Tour Visits
  - Results of Condition Evaluation of Roger Road WWTP and Ina Road WPCF
  - Develop Risk Matrix
  - Develop Alternative Evaluation Matrix
  - Brainstorm Study Alternatives
  - Finalize Flow and Loading Projections

- **Workshop #5: Ina Road WPCF Facility (1/2 Day)**
  - Ina Road WPCF Operation Practices
  - Ina Road WPCF Nutrient Removal Operation Considerations
  - Alternative Considerations
  - Impact on Existing Facilities

- **Workshop #6: Roger Road WWTP Facility (1/2 Day)**
  - Roger Road WWTP Operation Practices
  - Roger Road WWTP Nutrient Removal Operation Considerations
  - Alternative Considerations
  - Impact on Existing Facilities

- **Workshop #7: Biosolids Workshop (1/2 Day)**
  - Biosolids Regulatory Requirements/Operation Considerations
  - Biosolids State-of-the-Art Technologies/Operation Considerations
  - Biosolids Alternatives (Current/Future)
  - Biosolids and Existing Facilities

- **Workshop #8: Plant Interconnect/Conveyance System (1/2 Day)**
  - Plant Interconnect/Conveyance System Conceptual Layouts
  - Plant Interconnect Operation Considerations
  - Plant Interconnect Existing System Interface
  - Basin Model from Facility Plan
  - Use of Plant Interconnect to Share Peaks in Existing or Transfer Some Options

- **Workshop #9: Second Brainstorming Workshop & Facility Oriented Workshop (1 Day)**
  - Results of Workshops
  - Operation Practices at Other Nutrient Control Locations
  - Nutrient Control Operation Considerations
  - Conveyance System Operation Considerations
  - Impact of reduced discharge from Roger Road WWTP on the Santa Cruz River riparian habitats
  - Regulatory Compliance Plan
  - Reclaimed Water Quality
  - Effluent Water Quality Design Standards
  - Project Design Criteria

- **Workshop #10: Technologies Workshop (1-Day)**
  - Regulatory Requirements/Operation Considerations
  - State-of-the-Art Technologies/Operation Considerations (A presentation by the Consultant on relevant ammonia and nitrogen removal technologies)
  - Discussion of the inter-relationship of the Roger Road and Ina Road facilities in meeting treatment objectives (if applicable)
  - Brainstorming of applicable treatment technologies and strategies
  - Select Top Process Options to Carry Forward

- **Workshop #11: Evaluation of Treatment Plant Alternatives (1-Day)**
  - Conceptual Project Layouts
  - Treatment Facility
  - Facility Modifications and Additions
  - Impact of reduced discharge from Roger Road WWTP on the Santa Cruz River riparian habitats
  - Biosolids Treatment/Disposal/Reuse
  - Bio-Gas Generation
  - Alternate Power Supply Options
  - Power Generation Facilities
  - Laboratory Analysis

- **Workshop #12: Conveyance System Alternatives/Recommended Flow Management Plan (1-Day)**
  - Identification of Conveyance/Flow Management Alternatives
  - Conceptual/Operation Needs to Meet Flow Requirements
  - Outlying Area Evaluation/Identify Sub regional Plant Needs, if any
  - Outlying Area Guidelines
  - Developer Agreement Topics

- **Workshop #13: Recommended Outlying Area Plan (1-Day)**
  - Location/Configuration of Sub-regional Plant
  - Operations Intent
  - Preliminary Decision/Operation Needs

- **Workshop #14: First Draft of Report Study (1-Day)**
  - Presentation of Draft Report (Chapters 2 through 9)
  - Overall Treatment Strategy

- **Workshop #15: CIP Phasing and Cost Schedules (1-Day)**
  - Overall Strategy
  - Project Delivery –Alternative Delivery Methods
  - Funding Alternatives/Rate Impacts

- **Workshop #16: Presentation of Implementation Plan/Final Report (1-Day)**
  - Plan Elements
  - Agreement of Final Plan
  - Final Implementation Schedule
  - Project Delivery –Alternative Delivery Methods (Program Management Options)
  - Funding Considerations
  - Rate Impacts

Workshop #1 Meeting Notes
Study Initiation and Kick-Off

1. The Study Initiation and Kick-Off Workshop for Pima County Metropolitan Wastewater Treatment System Capacity Management, Nutrient Removal, Solids Handling/Treatment and CIP Development Study was held on April 19, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
Controller
Jeff Nichols
County Administrator's Office Water Policy
Kathy Chavez
PCWMD Staff
David Bartos
Tom Berry
Bob Decker
James Doyle
Laura Fairbanks
Frank Gall
David Garrett
Jeff Graunke
Tim Harmon
Michael Kostrzewski
David Longobardi
Frank Luiz
Jing Luo
Peter Magaddino
Tim McGarry
Byron McMillan
John Numden
Glen Peterson
Jeff Prevatt
Prakash Rao
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager

PCWMD Staff (con't)
Mandley Rust
Jack Van Riper
John Warner
Ken Weber
Eric Wieduwilt
Legal
Harlan Agnew
Chuck Wesselhoff

TUCSON WATER
Director
David Modeer
TW Staff
Jeff Biggs
Karen Dotson
Melodee Loyer
Ralph Marra
Dennis Rule
Mark Seamans
Tim Thomure

TOWN OF MARANA
Brad DeSpain

GREELEY AND HANSEN PROJECT TEAM
Orrie Albertson
Jerry Bish
Gordon Culp
Carl Koch
Eric Petersen
Joe Popeck
Andrew Richardson
Harold Smith
Joe Sullivan

2. The major topics of the workshop were:

- Workshop #1: Study Initiation and Kick-Off
  - ► Study Schedule Review and Workshop Schedule Review
  - ► Study Approach and Scope of Services Review
  - ► Study Expectations
  - ► Preliminary Project Implementation Schedule, Delivery Options/Funding Options
  - ► Identify and Review of Initial Study Alternatives
  - ► Opinion of Probable Cost Level
  - ► Background Information Available
  - ► Study Report Outline Review
  - ► Develop Evaluation Criteria
  - ► Identify Stakeholders

A handout was provided to each attendee which included all slides used during the presentation and a detailed summary of the future workshops.

Throughout the workshop, a list of notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk opened the workshop stating that this project is a regional master plan to define and establish the future wastewater management system for the County. At the start there is no option that has preference. Each option under study will be given equal weight until proven otherwise.

The approach of the study is to involve stakeholders, including all in attendance. Decisions will be made based on multi-disciplined evaluations and stakeholders input. The study will develop the right plan for the County by identifying best applicable technologies and an overall cost-effective program.

Where we go with reclaimed water is an important consideration in the overall wastewater management program for the County. Dave Modeer, Director of Tucson Water, and his staff were in attendance to cooperate in developing the right reclaimed water plan for the County.

Ron Riska was recognized as the Project Manager for PCWMD.

4. Andy Richardson defined his role as facilitator to move the group through the agenda and to encourage participation from the expertise available in the room. The purpose of this workshop and future workshops is to make decisions and to work toward informed consent, if consensus is unachievable. The emphasis is on participation and that the project is a group project.

Agenda, ground rules and objectives of the first workshop were presented and covered pages 1 through 4 of the handout.

5. Andy Richardson covered the study schedule and the future workshops descriptions. It was noted that the dates for implementation of nutrient removal at Roger Road WWTP and Ina Road WPCF (2014 and 2015, respectively) are important. The group was informed that more detail on future workshops were provided in the back of the handout. The schedule and future workshops were covered on pages 5 and 6 of the handout.

6. Joe Popeck began the review of the scope of the study by citing the goals of the study elements. The emphasis was on optimization of flow management, wastewater treatment, biosolids handling/treatment, and water reuse throughout the County. For the regional plants, three basic starting points are to be considered:

   - Maintain existing plan
   - Transfer Some Flow from Roger Road WWTP to Ina Road WPCF (treat 20 mgd ± at Roger Road WWTP)
   - Transfer All Flow from Roger Road WWTP to Ina Road WPCF

   In development of options, treatment of wastewater outside the metropolitan area will be addressed, including issues in those areas like connecting septic tanks to the collection system, treating wastewater down gradient from Ina Road WPCF, growth projections, permit limitations, and ultimate use of effluent. Long-term biosolids disposal options, conveyance system capacity and ADEQ requirements are integral to the study results along with the financing needs to support the effort.

   The decision making process of the study requires input and consideration of the stakeholders on the various elements. For scheduling short-term projects underway or those identified during the study, PCWMD management will decide on their priority. The scope of the study was covered on pages 7 through 16 of the handout.

7. Andy Richardson opened the floor of the workshop meeting to the group at large to offer study expectation and obstacles. Expectations range from developing points of synergy between Tucson Water and PCWMD to meet community needs, to creating a single comprehensive plan for PCWMD that is followed into the future. Obstacles range from affordability, legislative issues, staffing concerns, land acquisition, developing a realistic schedule for future facilities, political and environmental issues and more. Expectations and obstacles will be reviewed by the project team and PCWMD to incorporate into the study actions and results where appropriate.

   The plan needs to have a reasonable expectation for successful implementation, but meet current regulatory requirements and be flexible to meet future regulations. In addition, future considerations of Roger Road WWTP must bring it into the 21st century. Additional comments and concerns were captured on Pages 1 and 2 of the attached meeting “flip chart” notes.

8. Joe Popeck provided an overview of the project schedule which included time for design, ADEQ review and approval schedule, and construction of new facilities to meet future needs. It was noted that the current schedule for the plant interconnect is faster than that presented on the schedule, and there is a need to address this issue early. Funding was highlighted as an ongoing activity.

9. Harold Smith addressed the funding aspects of the project. Funding sources: public debt, state-revolving loans, grants, rates and charges were covered. Intergenerational equity was explained as a means to spread costs equitably to the users over a long period of time. The importance for communicating rate impacts to ratepayers and politicians is vital to producing an adequate funding stream for the required projects. The funding plan will need to recognize current bonding commitments and bonding needs of other agencies. Funding issues were covered on pages 17 through 21 of the handout.

10. Eric Petersen addressed the various delivery methods allowable under Arizona law. Issues of control with the design-bid-build process versus the construction-manager-at-risk (CMAR) versus design-build were presented to the group. The most control by the owner is provided in the traditional design-bid-build approach. With CMAR the designer and the contractor are hired separately by the owner and the project delivery is a collaborative process. With design-build delivery the submission by the competing teams is a proposal which encourages innovation to reduce costs. This latter approach gives the owner the least control over the final project. Further presentation provided the potentials benefits and drawbacks of the various delivery methods.

    By Arizona law the County could proceed with design and construction under a request for qualifications/request for proposal (RFQ/RFP) process. This process allows the county to shortlist competent and capable firms based on selective criteria. An honorarium is typically offered to the shortlisted firms to prepare proposals to meet design intent and project constraints.

    For every delivery method there are risks retained by the owner and risks transferred. From the beginning of the project through startup there are risks. On a project there are permitting, design, construction and operations and maintenance risks.

    Contractors are responsible for what is known not what is unknown. With rehabilitation projects the owner can lower costs for a project, but cannot shift risk to the contractor. This is an “as-is” risk which carries a higher risk premium for the contractor because of the potential unknowns. Higher risks result in higher bid costs.

    The plan will need to determine which projects lend themselves to alternative delivery and which projects can be bundled. The delivery methods and risks issues were covered in pages 21 through 26 of the handout.

11. Joe Popeck presented the study options and key study elements. The existing plan, transfer some and transfer all options will be looked at in the context of the new more restrictive effluent standards at Roger Road WWTP and Ina Road WPCF. Addition of “scalping” plants in the Roger Road WWTP and Ina Road WPCF sewer basins, a treatment plant north of Ina Road WPCF, and the possibility of reuse needs greater than 20 mgd near Roger Road WWTP should be evaluated. Space, constructability, operability and costs are important issues to be considered in the overall planning. The study options and key elements were covered on pages 27 through 31 in the handout.

12. Jerry Bish stated that each study option has conveyance issues that needed to be addressed. The existing plan has the transfer of some flow from the Roger Road WWTP sewer basin to the Ina Road WPCF sewer basin. There is some capacity to transfer wastewater through existing flow

management structures. This capacity appears to be limited. A plant interconnect can be sized to transfer significant flows between the water basins. Is there a cost advantage to use upstream flow management structures with the plant interconnect, or the transfer flow entirely through a plant interconnect sized for the appropriate flow? Will the Randolph Park WRF operate continuously and at what flow? The most cost effective conveyance approach in combination with treatment plant sizing will be determined through the study. With the review of the conveyance system a redundancy of where flows can be conveyed needs to be considered. Furthermore, environmental restoration projects need to be addressed when considering discharge options. The conveyance issues were covered in pages 31 through 34 in the handout.

13. Andy Richardson asked the group about the risks related to Roger Road WWTP and Ina Road WPCF. In general it was pointed out that the cost to build new is less costly than to rehabilitate facilities when considerations for keeping facilities in service during construction and the costs of selective demolition are factored into the project. In addition, the impacts of taking an element out of service for an extended period for rehabilitation must be considered. More comments related to the use of proven technologies, not leading (bleeding) edge technologies without a proven track record. Currently, there is a mixture of technologies utilized at the various County owned and operated facilities which complicates the utilization of operators from one plant to another.

    Jeff Prevatt offered that the laboratory space is quite limited and dispersed throughout the Ina Road WPCF. This results in inefficiencies in function and performance that may be relieved with temporary facilities until a permanent location is identified

14. Orrie Albertson introduced the specific needs required to select the appropriate wastewater treatment technology to meet the goals of the future permit requirements. Flow, characteristic strengths, future growth requirements, system reliability, process stability and many other factors will be included in the process evaluation. Changes in basic data such as gpcd will need significant documentation and consensus from numerous stakeholders to change.

    When asked about the biotowers at Roger Road WWTP, the preliminary evaluation suggests that they will not survive the final cut of alternatives that will meet the stringent new standards required by the State of Arizona.

    Disinfection of the effluent from the facilities will become an issue. Ultraviolet or ozone treatment may need to be considered to meet residual toxicity limits.

    Whatever process selected should not be designed to the very edge of its capacity or limits, but be robust to do the job. The process evaluations were covered on pages 35 through 39 of the handout.

15. Carl Koch reviewed the current facilities for processing biosolids and what may be required to achieve a class A biosolids designation. Current operations produces a Class B biosolids output which is land applied. Class A requires advance processing of biosolids to lower pathogens and odor potentials. There are various markets for the higher biosolids classification, but is it large enough to absorb the volumes produced from Pima County facilities? Does the higher

classification warrant the higher costs of treatment? With any future biosolids program the existing storage facility and future storage requirements need to be considered.

As with any biosolids program it is prudent to have multiple outlets for sludge disposal in the event that one is temporarily restricted. Mine reclamation would be a possible alternative disposal option. It was noted that California has a very high standard for biosolids which exceed the Class A requirement. Achieving the California standard comes at higher costs, but may be without a higher product value to offset the additional cost of treatment. The Camby process should be given consideration during the study. The biosolids issues were covered on pages 40 through 45 of the handout.

16. Jerry Bish presented the issues with the areas that lie outside the metropolitan service areas of Roger Road WWTP and Ina Road WPCF. These areas are projected to see explosive growth over the next 25 years and are served by small wastewater treatment facilities scattered to the south, west and northwest. There are some plans to consolidate some facilities that are currently in service, but there are also plans to build additional facilities as growth expands in these outlying areas. This may present an opportunity to consolidate some facilities into a sub-regional facility to the south of the metropolitan area. There may also be an opportunity to consolidate facilities and construct a sub-regional facility in the northwest. Conveyance capacity in existing sewer systems and the costs of transferring flows are key to developing a cost effective approach to treat wastewater in the outlying areas. Consolidation may be effective for sub-areas with proximity, but may not be suitable for all areas. The outlying areas issues were covered in pages 45 through 47 of the handout.

17. Gordon Culp covered the development of evaluation criteria for the study that incorporates all facets of a multi-discipline study. Factors in the evaluation include costs for capital and operations and maintenance, but must integrate non-cost aspects, such as public acceptance and system reliability, which may not carry a cost value. In the end a matrix for cost, and a matrix for cost and other factors will be utilized in the decision making process. It was further recognized that not all evaluation criteria may carry the same weight in an evaluation matrix. It was agreed that the weighting of evaluation criteria would be deferred until a later date rather than tackle that issue with the workshop group. The evaluation criteria were covered in pages 48 through 51 of the handout.

18. Joe Popeck addressed the importance of the level of costs for various elements in the plan. Initially, detailed cost estimates are unnecessary in making capital cost comparisons between alternatives. Representative values that are consistent among the alternatives are necessary to make judgments of costs for the various options. O&M costs will be developed for various elements of a system and will consist of estimates of power usage, chemical consumption, and allowances for O&M of equipment and structures. Capital costs will include equipment, structures and identified significant special costs. Common elements such as roads, sitework, landscaping which are common to all alternatives will have limited cost development. A cost sensitivity analysis will be evaluated for various elements of the costs for each option. Level of costs estimates were covered in pages 52 and 53 of the handout

19. Harold Smith followed the costs development with a presentation on how those costs are utilized in a financial analysis. Costs are not only use in a comparative analysis of option but are included in the funding options analysis. Cost model inputs result in cost outputs that address affordability, rate structure, debt service and cost risk profiles. The cost model can be easily updated to adapt to changing financial conditions and be capable of showing current dollar values. The funding analysis will look at the rates and bonding capacity of other communities comparable to Pima County. Financial analysis was covered in pages 54 through 56 of the handout.

20. Jerry Bish presented the available background information on which to build the master plan documentation. The 2006 Facility Plan Update and the Tucson Water -Water Plan 2000-2050 provide background information for existing facilities, population forecasts and proposed future facilities. Regulatory permits provide the current requirements for operating facilities and a request to achieve higher standards in the near future. Additional information needs to be collected in various areas of treatment, conveyance and finance in order to assess the current situation. Further onsite evaluation of the existing wastewater treatment facilities will be conducted to capture the current assessment of conditions at each site. Background information was covered in pages 56 through 59 of the handout.

21. Andy Richardson presented a list of stakeholders for consideration of the group. Additional stakeholders were offered by the group which included: Chamber of Commerce, TREO, SAHBA, Tucson Electric Power Company and other utilities, Neighborhood associations, Southwest Gas Corp., Bureau of Reclamation, AVRA Water Valley Co-op (Bob Decker, President), US Forest Service, PAG, Pima County Flood Control, Indian Nations, City of Tucson and Town of Sahuarita.

22. Andy Richardson previewed the next workshop scheduled for May 31, 2006. Workshop # 2 will address water reuse and how that impacts the various options under consideration. The workshop outline was presented on page 60 of the handout.

23. Mike Gritzuk provided closing remarks for the workshop. The workshop was intended to introduce the department and various stakeholders to the overall goals and intent of the study. The study is to determine the right plan for the future of PCWMD using a multi-discipline approach. For the study to be successful we need to cooperate and work together. Communications within the department and with public officials and others is key; and each is to share the information with others in their departments. Working together with Tucson Water, a reclaimed water plan will be developed that will best serve the community. With the results of the study, PCWMD will move forward together.

Agenda

Time	Topic	Presenter	Pg
8:00 am	Opening Session • Welcoming Remarks • Overview of Agenda • Adoption of Groundrules: Role of Facilitator • Confirmation of Agenda • Workshop Objectives	 Mike Gritzuk Andy Richardson	1
8:30 am	Study and Workshop Schedule Review	Andy Richardson	4
8:45 am	Scope of Services and Study Approach - Overview • Study Report Outline	Joe Popeck	6
9:15 am	Study Expectations/Obstacles (Develop List)	Andy Richardson	16
9:45 am	Project Implementation Schedule (Based on Study Results) Funding Options Delivery Options/Contractor's Risk	Joe Popeck Harold Smith Eric Petersen	17 17 21
10:15 am	Break		
10:30 am	Overview Study Options and Key Elements • "Existing Plan" • "Transfer Some" • "Transfer All" • Others • Agreement on Study Options/Key Elements	Joe Popeck/ Jerry Bish	26
11:30 am	Roger Road WWTP/Ina Road WPCF Evaluations	Andy Richardson	34
Noon	Lunch		
1:00 pm	BNR Alternatives under Consideration	Orrie Albertson	35
1:40 pm	Solids Handling/Treatment	Carl Koch	39
2:00 pm	Outlying Area Scenarios	Jerry Bish	45
2:15 pm	Break		
2:30 pm	Evaluation Criteria • Develop • Agreement on Evaluation Criteria	Gordon Culp	48
3:15 pm	Level of Cost Estimates	Joe Popeck/Harold Smith	52
3:45 pm	Background Information and Detail of Information for Decision Making	Jerry Bish	56
4:00 pm	Identify List of Stakeholders	Andy Richardson	59
4:10 pm	Preview of Next Workshop	Andy Richardson	60
4:20 pm	Summary Wrap-Up Comment by Group Remarks by Mike Gritzuk	Andy Richardson All Mike Gritzuk	60
4:30 pm	Adjourn		

Flip Chart Notes – April 19, 2006

Schedule

- Plant interconnect needs to be in place to meet the needs of Tucson Water's reclamation facilities
- Timeline – consider time for ADEQ to respond to "plan"
- Plant interconnect – need now
- How will land acquisition be taken into consideration?
- Need to plan now for land acquisition for a new Metro and outlying area treatment plants

Scope

- Will we identify short-term projects to meet need? Yes
- What is our list of assumptions? Will develop as we move forward
- Explanation of assumptions are key – need to be supportable
- Area downstream of Ina – how addressed?

Expectations

- Come up with a plan that can be implemented and meet proposed and future regulatory requirements
- This is "the" plan for 25-years – the year 2030
- The plan should include how it will be "sold" to the community
- Puts Roger Road into the 21st century
- Keep annual O&M to minimum
- Pan will address water reuse water quality requirements – water use and needs of reclaimed water system will be included
- Identify points of synergy and water reuse – where Tucson Water and Pima County can work together to meet "entire" community needs
- Need to have flexibility on short term; be able to adjust the unknowns of water side – identify leading indicators and monitor those indicators as plan is implemented
- Support policy decisions that have to be made
- Create a name for the "plan" that the public can identify with
- Optimal technology ***cost effective*** plan for long-term wastewater management in Pima County as well as affordable

Obstacles

- What impact will the 25-year plan have on staffing? Needs to be addressed in plan
- Include stakeholders – so they accept solution – still identify more stakeholders
- Be willing to try and understand other people's view – not easy to do
- How do we make plan a "living" document?
- How do we integrate other entities plans – that are concurrent with our "plan"?
- Communication to those outside the workshops – on what's going on; keep people in Pima County up-to-date for "buy-in" – operators are key. People at workshops need to communicate to others that were not present in the workshops
- Listen to operators
- We need to make this happen
- Be aware of legislative issues

- Where the effluent goes, where the biosolids go is a major issue that needs to be addressed
- Opportunity – institutional structure of water and wastewater management needs to be taken into consideration
- How does entitlement affect water reuse?
- Keep open mind as we all work through study
- Look at how partnership can evolve – let go of the past
- Money – will be key to implement plan – or it will be outdated by the time it is done
- Disconnect between technological reality and political reality
- Look at Mother Nature / natural ways to treat wastewater
- Need to accept framework to show how plan was developed and how it should be updated
- Need to state assumptions and get "buy-in" on assumptions and monitor them as they change
- How do we get consensus? How do we get "buy-in"?
- Lot of "unknowns" – scope is broad
- Need realistic schedule on implementation
- Antiquated institutional arrangements need to be evaluated
- Politics has to be taken into consideration for projects to be implemented
- Inability to change will be a major issue
- Affordability
- Regulatory uncertainty, i.e., pharmaceuticals removals, etc.
- Municipal competition instead of cooperation

Funding Options

- When will funding start? Need to look at funding sources right now
- Community capacity on funding – other funding needs – look at both "water and wastewater bill" impact
- Look at current bonding levels and how it relates to future capacity
- Proactive in tax incentive for commercial and developer for locations of wastewater service
- Impact on costs based on construction funding and activity; will labor force be there to build CIP?
- Need to consider all construction activity in Pima County -- road, water, etc.

Delivery Options/Contractor's Risk

- Are there really time and cost savings? (Would like documented information.)
- How is the issue of control addressed?
- What are the relative "cost" impacts and "savings" on each method?
- Data needs to back up cost savings with different methods
- Value engineering – how should it be used to manage risks and costs?
- Program management – look at program management as a way to implement entire CIP – will this method manage risks and result in cost savings?

Study Options

- Make sure to include the concept of scalping water reclamation plants in options development and evaluation
- Another big plant between Ina Road and Roger Road?
- New option: look at North Regional WWTP to handle flow North of Ina Road WPCF sewer basin. Plant would be located around Tangerine Road
- Make sure we look at solids load if scalping plants are used

- Transfer some – build plant only to meet Tucson Water need at Tucson Water quality requirements and decommission Tucson Water AWT Plant
- Look at the issue of reclaimed water storage
- What is the volume needed that is optimal for Roger Road?
- Still deliver to Sweetwater Facility; look at age and conditions at Tucson Facility
- For outlying areas, look at direct aquifer recharge of reclaimed water
- Make sure aware of odor issues as we move forward
- Talk to Tucson Water on how costs may be shared on different reclaimed water options

Conveyance Options

- Address reliability and redundancy for options considered
- Environmental restoration projects impacts have to be taken into consideration in the evaluation of flow routing

Roger Road / Ina Road Evaluations

- Bid Build – Pima County may keep all the risk on rehabilitation?
- Cost more to rehabilitate – than new
- Cost to build new and cost of demolition need to be evaluated
- Catastrophic failure and risk of that happening
- Maintain to extend useful life
- What methods for assuming risk

BNR Alternatives

- How were target treatment limits picked? Need to justify
- Basic assumption on gpcd values; need to look at "buy-in"; have to work together on planning data; need to make sure Pima County and Tucson Water are together on water use values
- Look at robustness of lower limits and cost as it relates to treatment alternatives
- How comfortable are we with nitrogen limits under 6 and what is the cost?
- What about phosphorus?
- On BNR alternative evaluations, indicate why deleted from further evaluation and state the justification
- How does BCAT impact disinfection considerations?

Solids Handling / Treatment

- Need to interact with ongoing projects as they relate to this study; need to be aware that conditions will change as those projects are implemented
- How long will market exist for Class B and will there be a market for Class A?
- Look at additional storage space for biosolids; need storage space right now
- Use existing research on Class A as evaluations are made
- Look at developers on marketing Class A process
- Consider keeping two options open for final biosolids disposal for County as a back-up plan

Outlying Area Scenarios

- Be mindful of how certain areas will grow in future; pygmy owl vs. other areas
- What to do about Indian nation?
- Shift of growth from Ina WPCF service area to Marana area
- Future is 2030, plan for "build out"

- Look at the issue at how flow diversion can offer relief to Roger Road?
- Desert Museum WWTP does not exist
- Operational responsibility for Randolph Park WRF is with outlying areas
- How is effluent going to be used relative to outlying areas?
- Proactive guidelines for satellite plants – Pima County control, not developers
- Look at solids impacts

Evaluation Criteria

- Technology new – reliability
- Reuse of entire effluent – value of water
- Recharge potential
- To what extent are we using proven technology?
- How to measure risk – how to convert to $?
- User friendly – labor impacts
- Employee safety
- Odor generation potential
- Transition from new to old
- Flexibility to expand over time
- Archeological impacts
- Ease of conversion from existing to new – compatibility
- Alternative energy sources and impact on costs
- How do we work into evaluating the value of the reclaimed water?
- SCADA – support for technology and impact on O&M
- How to measure risk in $ - what other ways to measure risk?
- Look at space issues; need space for support facilities such as a new laboratory
- Willing to take risk not to look at new technology
- How to make it work vs. adaptation at other locations
- Have to make business case for use of existing facilities if it drives up O&M cost
- Look at all technologies that are out there; is there uniformity? In future would like ease of operation
- Need to consider impacts of being on the "bleeding edge" versus proven technology

Level of Cost Estimates (Types of Cost Estimates – Comparative Cost Estimates)

- O&M cost development as a percentage of capital – not comfortable with approach, would like some additional consideration; example: maintenance on certain types of technologies considered
- O&M cost relative to benchmarking as a check – need to compare
- Have Pima County O&M staff look at O&M cost numbers
- 80% of O&M costs with four areas: labor, energy, chemicals, supplies
- Complexity of process; take into consideration on development of O&M costs
- Need to be able to defend O&M numbers on comparative estimates

Level of Cost Estimates (Financial Analysis)

- Would like a sensitivity analysis on each of the options
- How do Pima County rates compare to other rates?
- May not be collecting revenues of areas we need to
- How much bonding should Pima County have compared to similar size utilities?
- 2006 dollars – year when construction will occur; dollars need to be included in plan

Background Data

- Tucson Water reclaimed water usage plan – plus other document relative to water reuse
- November 15, 2005 CMOM State Rule
- Permits for recharge
- Randolph Park, Ina and Roger reuse permits
- Stormwater permits, APP
- Need to look at developer agreements
- Need to review Pima County planning strategy documents
- Need previous biosolids study and agreements

Stakeholders

- ADWR
- Development community
- Indian nations
- Environmental community
- SAHBA
- Pima County Flood Control
- Chamber of Commerce
- TREO
- Tucson Electric Power Company (TEP)
- Neighborhood Associations
- Southwest Energy Solutions, Inc.
- Southwest Gas Corp
- Town of Sahuarita
- PAG 208 Program
- State Land
- Arva Valley Water Co-op
- Pinal County
- US Forest Service
- USGS
- Bureau of Reclamation
- City of Tucson, Habitat Conservation Planning

Regionalization Study of Metropolitan Treatment Facilities and CIP

Workshop #1
Kick-Off Meeting

April 19, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Joe Popeck	Project Mgt/Overview
Howard Smith	Financial
Eric Petersen	Legal
Jerry Bish	Conveyance/Outlying Areas
Orrie Albertson	Treatment Alternatives
Carl Koch	Biosolids
Gordon Culp	Evaluation Criteria

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Study overview
- Treatment alternatives
- Biosolids
- Outlying areas
- Evaluation criteria
- Background information
- Closing

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Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

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Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

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Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

9

Workshop Objectives

- Familiarize group with scope of study , approach and schedule
- Familiarize group with workshop process for study execution
- Develop list of study expectations and identify obstacles
- Review project funding options, project delivery options and concept of contractor's risk
- Reach agreement on study options and key elements

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Workshop Objectives

- Gain consensus or informed consent on issues associated with Roger Road WWTP / Ina Road WPCF condition evaluations
- Review BNR and solids handling/treatment alternatives under consideration
- Reach agreement on study options evaluation criteria
- Gain understanding and agreement on level of cost estimates used
- Gain consensus or informed consent on level of detail of information used for final decision making
- Identify/verify study stakeholders

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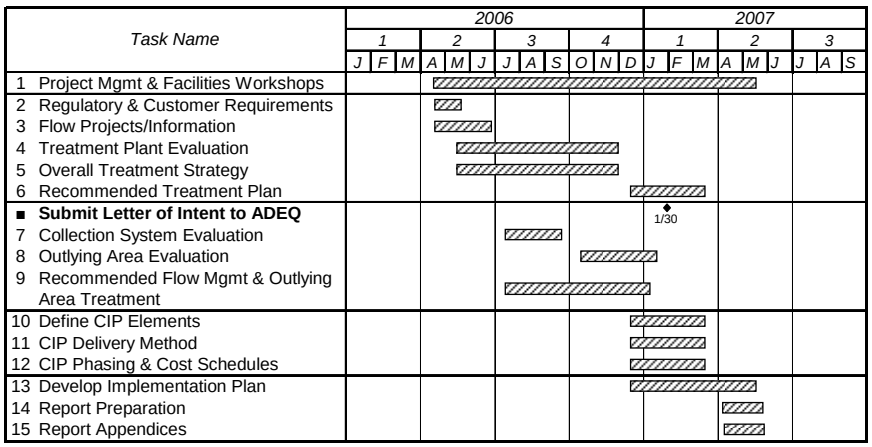
Pima County Wastewater Management Department

GREELEY AND HANSEN

Study and Workshop Schedule Review

Andy Richardson

Study Schedule



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Workshop Descriptions

- *Workshop #1*: Study Initiation and Kick-Off
- *Workshop #2*: Reuse Workshop
- *Workshop #3*: Stakeholder Regulatory Requirements
- *Workshop #4*: First Brainstorming Workshop and Background Data Review

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Workshop Descriptions

- *Workshop #5*: Ina Road WPCF Facility Oriented Workshop
- *Workshop #6*: Roger Road WWTP Facility Oriented Workshop
- *Workshop #7*: Biosolids Workshop
- *Workshop #8*: Plant Interconnect/ Conveyance System Workshop

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Workshop Descriptions

- *Workshop #9*: Second Brainstorming Workshop and Facility Oriented Workshop Results
- *Workshop #10*: Technologies Workshop
- *Workshop #11*: Evaluation of Treatment Plant Alternatives
- *Workshop #12*: Conveyance System Alternatives/Recommended Flow Management Plan

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Workshop Descriptions

- *Workshop #13*: Recommended Outlying Area Plan
- *Workshop #14*: First Draft of Report Study
- *Workshop #15*: CIP Phasing and Cost Schedules
- *Workshop #16*: Presentation of Implementation Plan/Final Report

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Scope of Study

Joe Popeck

Goals of the Study

- Determine strategy for:
  - Managing long-term flow/capacity
  - Treating additional loading of Metro basin wastewater
  - Rehabilitating existing facilities
  - Handling biosolids
  - Providing reclaimed water

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Goals of the Study *(continued)*

- Develop coordinated Capital Improvement Design and Construction Program:
  - Cost estimates
  - Schedules
  - Recommended delivery strategy
  - Funding strategy
  - Integration with PCWMD CIP

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Major Project Scope Elements

- Regionalization study of Metropolitan treatment facilities
- Wastewater treatment
  - Location of treatment
  - Nutrient removal
  - Reclaimed water/outlying treatment facilities
- Long-term biosolids disposal
- Conveyance system issues
- Implementation schedule
- Financial requirements
- Stakeholder involvement
- Study report outline

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Regionalization Study of Metropolitan Treatment Facilities

- Optimize flow management scheme across the county wastewater service areas
- Optimize treatment processes to meet future needs
- Optimize biosolids handling / utilization

22

Regionalization Study of Metropolitan Treatment Facilities *(continued)*

- Optimize configuration for meeting regional reuse needs
- Optimize configuration of facilities for Roger Road WWTP, Ina Road WPCF and outlying facilities
- Cost effective allocation of resources
- Comprehensive financial plan to achieve results

23

Regionalization Study of Metropolitan Treatment Facilities *(continued)*

- Which regionalization option for Roger Road WWTP and Ina Road WPCF is best?
  - Maintain existing plan (Facility Plan)
  - Transfer some flow from Roger Road WWTP to Ina Road WPCF
  - Transfer all flow from Roger Road WWTP to Ina Road WPCF

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Regionalization Study of Metropolitan Treatment Facilities *(continued)*

- What are benefits/concerns of each option?
- How does reclaimed water fit in?

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Wastewater Treatment

- What nutrient removal treatment alternative best suits Pima County's needs?
  - To meet 2014 / 2015 regulatory requirements
  - For consideration of potential future requirements
- How does nutrient removal treatment work with reclaimed water treatment?

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Wastewater Treatment *(continued)*

- Which wastewater flow treatment scenario best addresses outlying facilities?
  - Add capacity to conveyance system through Tucson and treat future flows at Roger Road WWTP and/or Ina Road WPCF?
  - Connect some or all outlying facilities to regional facilities?
  - Construct sub-regional WPCF/WRF to treat flows from outlying areas.

27

Long-Term Biosolids Disposal

- How will the treatment, solids and conveyance issues be implemented?
  - What is the plan to transition from old to new?
  - How will elements of the program be phased in or phased out?

28

Conveyance System Issues

- Location of treatment
- Rehabilitation phasing
- Implementation phasing
- Conveyance system expansion vs. satellite plants

29

Implementation Schedule

- Result in compliance with ADEQ discharge limits
- Temporary and permanent Improvement projects
- Operational considerations

30

Financial Requirements

- What are the financial impacts of the recommended plan?
  - What are the program elements/phasing?
  - What are the element costs?
  - Where is the money?
  - When does the money need to be available?
  - What is the supporting rate structure?

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Stakeholder Involvement

- Facilitated Workshops
  - PCWMD Staff/Review Team Leaders
  - Greeley and Hansen Team
  - Peer Group Members
  - ADEQ
  - Tucson Water
  - Selected Stakeholders

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Stakeholder Involvement *(continued)*

- Public Meetings:
  - PCWMD Management/PIO
  - Greeley and Hansen Management Team
  - Invited Selected Stakeholders
  - Elected Officials
  - ADEQ
  - Public

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Study Report Outline

- Chapter 1 – Introduction and Report Summary
- Chapter 2 – Regulatory and Customer Requirements
- Chapter 3 – Flow Projections and Capacity Needs
- Chapter 4 – Treatment Plant Evaluation
- Chapter 5 – Overall Treatment Strategy
- Chapter 6 – Recommended Treatment Plant Plan
- Chapter 7 – Conveyance System Evaluation
- Chapter 8 – Outlying Area Evaluation
- Chapter 9 – Recommended Flow Management and Outlying Area Treatment Plan
- Chapter 10 – CIP Elements
- Chapter 11 – CIP Delivery Method
- Chapter 12 – CIP Phasing and Cost Schedules
- Chapter 13 – Implementation Plan
- Report Appendices

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Study Report Outline *(continued)*

Chapter 2 – Regulatory and Customer Requirements

2.1 Introduction
2.2 System Capacity
  2.2.1 Conveyance System Capacity
  2.2.2 Treatment Capacity
2.3 Effluent Quality (River Discharge and Reclaimed Water Use)
  2.3.1 AZPDES and APP Permit Requirements
  2.3.2 Pathogen Removal
  2.3.3 Salinity
  2.3.4 Emerging Contaminants
  2.3.5 Future Customer Requirements
  2.3.6 Environmental Requirements
  2.3.7 Risk
2.4 Environmental Habitat Considerations for the Santa Cruz River
2.5 Residuals Quality
2.6 Air Quality
2.7 Redundancy, Flexibility, and Reliability
2.8 Roger Road WWTP Condition Assessment
2.9 Ina Road WPCF Condition Assessment
2.10 Conveyance System Assessment
2.11 Water Reuse Considerations
2.12 Summary

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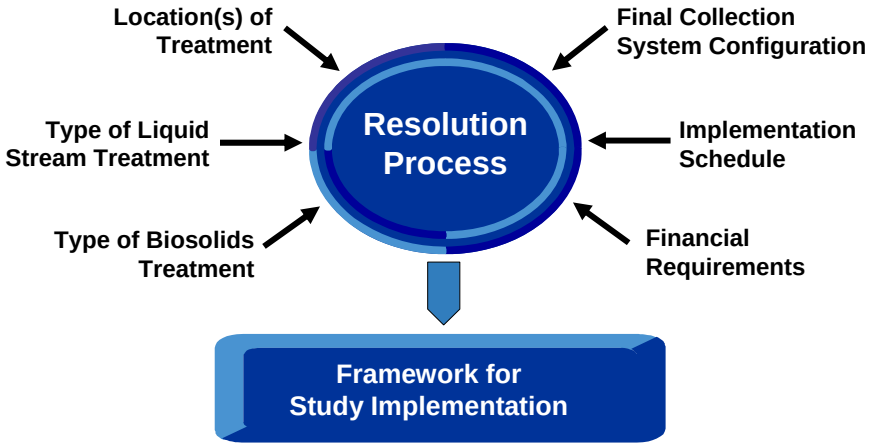
What We Have to Decide



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How to Answer the Questions?

- Identify major decisions / issues
- Gather and review pertinent information
- Collaborate with internal / external stakeholders
- Build consensus (workshops)
- Agree on decision

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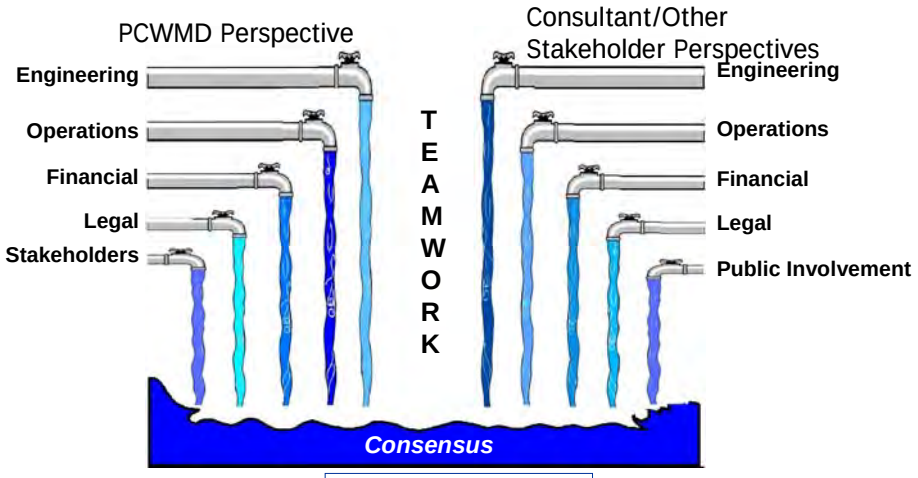
Study Interaction "Building Teamwork"



"Facilitation Makes It Work"

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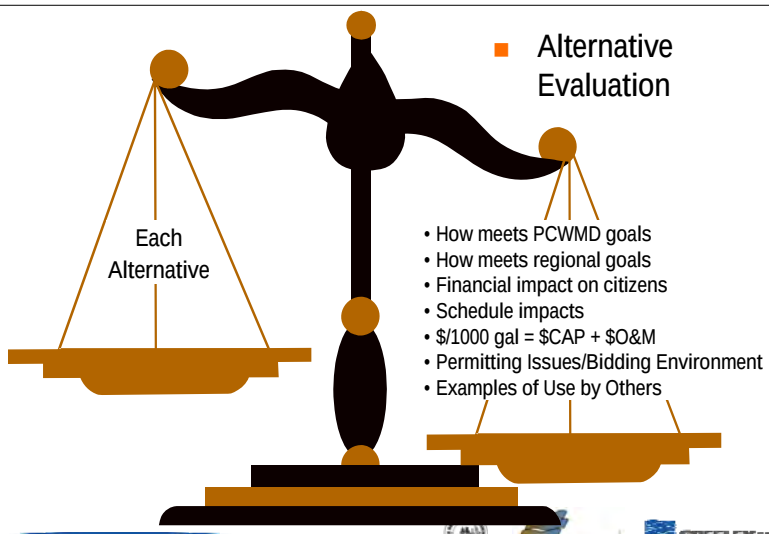
Evaluate Alternative and Subalternative



- Alternative Evaluation
  - How meets PCWMD goals
  - How meets regional goals
  - Financial impact on citizens
  - Schedule impacts
  - $/1000 gal = $CAP + $O&M
  - Permitting Issues/Bidding Environment
  - Examples of Use by Others

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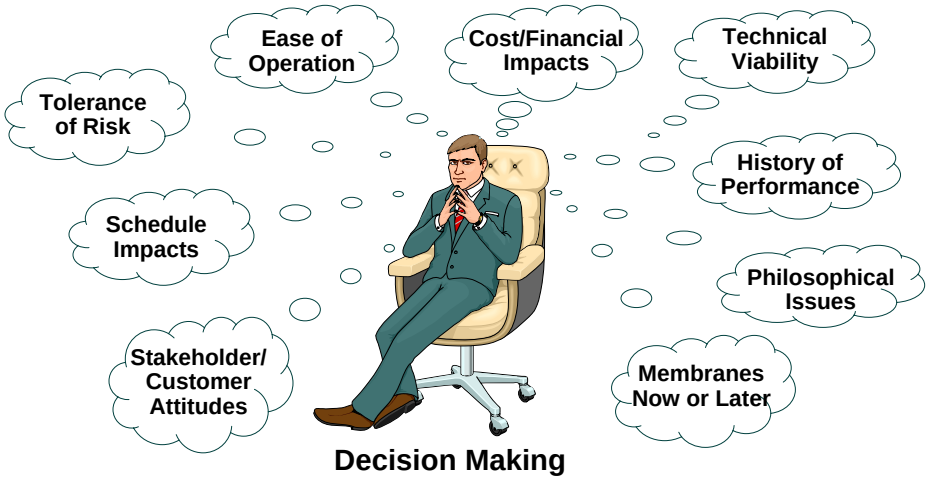
Major Decision Process



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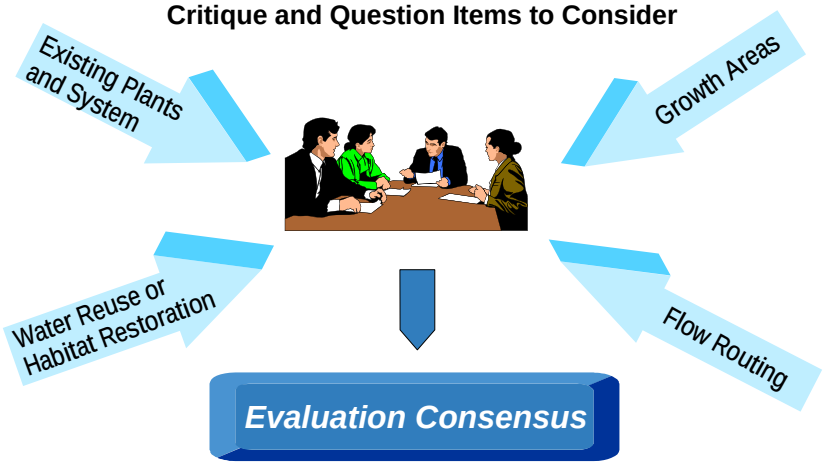
Location(s) of Treatment

Critique and Question Items to Consider



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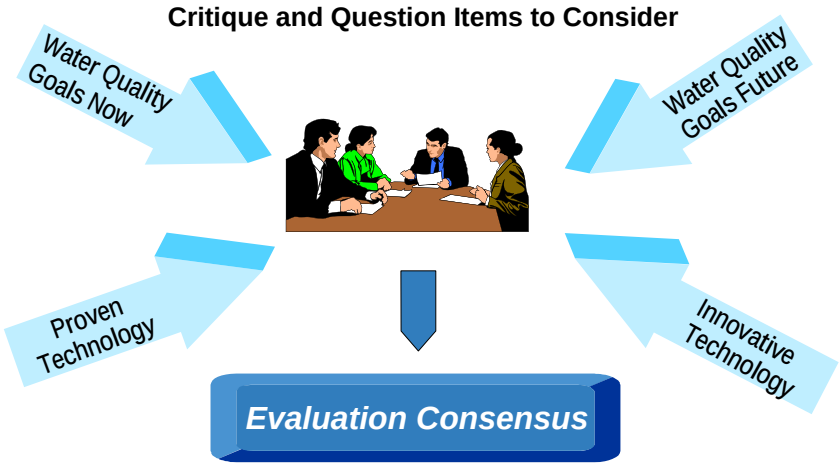
Type of Wastewater Treatment

Critique and Question Items to Consider



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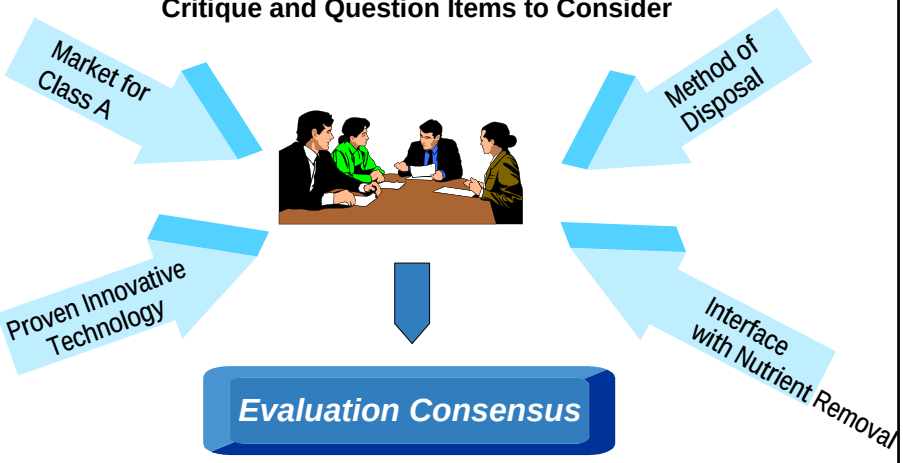
Type of Biosolids Treatment

Critique and Question Items to Consider



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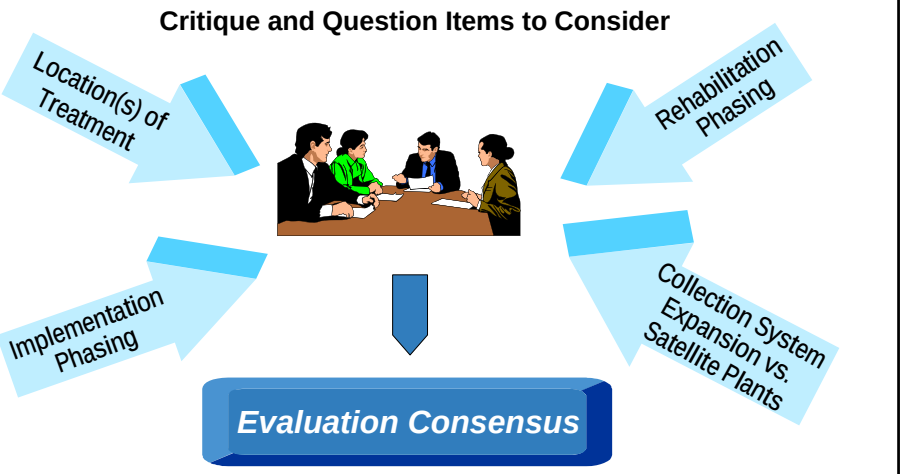
Type of Collection System Configuration

Critique and Question Items to Consider



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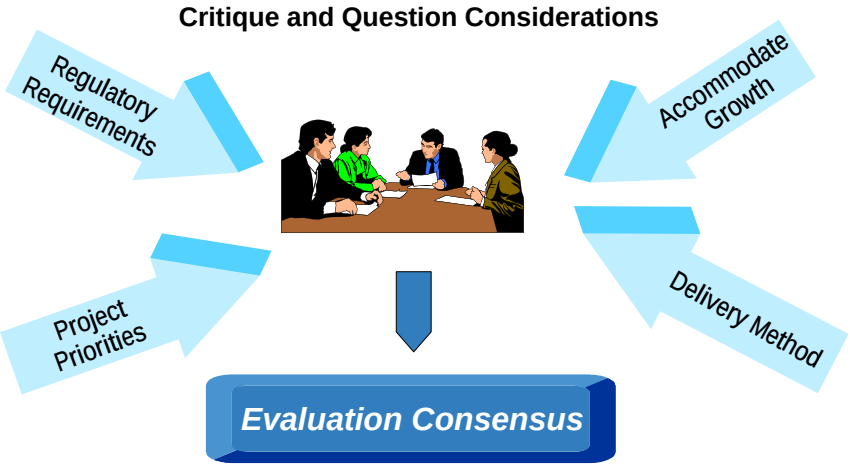
Implementation Schedule

Critique and Question Considerations



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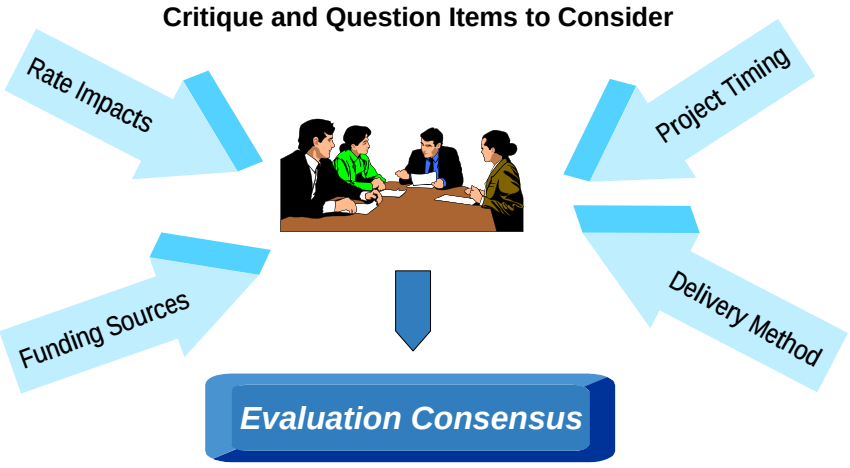
Financial Requirements

Critique and Question Items to Consider



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Interview Stakeholders

- Questions
  - What will success look like?
  - What are goals and needs?
  - What needs to happen for success?
  - What three difficult/important issues have to be worked through?
  - What issues can be addressed with confidence/no confidence?
  - What has worked well / what hasn't?
  - What topics need to be addressed in each of the workshops?

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Study Expectations/Obstacles

Andy Richardson

Project Implementation Schedule

Joe Popeck

Project Implementation Schedule

			ADEQ Report Proposed Solution					Ina Road BNR	Roger Road BNR		
Item	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Metro Study											
Arrange Funding											
RR to IR Plant Interconnect											
Design											
Construct											
Convert Ina Road WPCF to BNR											
Design											
Construct											
Convert Roger Road WWTP to BNR											
Design											
Construct											

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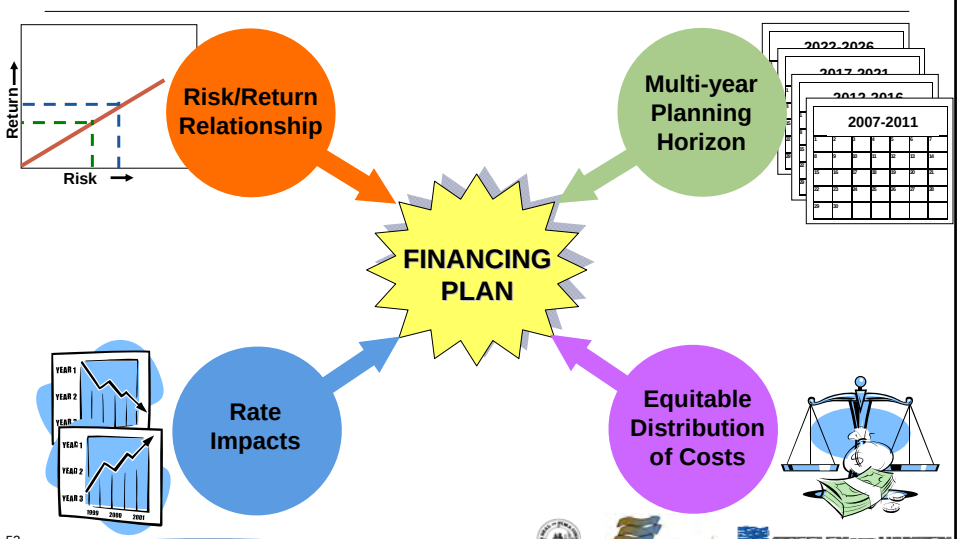
Funding Options

Harold Smith

Financial Planning Considerations



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Current Plan

- CIP program funding sources:
  - 1997 Bond Authorization –$105 million
  - 2004 Bond Authorization –$150 million
  - Future Bond Authorizations –2008 ($245 –$355 million), 2012, 2016, 2020
  - System Development Funds (connection fee/ user fee funds allocated to capital projects)
  - Supporting rates

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Project Funding Options

- Rates
- Connection fees
- Public debt funding
- State revolving funds (SRF)
- Federal/state grants
- Regional stakeholders
- Private funding

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Rates and Charges

- Existing
  - Wastewater rates
  - Connection fees
  - Reserve funds
- New
  - Environmental fee
  - Capital replacement fee
  - CMOM Fee

55

Public Debt Funding

- Short-term tax-exempt debt
- Revenue bonds
- Water lease revenue financing
- Zero coupon bonds and capital appreciation bonds
- Interest rate swaps and other derivatives

56

SRFs and Federal/State Grants

- AZWIFA Clean Water Revolving Funds
- EPA Loans and Grants

57

Regional Stakeholders

- Neighboring Communities
- Developers
- Options for Participation
  - Up-front contribution of capital
  - Charges for service
  - Contributed assets

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Private Funding

- Private equity
- Private debt
- Private activity bonds

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Assessing Funding Options

- Typical assessment criteria
  - Applicability and availability
  - Administrative and compliance requirements
  - Issuance costs
  - Effective interest rate
  - Interest rate risk
  - Rate impacts
  - Effect on balance sheet

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Assessing Funding Options

- Typical assessment criteria
  - Applicability and availability
  - Administrative and compliance requirements
  - Issuance costs
  - Effective interest rate
  - Interest rate risk
  - Rate impacts
  - Effect on balance sheet

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Delivery Options/ Contractor's Risk

Eric Petersen

Alternative Project Delivery Methods Under Arizona Law

- Section 41-2579: Project Delivery Methods for Design and Construction Services
  - Design-bid-build ("bid-build")
  - Construction-manager-at-risk
  - Design-build and design-build-operate (D/B and D/B/O)

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Construction-Manager-at-Risk Considerations

- Potential Benefits
  - Qualifications-based selection of construction manager
  - Owner control over design
  - Collaboration between designer and construction manager
  - Capping of price

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Construction-Manager-at-Risk Considerations *(continued)*

- Potential Drawbacks
  - No transfer of design liability
  - Two points of responsibility (designer and construction manager)
  - Separate responsibility for operations
  - Limited risk transfer

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Design-Build and Design-Build-Operate Considerations

- Potential Benefits
  - Single point of responsibility
  - Guaranteed performance
  - Cost savings
  - Time savings
  - Substantial risk transfer
  - Early stage price certainty

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D/B and D/B/O Considerations
(continued)

- Potential Benefits
  - Competition and innovation
  - Financial strength of proposers
  - Willingness of proposers to invest
  - Fewer disputes
  - Less monitoring cost
  - Proven in Arizona and nationally

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D/B and D/B/O Considerations
(continued)

- Potential Drawbacks
  - Less control over project details
  - Less familiarity
  - More complex selection
  - More involved negotiations
  - Possibility of smaller number of competitors

68

Process in Arizona – RFQ

- Selection committee
- Request for qualifications (RFQ)
- Create short-list based on criteria published in RFQ
- Short-list may contain only 3 firms
- Negotiate with the most qualified firm on the RFQ short-list

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Process in Arizona – RFP

- RFP is distributed to every firm on the RFQ short-list
- RFP contains scoring method
- Submittals contain separate technical and price proposals (option of preliminary and final)
- Award based on highest score
- Honorarium

70

Risk Considerations

- Risks retained under any delivery method
  - Changes in law
  - Force majeure
  - Unusual influent parameters
  - Pre-existing site and environmental conditions
  - Buried infrastructure conditions
  - General price inflation

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Risk Considerations *(continued)*

- Risk transfer (D/B and D/B/O)
  - Permitting risks
    - Terms and conditions
    - Delays
    - Non-issuance
    - Permitting cost overruns
    - Limitations

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Risk Considerations *(continued)*

- Risk transfer (D/B and D/B/O)
  - Design risks
    - Design liability
    - Design cost overruns
    - Technological obsolescence
    - Securing patents and licenses

73

Risk Considerations *(continued)*

- Risk transfer (D/B and D/B/O)
  - Construction risks
    - Completion risk (delay and efficacy)
    - Construction cost overruns
    - Disputes between designer and builder
    - Labor relations

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Risk Considerations *(continued)*

- Risk transfer (D/B/O)
  - Operation and maintenance risks
    - O&M cost overruns
    - Regulatory compliance
    - Capital maintenance
    - Excess electricity consumption
    - Market conditions affecting sludge disposal
    - Labor relations

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Risk Considerations *(continued)*

- Existing facilities
  - "As-is" risk generally
    - Facility design
    - Facility condition
    - Facility information
    - Appropriate circumstances for transfer of "as-is" risk

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Risk Considerations *(continued)*

- Existing facilities
  - "As-is" risk – limitations
    - Assurances companies will require
    - Opportunity for renegotiation if assumptions prove false
    - Risk premium
    - Industry reluctance

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Pima County Wastewater Management Department

GREELEY AND HANSEN

Overview Study Options and Key Elements

Joe Popeck – Jerry Bish

Study Options

- Existing Plan
- Transfer All
- Transfer Some

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Key Elements

- GPS-X Modeling of RR and IR
  - Select BNR process to be implemented
  - Model each plant to determine BNR Treatment Capacity after modification

80

Key Elements

- Existing Plant Space and Configuration
  - Is there enough space to accommodate BNR modifications?
  - Does the existing configuration lend itself to a sensible re-configuration for BNR?

81

Key Elements

- Constructability
  - Can existing treatment capacity (or sufficient capacity) be maintained during reconfiguration to BNR?
  - Construction Risk associated with modifications to facilities that are 30, 40 or 50 years old

82

Key Elements

- Viability/operability
  - Hydraulics
  - Size and depth of process tanks
  - Logical Flow Path
  - Operational Flexibility

83

Key Elements

- Costs
  - For BNR Conversion
  - To upgrade aging unit processes
  - For upgrades to outdated utility services
  - For Code upgrades
  - For additional odor control
  - For pumping effluent

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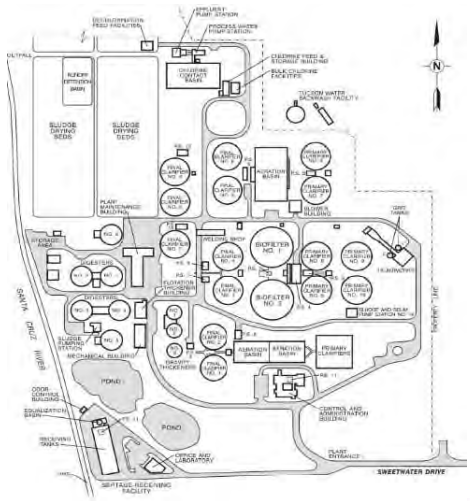
Roger Road WWTP Site Plan



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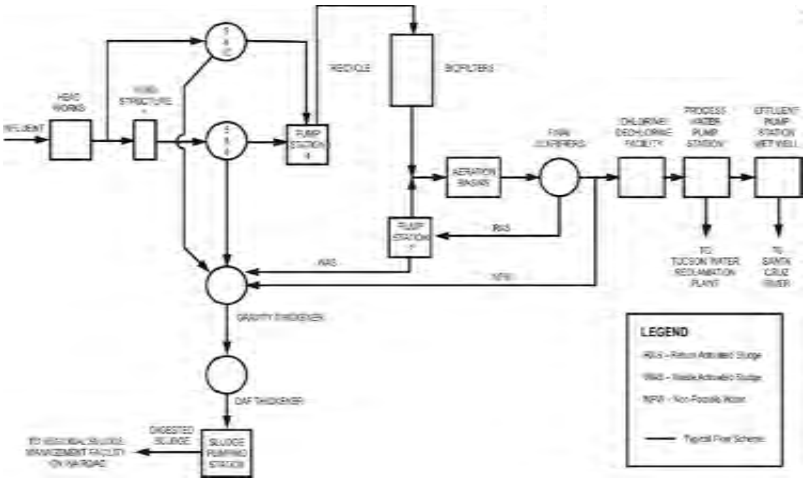
Roger Road WWTP Process Flow Diagram



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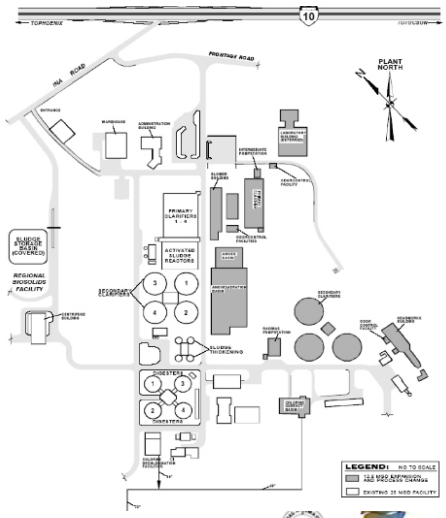
Ina Road WPCF Site Plan



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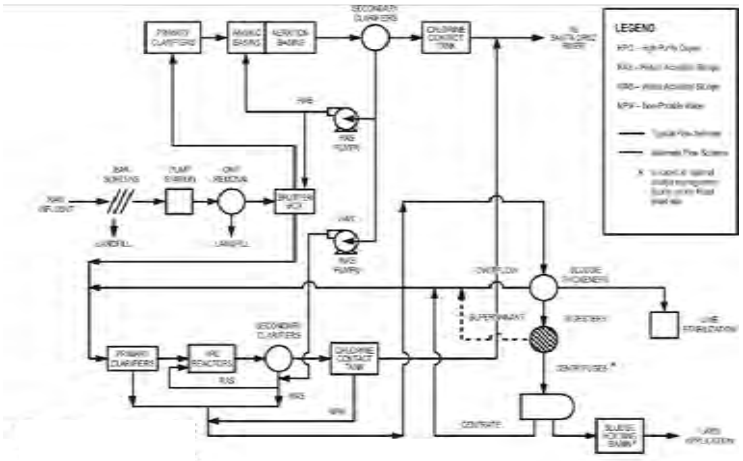
Ina Road WPCF Process Flow Diagram



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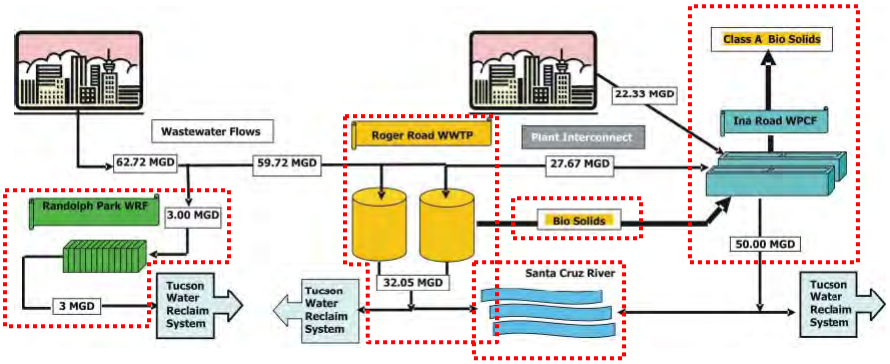
Existing Plan Schematic



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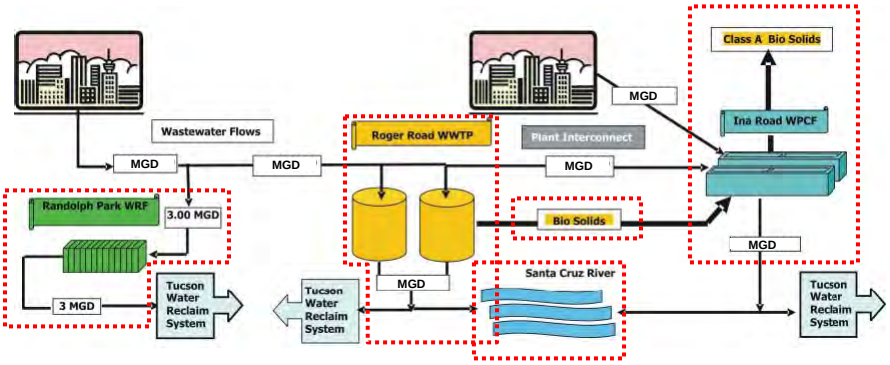
Transfer Some Schematic



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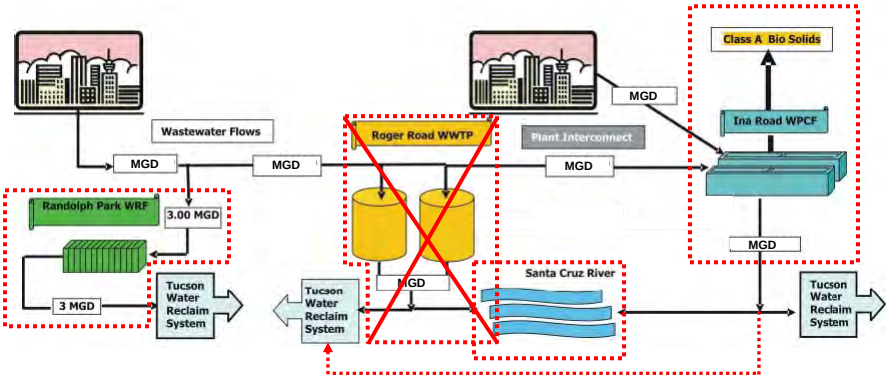
Transfer All Schematic



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Conveyance Issues/Options

- Existing Plan: Roger Road WWTP
  Ina Road WPCF
  Randolph Park WRF
- Transfer Some: Roger Road WWTP (downsized)
  Ina Road WPCF (expanded)
  Randolph Road WRF
- Transfer All: Ina Road WPCF
  (expanded significantly)
  Randolph Road WRF

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Conveyance Issues/Options

- Existing Plan:
  - Roger Road WWTP
  - Ina Road WPCF
  - Randolph Park WRF
- Transfer Some:
  - Roger Road WWTP (downsized)
  - Ina Road WPCF (expanded)
  - Randolph Road WRF
- Transfer All:
  - Ina Road WPCF (expanded significantly)
  - Randolph Road WRF

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Transfer Flow Issues

- What are environmental impacts?
  - Groundwater recharge
  - Santa Cruz River habitat
- How will reclaimed water needs be provided?
  - From where?
  - By whom?
- New conveyance system – size/route

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Flow Transfer

- Plant interconnect
- Flow management structures
  - Tucson Boulevard – 5.35 mgd
  - Craycroft Road – 2 mgd
  - Others?

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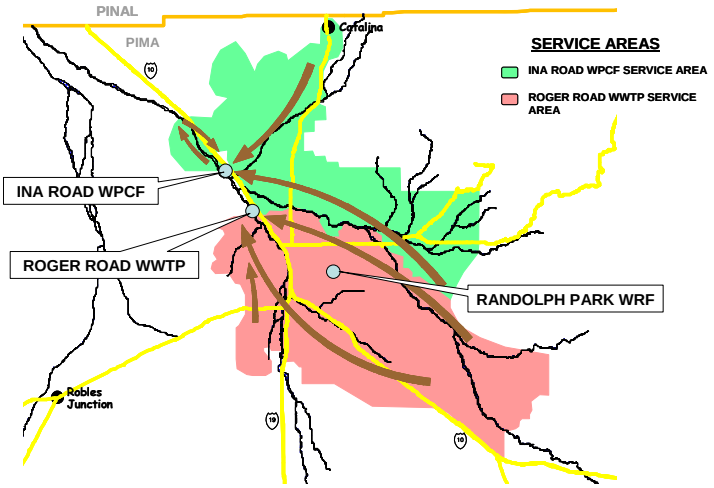
Roger Road WWTP/Ina Road WPCF Service Area



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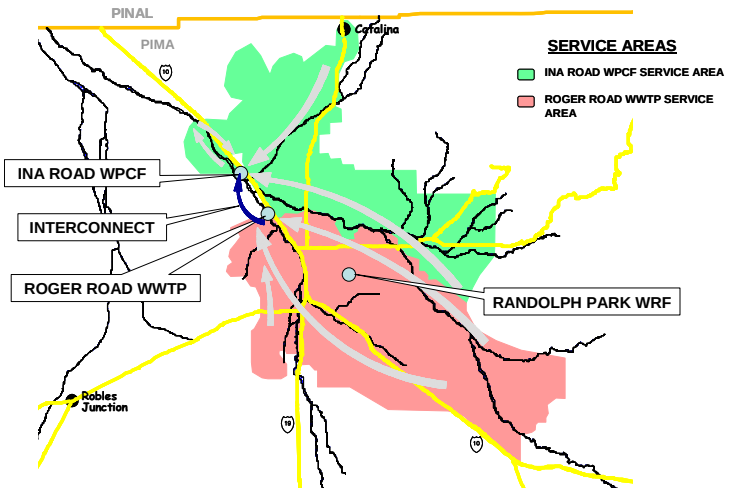
Transfer Some



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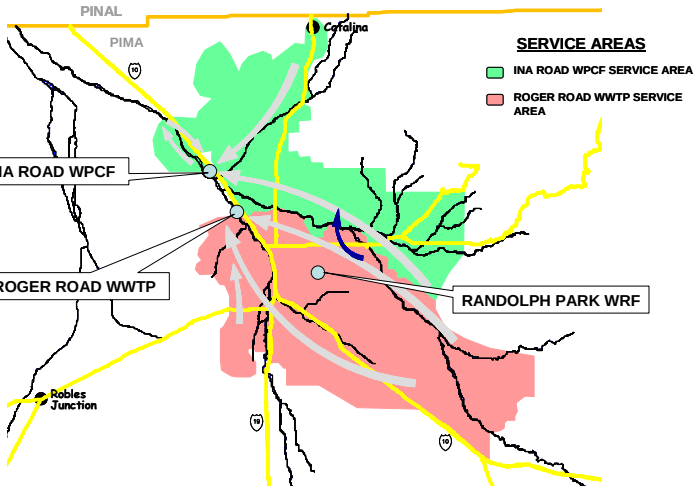

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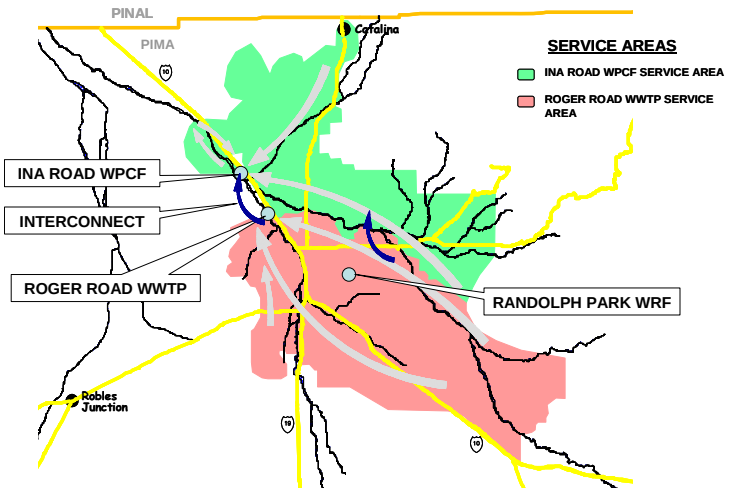

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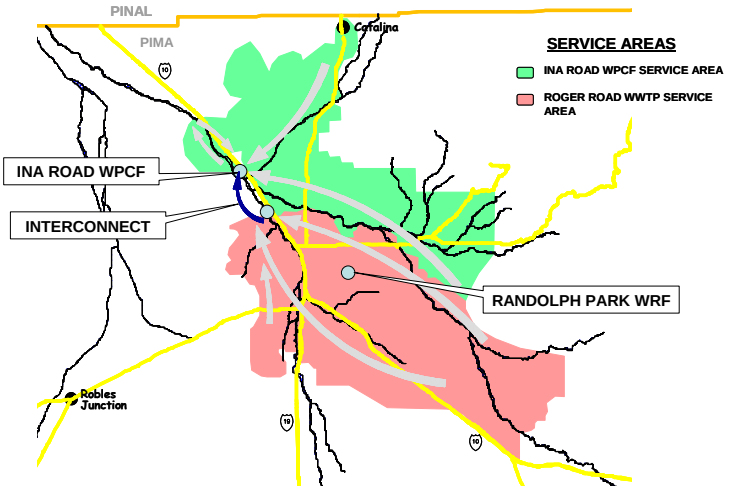
Transfer All



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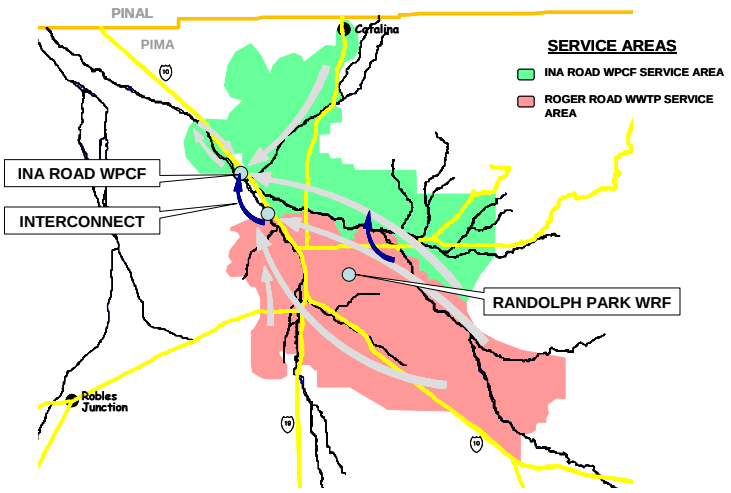
Transfer All



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Pima County Wastewater Management Department

GREELEY AND HANSEN

Roger Road WWTP/ Ina Road WPCF Evaluations

Andy Richardson

Roger Road WWTP/Ina Road WPCF Condition Evaluations

- Issues for discussion
  - Cost of risk transfer to contractor?
  - Cost premium for rehabilitation construction versus new?
  - When has a useful life been used?
  - How should we evaluate technology risk?

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Treatment Alternatives

Orrie Albertson

Process Evaluation

- Wastewater characteristics/analyses (3 yr.)
  - Ina Road WWTP
  - Rogers Road WWTP
- Allocation for future flows and loadings
- Flow and loading allocation to
  - Ina Road WWTP
  - Rogers Road WWTP

105

Process Evaluation *(continued)*

- Reusable components of each Plant
- Alternative process evaluation
- Process selection criteria
- Permit and target effluent quality
  - Current
  - Future?

106

Wastewater Characteristics/ Analyses

- Analyze last 3 years of data
- Present data in tabular and graphical formats
  - Average annual
  - Maximum month
  - Average monthly ± 2 std dev
  - Chronological / annual trends
- Summarize recent data
- Define additional tasks, if needed

107

Wastewater Characteristics/ Analyses *(continued)*

Summary of Current Data

Plant:_____ Period: _____to _____

Parameter	*Units*	*Annual Average*	*Maximum Month*	*Maximum Day*	*Peak Hour*
Flow	mgd				
COD	lb/d				
BODs	lb/d				
TSS	lb/d				
TKN	lb/d				
NH_4-N	lb/d				
TP	lb/d				
Tmin	°C				

Add future flow and loads for each plant.

108

Allocation for Future Flow and Loadings

- Definition of population growth
  - Allocations for industrial growth
  - Establish total design criteria
- Flow and loading allocations to plants
  - Key: early decision for process design
  - Influent quality is different for each plant
- Required for process evaluation and facility sizing

109

Reusable Components of Each Plant

- Inventory existing tankage
  - Condition
  - Volume, size, water surface elevation
  - Cost of refurbishing
  - Needed?
- Inventory existing equipment
  - Condition
  - Refurbish/replace
  - Needed?

110

Alternative Process Evaluation

- Baseline Processes
  - TKN ≤ 45 to 50 mg/L
    Modified Luzack-Ettinger Flowsheet (MLE, MLR, AO)
  - TKN ≥ 50 mg/L
    Four-Stage Bardenpho Flowsheet (Phoredox, A202)

Note:

All activated sludge processes will incorporate 3 or 4 stage bioselectors or other well documented method(s) of controlling sludge bulking without chemicals.

111

Alternative Process Evaluation
(continued)

- Processes to be considered:
  - MLE Flowsheet (Phoenix NdeN Process)
  - Four-Stage Bardenpho Flowsheet
  - IFAS Reactor (Kaldnes, etc.)
  - Step-Feed Flowsheet
  - MBR System
  - Trickling Filter / Activated Sludge / Denite Filters
  - Activated Sludge / NTF / Denite Filters

112

Process Selection Criteria (Measurement Tools)

- Process performance reliability
- High mechanical reliability
- Process stability, ease of operation
- Low operating and maintenance cost
- Long-life of mechanical components
- Fit available space
- Acceptable capital cost

Quantifiable: Life cycle cost
Non-Quantifiable: Mutual agreement of value/need

113

Permit and Target Effluent Quality

Parameter	*Units*	*Permit*	*Design Target*
BODs	**mg/L**		**< 6**
TSS	**mg/L**		**< 10**
NH_4-N	**mg/L**	**2**	**< 1**
TN	**mg/L**	**8**	**< 6**
pH	**-**		**6.8 – 7.2**

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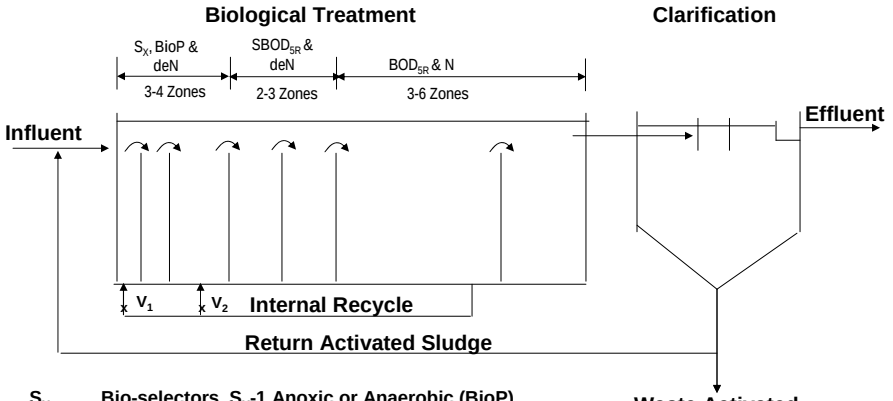
Semi-Aerobic Process for Bulking Control and Nutrient Removal

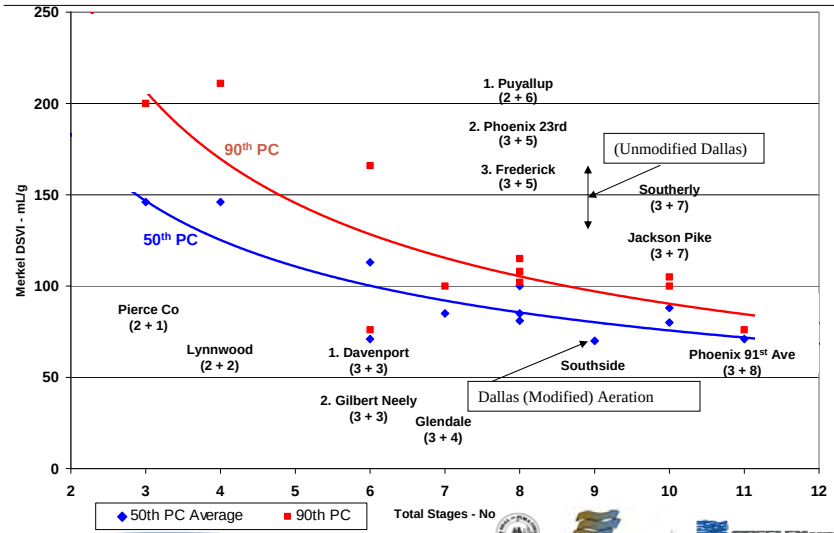


S_X	Bio-selectors, S_X-1 Anoxic or Anaerobic (BioP)
deN	Denitrification and $sBOD_5$ Removal/Oxidation
BioP	Biological Phosphorus Removal with V_1 closed
N	Nitrification and BOD_5 Oxidation

Mixing is Provided by Diffuser Aeration or Mixers

115

Effect of Number of Biological Stages (Bioselector + Anoxic and Oxic Stages)



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Biosolids

Carl Koch

Existing Conditions – Facilities

- Roger Road WWTP
  - GT corrosion problems
  - DAF function problems
  - Scum/grit/rag problems in digesters
  - Possible structural issues with digesters
  - Digester gas storage problems
  - Possible sludge pump issues

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Existing Conditions – Facilities

- Ina Road WPCF
  - Possible corrosion problems in thickening process
  - Hydrogen sulfide in compressor seal water
  - Digester mixers maintenance issues
  - Gas piping capacity issues
  - Limitations on centrifuge dewatering
  - Odor control issues

119

Existing Conditions – Class B

- Producing Class B product
- Land application of dewatered sludge
- Transport issues associated with % solids
- Future loss of application sites
- Potential public resistance to Class B product

120

Why Continue with Class B?

- Less Expensive
- Simpler to Operate
- Satisfies EPA Regulations
  - Acceptable Risk
- Consistent with Current Market Conditions

121

Why Consider Class A Process?

- Less Restrictive Management and Monitoring Requirements
- Lower Level of Pathogens
- Lower Odor Potential
- Perceived Superior Product
- More Utilization Options
- Public Pressure

122

Likely Class A Processes

- Staged/Thermophilic Digestion
- Alkaline Stabilization
- Composting
- Heat Drying

123

Types of Class A Products

- Liquid
- Cake
- Soil Amendment
- Compost
- Dried Pellet
- Aggregate

124

What Are the Markets?

- Fertilizer
  - Liquid/Cake
  - Compost
  - Alkaline Conditioned Product
  - Dried Pellet
- Construction
  - Vitrified aggregate
  - Artificial soil

125

What Are the Markets?

- Energy
  - Fuel Supplement
  - Oil Conversion
  - Digester Gas
- Manufacturing
  - Cement Kilns
  - Fertilizer Additive
  - Building Materials

126

What's New In Biosolids Dewatering

- More Efficient Centrifuges
- Enclosed Belt Press
- Disc Press
- Screw Press
- Robot Assisted Drying Beds
- Increased Pressure Belt Presses
- Heat assisted mechanical drying

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Biosolids Processing Issues

- Biosolids "Existing Plan"
  - Pump raw solids from Roger Road to Ina Road for processing
    - Eliminates solids handling/treatment at Roger Road
    - Increases recycle stream issues at Ina Road due to unbalance liquid flow/solids flow
  - Prepare for conversion to Class A

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Biosolids Processing Issues

- "Transfer Most" or "Transfer All" Options
  - Must consider biosolids processing with each alternative
    - Plan for recycle stream processing in alternatives
    - Plan for future disposal options/markets
    - Evaluate Class A conversion with market analysis and schedule
    - Centralized Sludge Processing can Increase Recycle Loads

129

Biosolids Processing Issues

- Selecting process/location of stabilization must consider future regulations and market
- Recycle streams are significant and must be planned for in liquid treatment
- Dryness of product (volume) significantly impacts operation costs
  - Biosolids processing considerations must be integral in plant process evaluations and cost analyses!

130

Biosolids Process Evaluation and Selection

- Evaluate with overall treatment option
  - Existing Plan, Transfer Most, Transfer All
- Evaluate future market changes
- Determine appropriate processes consistent with future markets
- Evaluate processes on cost, operation, maintenance, conversion, reliability
- Include stakeholders in determination

131

Expectations

- Prioritization of Biosolids Upgrade Projects
- Approach to Achieve Class A
- Determination of Site Requirements
- Determination of Recycle Impacts

132

Outlying Area Scenarios

Jerry Bish

Outlying Facilities Issues

- What is the future growth/flows?
- How to address future flows?
- Could growth stress Metro conveyance system?
- Can facilities be consolidated?
  - Connect to regional facilities
  - Construct sub-regional WPCF/WRF

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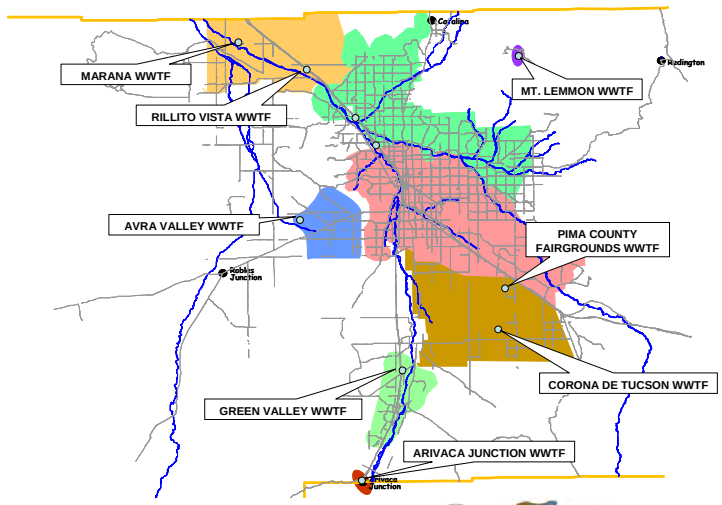
Outlying Facilities



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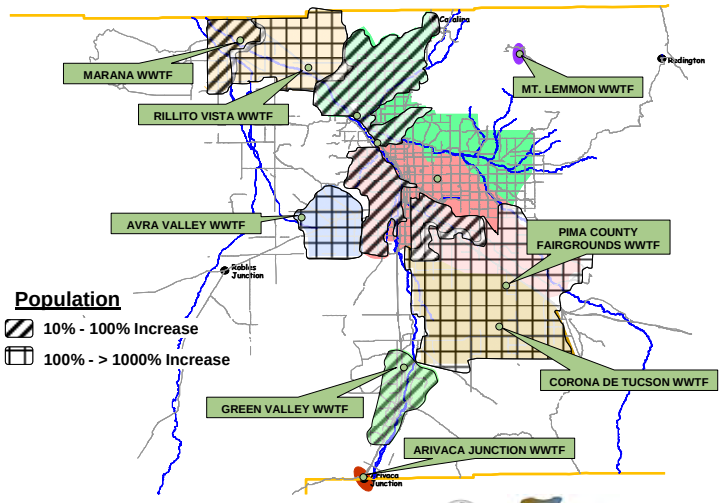
Projected Growth



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Outlying Treatment Facilities

- **Northwest Region**

Facility	*Capacity, mgd*	
	Current	*Future*
Marana WWTP	0.20	4.44
Rillito Vista WWTP	0.01	0.00
Totals	**0.21**	**4.44**

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Outlying Treatment Facilities

- **South/Southeast Regions**

Facility	*Capacity, mgd*	
	Current	*Future*
Avra Valley WWTP	1.600	2.950
Green Valley WWTP	4.100	6.100
Arivaca Junction WWTP	0.066	0.000
Southlands	0.000	13.700
Corona de Tucson WWTP	0.117	2.630
Fairgrounds WWTP	0.003	0.003
Totals	**5.890**	**25.380**

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Outlying Treatment Facilities

- **Other**

Facility	*Capacity, mgd*	
	Current	*Future*
Mt. Lemmon WWTP	**0.0125**	**0.0125**
Desert Museum WWTP	**??**	**??**
Sahuarita WWTP	**??**	**??**

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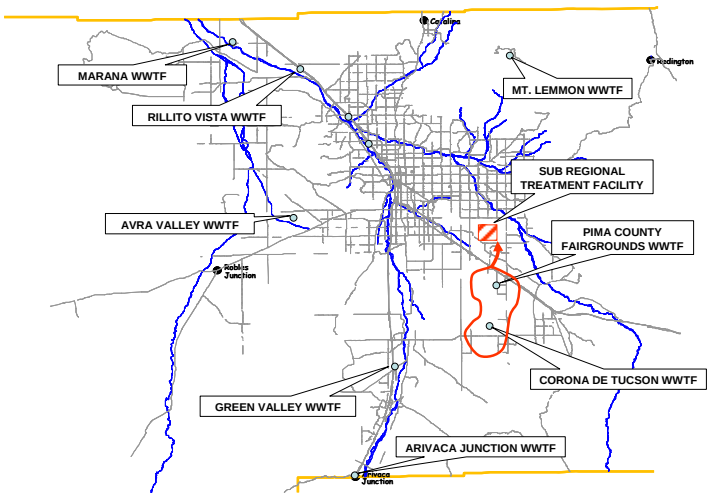
Sub-Regional Treatment Facility



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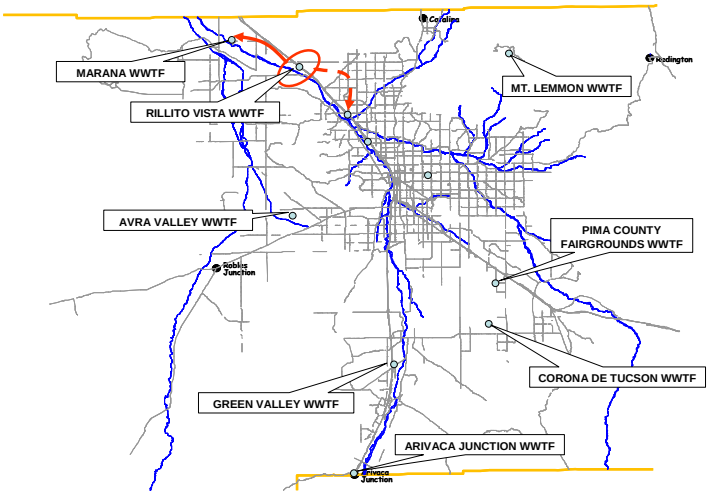
Consolidation of Northwest Facilities



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Evaluation Criteria

Gordon Culp

Potential Evaluation Criteria

- Feasibility
- Cost
- Schedule
- Flexibility
- Environmental impacts
- Water reuse potential
- Public acceptability
- Cost sharing potential
- Effects on ability to finance
- System reliability

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Potential Evaluation Criteria

- Feasibility (treatment alternatives)
  - Can existing facilities be converted to BNR?
  - Will the conversion result in a facility that is readily and reliably operable as a BNR plant?
  - Are there any other aspects of the alternative that are fatal flaws?

144

Potential Evaluation Criteria

- Cost (treatment plant plus collection system)
  - Capital
  - O&M
  - Life cycle (includes consideration of probable life of rehabilitated vs new facilities)

145

Potential Evaluation Criteria

- Schedule, includes consideration of time requirements for
  - Permitting
  - Financing
  - Land or easement acquisition
  - Construction
  - New multi-party agreements
  - Addressing other legal issues

146

Potential Evaluation Criteria

- Flexibility, includes consideration of ability to cope with
  - Changing development pace and patterns
  - Changing discharge and reuse requirements
  - NdeN requirements
  - Changing biosolids demands and regulations
  - Future expansion
  - Advances in available technology

147

Potential Evaluation Criteria

- Environmental impacts, includes consideration of
  - Nature of land uses impacted
  - Odor
  - Noise
  - Construction activities
  - Riparian habitat
  - Groundwater quality/quantity
  - Surface water quality

148

Potential Evaluation Criteria

- Water reuse potential, includes consideration of
  - Location of reclaimed water
  - Location of potential demand for reclaimed water
  - Quantity of reclaimed water
  - Quality of reclaimed water

149

Potential Evaluation Criteria

- Public acceptability
- Cost sharing potential
- Effects on ability to obtain financing
- System reliability

150

Criteria Weighting

Criteria	*Relative Weight*
Cost	
Schedule	
Flexibility	
Environmental impacts	
Water reuse potential	
Public acceptability	
Cost sharing potential	
Effects on ability to finance	
System reliability	

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Decision Matrix – Cost Comparison

System Element	*Existing Plan*	*Transfer Some*	*Transfer All*
Treatment-Capital Cost			
Conveyance-Capital Cost			
Treatment-Annual O&M			
Conveyance-Annual O&M			
Total, Present Worth Cost			

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Decision Matrix – Evaluation Criteria

Criteria	*Existing Plan*	*Transfer Some*	*Transfer All*
Cost			
Schedule			
Flexibility			
Environmental impacts			
Water reuse potential			
Public acceptability			
Cost sharing potential			
Effects on ability to finance			
System reliability			

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Level of Cost Estimates

Joe Popeck – Harold Smith

Types of Cost Estimates

- Comparative Cost Estimates
  - Used to compare alternatives
  - Do not include common elements (site work, roads, landscaping, etc.)
  - Present Worth of Capital and O&M Costs
- Conceptual Design Capital Cost Estimates
  - Used for Budgetary Planning of Recommended Alternative
  - Does include estimates for common elements

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Comparative Cost Estimates

- Capital
  - Unit costs per square foot or volume for process tankage and building structures
  - Vendor Cost Estimates for Major Equipment
  - Appropriate Contingency Costs for piping, mechanical, electrical, instrumentation, etc.

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Comparative Cost Estimates
(continued)

- O & M
  - 1% of Capital Cost for process tankage and structures
  - 3% of Capital Cost for major equipment
  - Power usage estimates for identified large motors
  - Current cost for power ($/kwh)
  - Chemical usage estimates
  - Current chemical costs

157

Conceptual Design Capital Cost Estimates

- Capital
  - Limited Quantity Take-offs for Demolition and Removal with prices from Means
  - Unit costs per square foot or volume for process tankage and building structures, or:
  - Limited Quantity Take-offs with Material Prices from Means
  - Updated Vendor Cost Estimates for Major Equipment
  - Limited Quantity Take-offs with prices from Means for piping, mechanical, electrical, instrumentation, etc.

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Conceptual Design Capital Cost Estimates *(continued)*

- Capital
  - Limited Quantity Take-offs for common elements (site work, roads, landscaping, etc.) with prices from Means
  - Appropriate Contingency Costs for undefined elements
  - Appropriate Contingency Costs for PCWMD Administration, Design Services, Contractor's OH&P, etc.

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Purpose of Financial Analysis

- Purpose of financial analysis is two-fold:
  - Comparative analysis for decision making purposes
  - Analysis of funding options

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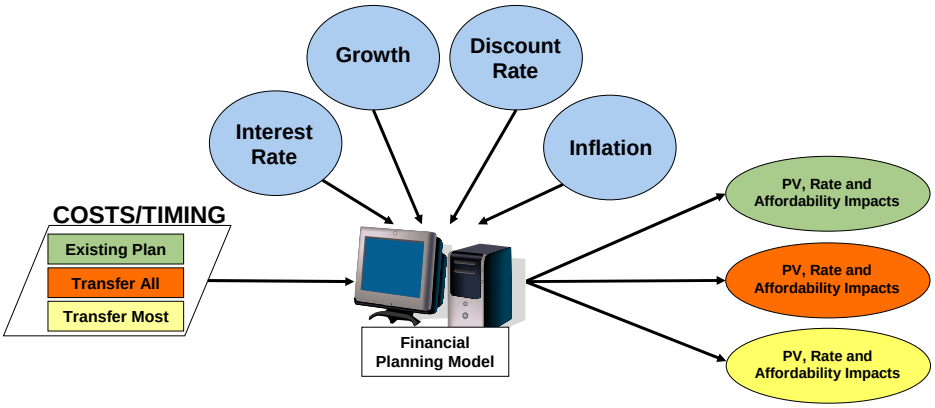
Comparative Analysis



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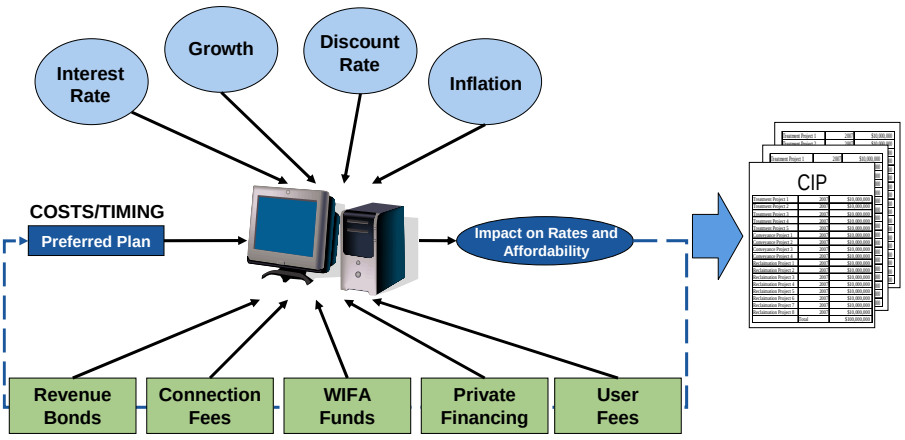
Funding Options Analysis



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Model Inputs

- Project costs
- Project timing
- O&M costs
- Inflation
- Interest rates
- Discount rate
- Growth (customers and flows)

163

Model Output

- Present value of each option
- Affordability impact analysis
- Customer type specific rate impacts
- Risk profiles
- Debt service coverage ratios
- Fund balances

164

Risk Analysis

- Uses sophisticated risk analysis software
- Capable of analyzing the impact of multiple variables
- Applicable to both sides of the financial equation

Costs
– Construction costs
– O&M Costs
– Interest Rates

Revenues
– Volume Discharged
– Growth

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Key Attributes of the Financial Planning Model

- Long-term (25 years)
- Navigational menu
- Centralized input schedules
- Custom scenario builder
- User friendly
- Easily updated

166

Background

Jerry Bish

Background Information

- 2006 Facility Plan Update
  - Population forecast (PAG)
  - Conveyance system capacity
  - Conveyance system condition
  - Treatment facility descriptions/capacities

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Background Information

- Tucson Water – Water Plan 2000-2050
  - Water resource challenges
  - Pressure to utilize reclaimed water
  - Encourages sewer connections
  - Construct new reclaimed supply sources
- Intergovernmental agreements

169

Background Information

- Ina Road WPCF AZPDES Permit (3/11)
- Roger Road WWTP AZPDES Permit (1/11)
- Ina Road WPCF APP dated 2-27-02
- Roger Road WWTP APP dated 2-27-02
- Biosolids NPDES (Part 503)
- Air Quality Permit

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Background Information

- To be collected:
  - Treatment plant capacity models
  - Conveyance system capacity information
  - Performance history at Roger Road WWTP and Ina Road WPCF
  - Financial/budget information
  - Bond statements
  - Rate history

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Background Information

- To be developed:
  - Condition assessment of Ina Road WPCF
  - Condition assessment of Roger Road WWTP
  - Condition assessment of outlying facilities

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Background Summary

- Population growth requires treatment and conveyance expansion
- Regulators require better wastewater treatment to achieve high quality effluent
- Existing capacity at Roger Road WWTP and Ina Road WPCF are limited
- Portions of conveyance system requires condition rehabilitation

173

Background Summary

- Conveyance capacity generally good
- Growth stresses conveyance capacity in certain areas
- Biosolids treatment requires expansion, modification and upgrades

174

Background Summary

- Reclaimed water use will increase
- Future bond authorizations (2008, 2012, 2016, 2020)
- CIP >$1.4 billion over 25 years

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Pima County Wastewater Management Department

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List of Stakeholders

Andy Richardson

Stakeholders

- Pima County
- Pima County Wastewater Management Department
- Tucson Water
- Metro Water
- Oro Valley Water
- Marana
- South Tucson
- ADEQ

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Pima County Wastewater Management Department

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Pima County Wastewater Management Department

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Preview of Next Workshop

Andy Richardson

Workshop #2 Draft Agenda

- Reuse Workshop
  - Impacts of continuation of existing reuse plan
  - Impacts of "transfer some" treatment option
  - Impacts of "transfer all" treatment option
  - Potential for "combined wastewater treatment and reuse treatment" reuse option

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Closing

Andy Richardson – Mike Gritzuk

Workshop Objectives

- Familiarize group with scope of study, approach and schedule
- Familiarize group with workshop process for study execution
- Develop list of study expectations and identify obstacles
- Review project funding options, project delivery options and concept of contractor's risk
- Reach agreement on study options and key elements

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Workshop Objectives

- Gain consensus or informed consent on issues associated with Roger Road WWTP / Ina Road WPCF condition evaluations
- Review BNR and solids handling/treatment alternatives under consideration
- Reach agreement on study options evaluation criteria
- Gain understanding and agreement on level of cost estimates used
- Gain consensus or informed consent on level of detail of information used for final decision making
- Identify/verify study stakeholders

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Pima County Wastewater
Management Department

GREELEY AND HANSEN

Workshop #2 Meeting Notes
Reuse and Flow Transfer

1. The Reuse and Flow Transfer Workshop for Pima County Regional Optimization Master Plan was held on May 31, 2006. The workshop agenda is attached. Attendance included:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Jackson Jenkins
PCWMD Staff
David Bartos
Bob Decker
James Doyle
Laura Fairbanks
Frank Gall
David Garrett
Frank Luiz
Jing Luo
Byron McMillan
Glen Peterson
Jeff Prevatt
Prakash Rao
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
Mandley Rust
John Sherlock
Jack Van Riper
John Warner
Ken Weber
Legal
Harlan Agnew
Chuck Wesselhoff

TUCSON WATER
Director
David Modeer
TW Staff
Jeff Biggs
Karen Dotson
Sandy Elder

TW Staff, cont.
Richard Herran
Melodee Loyer
Ralph Marra
Mark Seamans
Tim Thomure
Dean Trammel
Tom Victory
Alan Forrest, CH2M Hill
Ken Thompson, CH2M Hill

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
Frank Postillion

METRO WATER DISTRICT
Charlie Maish

ORO VALLEY WATER
Davis Ruiz
Phillip Saletta

PIMA ASSOCIATION OF GOVERNMENTS
C. Zucker

TOWN OF MARANA
Brad DeSpain

BUREAU OF RECLAMATION
Eric Holler

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Mark Cross
Gordon Culp
Andrew Richardson

2. Major topics of the workshop were:

- Workshop #2: Reuse and Flow Transfer
  - ► Overview of Reclaimed Water Operations
  - ► Impacts of Wastewater Treatment Options on Reuse
  - ► Planning Input Review – Quantity, Quality, Location
  - ► Underground Storage and Recharge /Recovery Considerations
  - ► Intergovernmental Agreement Impacts and Considerations
  - ► Identify wastewater treatment and reuse alternatives for technical and economic review

Two sets of handouts were provided to each attendee which included presentation slides used during the workshop. One set, entitled Reclaimed Water System, is a summary of current operations and near future planning of the Tucson Water reclaimed water system. The second set, entitled Workshop #2 Reuse/Flow Transfer, summarizes planning inputs, issues and considerations that are to be included in the master plan development.

Throughout the workshop, a list of notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, opened the workshop with a few remarks followed by Dave Modeer, Director of Tucson Water, with additional opening remarks. .The Directors stated the purpose of the meeting was to explore, identify and understand the reuse needs of Tucson Water and Pima County. The project is a technical evaluation of wastewater treatment and associated effluent reuse to provide a cost effective and practical way to deliver needed services to the community. This workshop is to review and discuss effluent reuse issues that will best serve the citizens of the community without regard to the current institutional arrangements that may act as barriers. Effluent reuse is becoming a very important part of the regional sustainability and will become more important to our future. The future will require that the County achieve maximum reuse of the wastewater effluent. Therefore the two organizations must work cooperatively on the technical issues to develop cost effective solutions to advanced wastewater treatment and future effluent reuse needs.

Effluent reuse is becoming increasingly important to the future of the community and needs to be dealt with cost effectively. The workshop is to clarify and enhance the understanding of how reclaimed water may be impacted by the three wastewater options under consideration in the master plan development – Existing Plan, Transfer Some, and Transfer All.

4. Andy Richardson defined his role as facilitator to move the group through the agenda and to encourage participation from the expertise available in the room. The purpose of this workshop is to clarify the inputs on effluent reuse. The emphasis is on participation by the assembled.

Agenda, ground rules and objectives of the first workshop were presented and covered on pages 1 through 4 of the Workshop #2 Reuse/Flow Transfer handout. Although the workshop proceeded in a different sequence than outlined on the agenda, each of the agenda topics was covered during the workshop.

5. Sandy Elder provided the introduction to the Tucson Water overview of effluent reuse. The reuse system is dependent upon the wastewater system operations including the quantity, quality of the raw effluent and where it is located.

6. Karen Dotson provided a summary of the Tucson Water organization, current reclaimed water users, effluent allocation agreements, quality of distributed reclaimed water (Class A). Reclaimed water users include 34 parks, schools, golf courses and 500 single family homes. Golf courses utilize 62% of the reclaimed water. The University of Arizona is the largest industrial user of reclaimed water.

7. Tim Thomure stated why reclaimed water is important to the community. It affects the potable water supply and affects the peak water summer demand in the community. Reclaimed water quality is suitable for a number of uses and relieves potable water demand. Population projections using the Pima Association of Governments (PAG) data for planning suggests that after 2025 additional renewable water sources will be needed.

   Effluent entitlements by entity were review based on 68.200 Acre Feet (AF)/year. Entities with effluent entitlement include the Water Providers, Pima County and the Federal government through the Southern Arizona Water Rights Settlement Act (SAWRSA). Tucson Water and Pima County will also participate in future conservation projects through the Conservation Effluent Pool (CEP) agreement.

   Locations of the effluent for reuse include the Sweetwater Facilities adjacent the Roger Road WWTP, recharge/recovery areas in the Santa Cruz River below Roger Road WWTP and Ina Road WPCF, and the Randolph Park WRF.

   New demands for reclaimed water are increasing. In the near future Oro Valley is adding 2,000 AF/year to their needs. The County needs are projected to increase from 11,000 to 12,000 AF/year to 20,000 AF/year by 2020. These estimates do not include the effluent needs of Metro Water, who has rights to some quantity of effluent.

   Constructed recharge and recovery basins can get credit for recovery of up to 100% of the effluent for use. Managed recharge can at best get credit for recovery up to 50% of the effluent for use in the community.

   To maximize effluent water utilization in the community, direct use and recharge/recover will need to be in the right place. Before addressing the options of the master plan, Tucson Water was considering the development of a reclaimed water supply at Ina Road WPCF, development of a "wet" water recovery system in the lower Santa Cruz River (below the Ina Road discharge) and expanding the Roger Road Sweetwater facility through re-permitting of the recharge and recovery basins from 6,500 AF/year to 9,000 AF/year.

   The future vision of Sweetwater recharge and recovery basins over the years is to increase that facility from 9,000AF/year to 12,000 AF/year then to 16,000 AF/year and ultimately to 20,000AF/year. Sweetwater is the hub of the Tucson Water operations and would costs $10's of millions to duplicate.

It is believed that there is sufficient demand for reclaimed water that underground storage is needed in the future even though Class A+ water is provided at the plant outfall. Direct recharge in wells is not permitted and Class A+ water does not meet the standard for aquifer recharge.

8. Tom Victory presented information on the reclaimed water distribution system. The average demand in the system is 11 million gallons per day (mgd). Peak demands are 2.3 times the average. Storage in the conveyance system is 15 million gallons plus storage at the golf courses in the lakes.

   The system experiences both seasonal and daily demands. The peak seasonal demands are in June and July. The low demand is in the winter. Daily demands peak at night when wastewater flows at the plant are low, making system storage necessary.

   It was noted that there are several "pinch" points in the existing distribution system that limit the capacity of the pipelines to deliver flow. If a source is developed at Ina Road WPCF, then there would be relief on the distribution system to the north of Roger Road WWTP and enable the system to be more flexible in meeting the customer demands. If all treatment is provided at Ina Road WPCF, there will need to be additional reclaimed water distribution piping to the south as the 24-inch line between Ina Road WPCF and Roger Road WWTP has a capacity of only 10 mgd.

   Effluent from the Sweetwater pressure filter treatment plant is blended with the recovered water from the recharge basin to achieve the Class A reclaimed water rating. The water blending is approximately a 50/50 split to achieve water quality. There is no regulatory requirement for a minimum volume of discharge to the Santa Cruz River at Roger Road WWTP, but the County needs to maintain a minimum discharge of 5 mgd to provide water for power plant cooling and sampling of the effluent.

   The Tucson Water criteria for success of the planning effort are:
   - Provide continuous service to existing customers
   - Water quality is maintained or improved
   - Supply must meet growing demand
   - Meet peak demands in most cost effective way, use aquifer for low cost storage
   - Preserve wetlands, they are perceived as an amenity
   - Retain existing infrastructure for reuse at Roger Road, a $200 million investment
   - Hold the cost down for the customers

   The reclaimed water system in Items 5, 6, 7, and 8 were covered in the handout entitled Reclaimed Water System.

9. John Warner indicated that the wastewater conveyance system would like to be customer of the reclaimed water system. Conveyance has instituted a sewer flushing program and would like access to reclaimed water throughout the conveyance service areas to reduce the usage of potable water for this activity. It was noted that often the cost to retrofit the system to make available reclaimed water can be expensive. Furthermore, the extent of the reclaimed water distribution system is somewhat limited as compared to the area covered by the conveyance system.

10. Mike Gritzuk stated that based on the forgoing workshop review of the current reclaimed water system and future needs; there are a number of alternatives that could be developed. (Assumes the treatment plants produce a Class A+ reclaimed water quality at the end of pipe.) Those alternatives are:

    - Base case – Roger Road WWTP remains in operation at 32 mgd with the Sweetwater Recharge/Recovery Facilities.
    - Roger Road WWTP size is reduced to match the Tucson Water demand for reclaimed water. (Scalping facility or with some discharge to the Santa Cruz River?)
    - All reclaimed water is produced at Ina Road WPCF. Roger Road WWTP is eliminated and Sweetwater Facilities are eliminated. Tucson Water or the County builds Sweetwater like facilities at or near Ina Road WPCF.
    - Ina Road WPCF produces reclaimed water and the Sweetwater Recharge and Recovery Facilities remain in operation next to Roger Road WWTP.
    - Randolph Road WRP remains at existing 3 mgd capacity
    - Randolph Park WRF expands to a greater capacity than 3 mgd. (This does not appear viable because of the limited service area connected with the plant.)
    - Abandon Randolph Park WRF.
    - Satellite wastewater treatment (scalping?) plants in the outlying areas are upgraded to reclaimed water quality and are used by Tucson Water to augment the reclaimed water system.
    - Santa Cruz River recovery is increased by constructed versus managed recharge systems.
    - Connect all outlying facilities to either Roger Road WWTP or Ina Road WPCF.
    - Provide an independent Southlands treatment facility with reclaimed water provisions.
    - Expand Roger Road WWTP to provide more flow to Tucson Water at a better elevation.
    - Provide potable quality reclaimed water and inject it directly into the aquifer

    If all the treatment is provided at one large Ina Road WPCF, the plant may produce a minimum flow adequate to meet reclaimed water demands without the need of underground storage.

    Determine what are the ultimate uses of effluent water? The plan should not box out any future options.

    The advantages and disadvantages for each of the above alternatives will need to be developed after the workshop.

11. The plan should take into account where water can be stored long-term. Storage will require land for recharge unless recharge wells are utilized. Avra Valley at the Pima Mine area has land available for recharge.

12. Laura Fairbanks reminded the group that odors must be considered with all alternatives. Long travel times of the wastewater in the sewers before the wastewater enters a treatment facility increase the potential for odor releases and complaints in the community.

13. There may be merit in locating “scalping” plants adjacent to the reclaimed water distribution system. Several locations were offered and include: Park and I-10, Rillito at Tucson Boulevard,

Harrison at Pantano, Tangerine at I-10, Thornydale at Tangerine, and a location adjacent the CAP canal. Brad DeSpain indicated that the Tangerine and I-10 would make a great water campus site.

14. Gordon Culp reviewed the wastewater treatment options and the areas of impact on the reclaimed water system. The options include:

    - Maintain existing plan
    - Transfer Some Flow from Roger Road WWTP to Ina Road WPCF (treat 20 mgd ± at Roger Road WWTP)
    - Transfer All Flow from Roger Road WWTP to Ina Road WPCF

    The Transfer Some and Transfer All options may require pumping plant effluent back to the Roger Road or Sweetwater facilities or both.

    The treatment options were covered on pages 16 through 19 in the Workshop #2 Reuse/Flow Transfer handout.

15. Jerry Bish reviewed the reclaimed water planning inputs. Quantities of effluent, diurnal and seasonal variation of reclaimed water demand, probable water quality, and current storage and recovery requirements were presented. The inputs were identical or similar to those presented by Tucson Water in Items 5 through 8 above. In addition, the effluent quantities at the outlying facilities were presented to complete the picture of the available effluent for reclaimed water use.

    The planning inputs were covered on pages 5 through 11 of the Workshop #2 Reuse/Flow Transfer handout.

16. Mark Cross reviewed the underground water storage in the aquifer and subsequent recovery considerations to meet seasonal storage and recovery needs. Underground storage is cost-effective and allows the current blending practice to meet Class A reclaimed water requirements. Potential for future use of injection wells for effluent was presented. It was stated that effluent at 2 NTU will cause clogging over time and would require periodic well maintenance and potential redrilling (especially for vadose zone injection wells) to keep viable. Further, the injection wells will require chlorination to prevent growths in the well. Zero discharge from Roger Road WWTP will change groundwater levels and groundwater movement in the local area. Conceptually from a hydrogeologic perspective, the underground storage facilities could be placed at Ina Road WPCF if land is available and other concerns and issues were met satisfactorily.

    The underground storage and recovery considerations were covered on pages 20 through 25 of the Workshop #2 Reuse/Flow Transfer handout.

17. Tim Thomure indicated that if all reclaimed water operations are at Ina Road WPCF, the pipeline to the south will need to be increased in capacity. Current capacity is 20 mgd. The flow capacity would be greater than 28 mgd.

18. Jerry Bish reviewed the intergovernmental agreements that have an impact on reclaimed water issues. Between Tucson Water and Pima County, there are five basic agreements that govern

effluent. The intergovernmental agreements were covered on pages 11 through 14 of the Workshop #2 Reuse/Flow Transfer handout.

19. Byron McMillan reminded the group that the ADEQ permit requirements have set the timeline for the future option to be executed. A letter to ADEQ describing the direction of Pima County's wastewater compliance is required by January of 2007 with facilities in place and operating by 2014 or 2015.

20. Changes to reclaimed water regulations will need to be factored into the future. The regulations have gotten progressively more restrictive in the past 22 years of operation.

21. A number of issues and concerns were offered in the closing remarks by the attendees. Comments ranged from the riparian habitat issues in the Santa Cruz River being difficult to address, to having a discussion with Marana on water reuse, to looking at the upper reaches of the local rivers for water reuse opportunities, to purchasing land for new facilities, to keep wet water in Pima County and more. Additional comments are provided in the attached "flip chart" notes.

22. Dave Modeer and Mike Gritzuk offered closing remarks. The master plan will involve substantial costs to the community. Dealing with public and politicians on costs will be difficult. The benefits for the costs will need to be clearly addressed in the master plan. In the meantime Tucson Water will need rate increases to meet its operational needs. Although Tucson Water and Pima County are different organizations, reclaimed water is a water resource issue for both organizations and the organizations need to work together and focus on the best technical and economical solution. The two organizations are serving the same people in the community and we need the right holistic approach.

    The regulatory timeline has given Pima County until January 2007 to identify and submit the optimal solution for their review. For Tucson Water and Pima County, water reuse will be difficult to narrow to one specific option. More discussions will be required between the two organizations in the next several weeks to focus on the optimal reuse option with regard to the wastewater options under consideration.

23. Andy Richardson previewed the next workshop scheduled for June 5, 2006. Workshop # 4 will brainstorm various wastewater treatment alternatives for Roger Road WWTP and Ina Road WPCF and address issues and consideration of each.

Agenda
Workshop #2 – Reuse/Flow Transfer Workshop*
May 31, 2006

Time	Topic	Presenter	Pg
7:30 am	*Continental Breakfast – Rio Nuevo Upstairs Conference Room, 52 W. Congress*		
8:00 am	Opening Session		
	• Welcoming Remarks	Mike Gritzuk	1
	• Overview of Agenda	Andy Richardson	2
	• Adoption of Groundrules: Role of Facilitator		
	• Confirmation of Agenda		
	• Workshop Objectives–Pima County/Tucson Water	Mike Gritzuk/Dave Modeer	4
8:30 am	Reclaimed Water Operations Overview	Tucson Water	4
9:30 am	Clarifying Planning Inputs	Jerry Bish	5
	• Volumes/Flow		
	• Reclaimed Water Quality		
	• Reclaimed Water Demand (Annual, Peak, Summer, Winter)		
	• Balanced (storage) Underground Recharge/Recovery Facilities		
	• Plant Effluent at Outlying Areas		
10:30 am	Break		
10:45 am	IGA Impacts/Considerations	Mike Gritzuk/Dave Modeer/Jerry Bish	11
11:05 am	Current/Future Reclaimed Water Treatment Operations	Jerry Bish	14
	• Sweetwater Facilities		
	• Randolph Park WRP		
11:20 am	Wastewater Treatment Options/Impacts	Gordon Culp	16
	• "Existing Plan"		
	• "Transfer Some"		
	• "Transfer All"		
11:40 pm	Underground Storage Recharge/Recovery Considerations	Mark Cross	20
Noon	Lunch		
1:00 pm	Summary of Reclaimed Water Issues	Andy Richardson	25
2:00 pm	Preview of Next Workshop	Andy Richardson	25
2:05 pm	Summary Wrap-Up	Andy Richardson	25
	Comment by Group	All	
	Closing Remarks	Mike Gritzuk	
2:30 pm	Adjourn		

* Workshop hosted by Tucson Water

Flip Chart Notes – May 31, 2006

Objectives

- Identify and understand current and future reuse needs
- Look at the current way the reuse systems operates
- Look at alternatives to improve future operations
- Identify technical and economical alternatives
- Provide for a sustainable, long term future of reclaimed water in Pima County
- Look at alternatives from point of view of the best interest to the community

Tucson Water Overview

- How much more reclaimed water will be needed, if level of treatment is higher than now?
- Consructed recharge has a 2 percent loss in recoverable water
- Major flow is going into Pinal County
- A higher level of treatment plus a place for it to be stored would make for more effluent use
- Recharge location is an issue to future use
- Sweetwater "prime" location for recharge – future 20,000 AF/yr - desired location by Tucson Water
- Move to a reclaimed water "quality" that could be directly recharged to keep water in Pima County
- Supply at Ina Road needs storage to manage seasonal demand
- Reclaimed water system has capacity issue in the north and central parts of the distribution system
- Need to consider location for new flow as it relates to constraints in reclaimed water distribution system
- Capacity: three types
  - Carrying capacity 5 fps/pressure loss in pipeline (conveyance/transmission)
  - Storage capacity for peak day demand
  - Booster capacity – moving flow from south to north
- Recharge and recovery at Sweetwater is a 6,500 AF/yr put and take
- Water quality controls location of recharge of effluent to the aquifer
- Roger Road WWTP needs to maintain a flow of 5 mgd out to river
- How merge both Tucson and Pima County success factors?
- Locate effluent where demands for reclaimed water is better; use of gravity can help
- Only 40 percent of customers pay for system, others pay a minimum fee for reclaimed water
- Future distribution system will be more looped, not branched
- Look at providing reclaimed water for sewer cleaning services? May not be economical
- Need to talk in terms of "wet" water
- 24-inch line is a pinch point for delivery to projected demand in north

Alternatives

- Base Roger Road, Sweetwater is location of all recharge
- If Roger Road remains, include filters at Tucson Water facility
- Down size Roger Road and treat to Tucson Water quality
- Roger Road is decommissioned, ***all*** reclaimed water at Ina Road; Tucson Water or Pima County builds facility at Ina Road
- Roger Road is decommissioned with flow to Sweetwater from Ina Road; Tucson Water or Pima County builds facility at Ina Road
- Roger Road growing, expand to meet needs
- Randolph maintained at 3 mgd
- Randolph Park expanded (in the future flow may drop may off to this facility)
- Randolph Park is decommissioned
- Satellite/scalping reclamation facilities upgraded to Tucson Water water quality
- Look at sub-regional WRPs to treat effluent to reclaim water quality (pipeline) – south and southeast – need to work out details
- Alternative – constructed recharge and recovery for Santa Cruz River to increase capacity of recharge – opportunity and constraints
- Membrane treatment to meet potable quality

Location of Facilities

- Place facilities where water can be stored, upgradient of Roger Road
- Place where there is flexibility regarding the reuse of water.
- Need locations where there is available land: Avra Valley and Pima Mine Road area; Southeast areas
- Locate reclaimed facilities next to reclaimed water systems
  - Park and I-10 (5 mgd flow available)
  - Tucson Boulevard at Rillito River
  - Southeast corner of Harrison and Pantano (60 acre site - HAMP area)
- Tangerine and I-10 east side (potential water campus site)
- Thornydale – on east side of Tangerine
- Need effluent for 100-year water supply

Inputs

- Bureau of Reclamation has water for sale

Groundwater

- Talk to County solid waste group relative to landfill site
- Transfer all – peak demand to be met by discharge from Ina Road
- Avra Valley recharge capability exists; bring into reclaimed water system by gravity flow from Roger Road
- No conveyance to Avra Valley at this time
- Pantano system with SAT could work
- Use Sweetwater for peak day storage

- Balance between how much storage for seasonal needs
- Can extend into Pinal County and get credits
- Tucson Water may be turning off wells; will have an impact on groundwater picture
- Bring flow back to CAP plant by way of Avra Valley – large plant in Marana discharge to CAP Canal

Summary Comments

- Approved sale of reclaimed water to Quail Creek
- Riparian habit below Roger Road WWTP needs to be addressed
- How do Tucson Water facilities and Pima County facilities line up?
- Timeline impacts on decisions regarding reclaimed water
- Talk to Marana about reclaimed water
- Projections to 2020; how to handle uncertainty beyond that year?
- Educate public on what we are doing – provide a united front between organizations
- Water standards will not back slide – look at standards in future
- Utilization of River for recharge
- What about land availability?
- Improvement of transport within right-of-way
- Understand SAWRSA
- First public meeting will be in 4 to 6 weeks
- How to generate funds for the new facilities.
- What are the future design changes by regulations?
- How to position reuse to benefit the community

Pima County Wastewater Regional Optimization Plan Study

Workshop #2
Reuse/Flow Transfer Workshop

May 31, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Tucson Water	Reclaimed Water Overview
Jerry Bish	Clarifying Planning Inputs
Gordon Culp	Treatment Plant Options
Mark Cross	Recharge/Recovery Considerations

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop objectives
- Reclaimed water overview
- Clarifying planning inputs
- IGA impacts
- Current/future reclaimed water operations
- Wastewater treatment options
- Underground storage considerations
- Discussion
- Closing

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

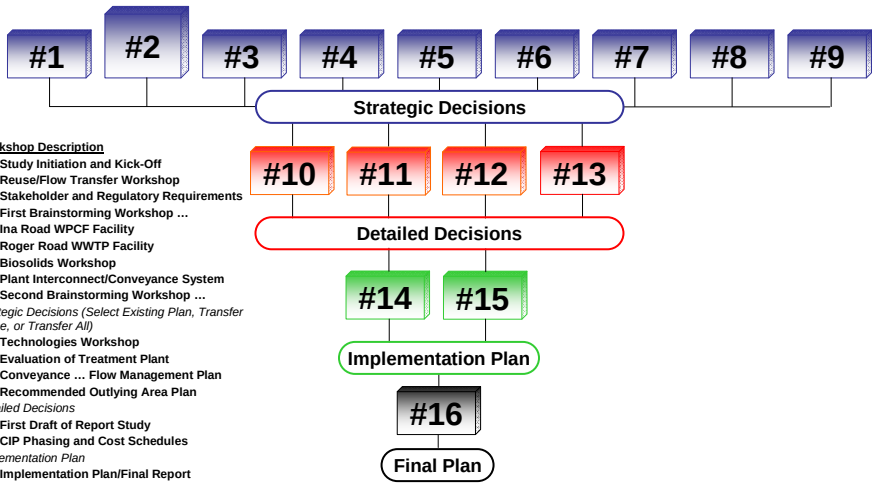
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop Objectives

- Reach understanding of Tucson Water's current reclaimed water operations
- Clarify existing data to be used for planning
- Discuss/understand underground storage considerations
- Impacts of continuation of *Existing* reuse plan
- Impacts of "*Transfer Some*" treatment option
- Impacts of "*Transfer All*" treatment option

11

Pima County Wastewater Management Department

GREELEY AND HANSEN

Tucson Water Operations Overview

Tucson Water

Clarifying Planning Inputs

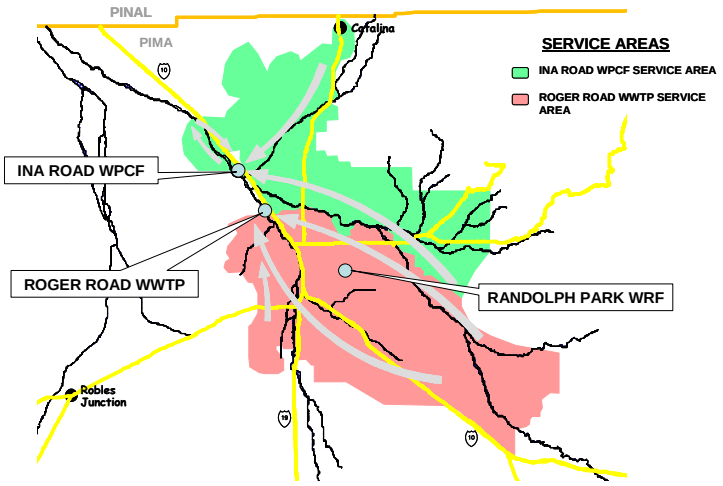
Jerry Bish

Reclaimed Water Uses

- Public/Private Turf Facilities
- Industrial Heavy Water Users
- Sweetwater Wetlands
- Sweetwater Recharge Facilities
- SCRMUSF
- LSCRMRP
- Conservation Projects (Sonoran Desert Conservation Plan)

14

Metro Wastewater Treatment Plants



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Roger Road WWTP

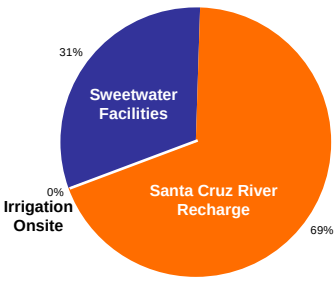
Roger Road WWTP Effluent

14 AF
Irrigation
Onsite

29,188 AF
Santa Cruz River
Recharge

13,124 AF
Tucson Water
Sweetwater Facilities/
Silverbell Golf Course

2005



Total 42,326 AF

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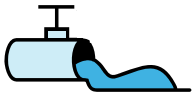
Randolph Park WRF

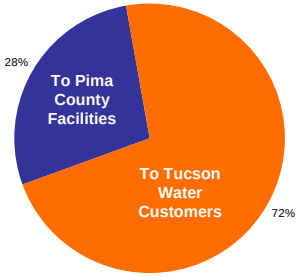


Randolph Park WRF Effluent

408 AF
To Pima County Facilities

1055 AF
To Tucson Water Customers

2005



Total 1,463 AF

17

Ina Road WPCF

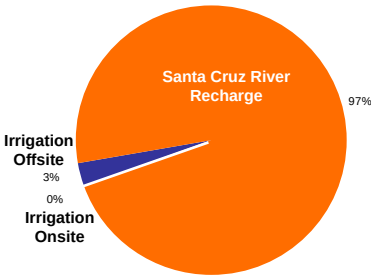
Ina Road WPCF Effluent

31 AF
Irrigation Onsite

635 AF
Irrigation County Owned/Operated Facility (Offsite)

24,552 AF
Santa Cruz River Recharge

2005



Total 25,218 AF

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Metropolitan Treatment Fac. Effluent (2005)

Treatment Facility	*Effluent Utilized (AF/YR)*
Ina Road WPCF	25,218
Roger Road WWTP	42,326
Randolph Park WRF	1,463
Total	69,007

19

Total Effluent (2005)

Total Effluent Utilized (AF/YR)	69,007
SAWRSA	28,200
Total less SAWRSA	40,807
Entities Share	
Water Providers (90%)	36,726
Pima County (10%)	4,081

20

Total Effluent with CEP (2005)

Total Effluent Utilized (AF/YR)	69,007
SAWRSA	28,200
CEP	10,000
Total less SAWRSA and CEP	30,807
Entities Share	
Water Providers (90%)	27,726
Pima County (10%)	3,081

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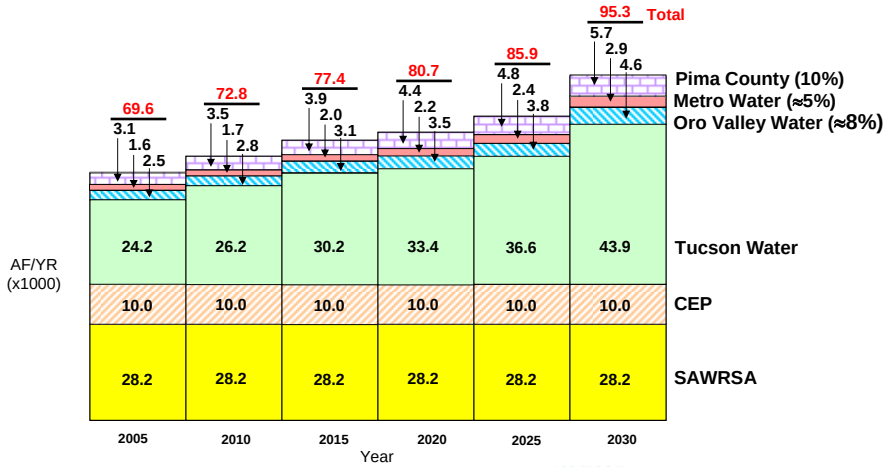
Joint Planning Group

- PCWMD and Tucson Water agree on:
  - Population projections
  - Effluent flows
- Utilizes PAG / TAZ data
- Forecasts to 2030
- Bases for planning

22

Metro Effluent



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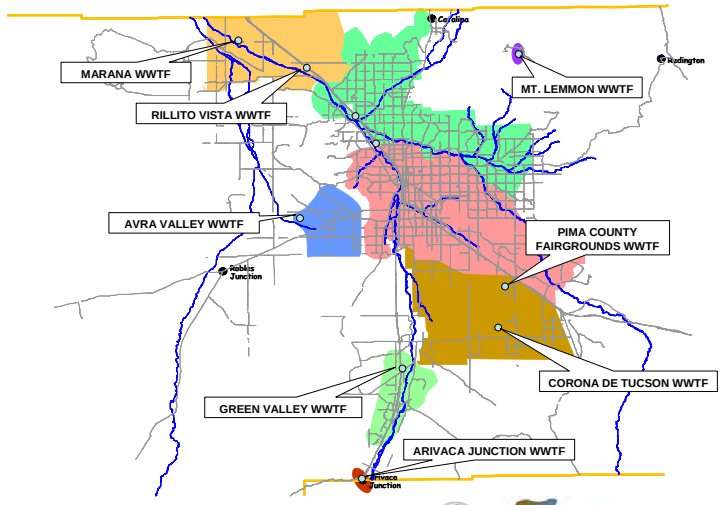
Outlying Facilities



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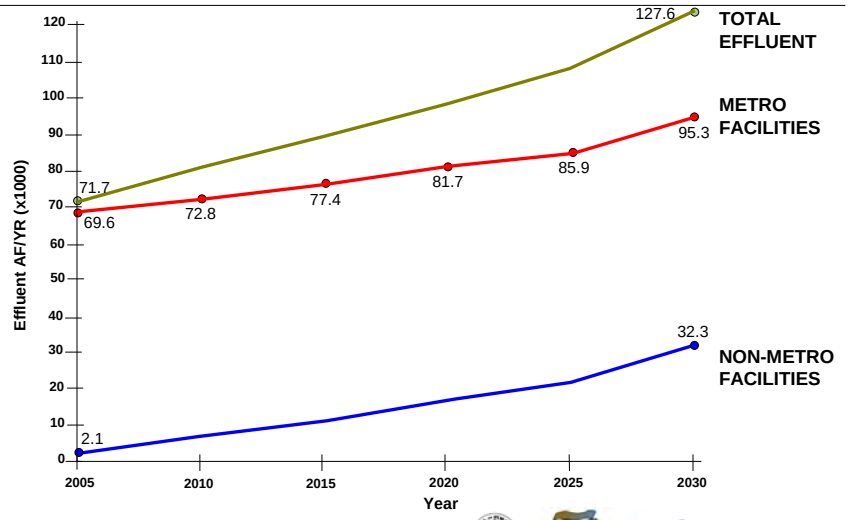
Outlying Facilities – Effluent Discharge

Facility	*Current (2005) AF*	*Future (2030) AF*
Arivaca Junction WWTP	85	0
Avra Valley WWTP	363	3,000
Green Valley WWTP	1,677	6,000
Mt. Lemmon WWTP	3	14
Marana WWTP	61	5,300
- Marana WWTP Usage	(30)	(30)
- Southlands	0	18,000
Total	2,121	≈32,300

25

Regional Effluent



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A.A.C. Class A+ Reclaimed Water

- Total nitrogen concentration less than 10 mg/L
- NTU – less than 2
- Disinfection
  - No detect (E. coli) in 4 out of 7 samples per week
  - None to exceed 23/100 mL

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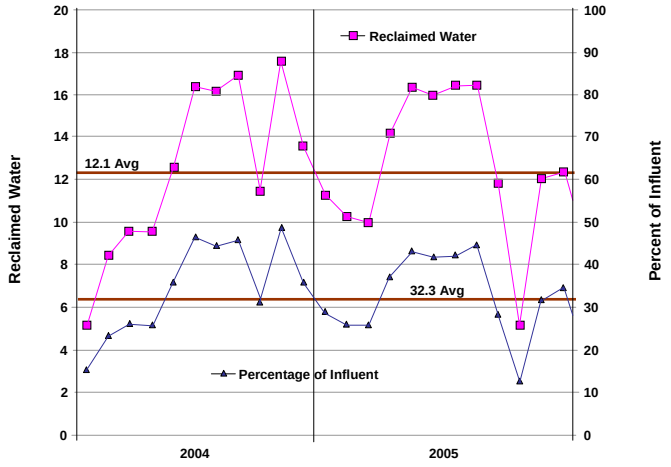
BADCT Requirements (WW Effluent)

- Total nitrogen concentration less than 10 mg/L
- Disinfection
  - No detect (E. coli) in 4 out of 7 samples per week
  - None to exceed 23/100 mL

28

Roger Road WWTP to Sweetwater



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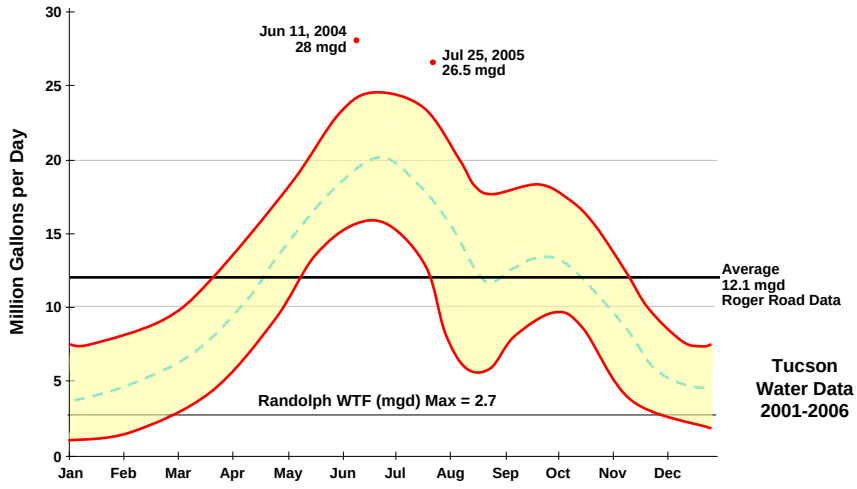
Seasonal Reclaimed Water Demands



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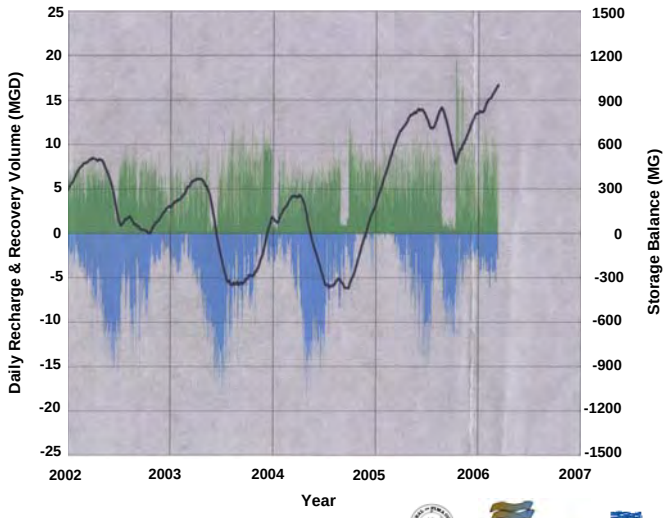
Balanced Underground Storage Recharge/Recovery

■ Production Capacity at Sweetwater Treatment	8 to 11 mgd
■ Production Capacity at Randolph Park WRF*	0 to 3 mgd
Total	8 to 14 mgd
■ Peak Demand	30 mgd
■ Recovery Wells	22 to 16 mgd

*Interruptible Operation

31

Daily Recharge, Recovery and Net Storage Balance, 2002 through 2006



Tucson Water Data

32

Intergovernmental Agreement Impacts / Considerations

Jerry Bish

Effluent Agreements

- 1979 Intergovernmental Agreement
- SAWRSA (1982)
- Supplemental IGA (2000)
- Wheeling Agreement (2003)
- Managed Recharge (2003)

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1979 IGA

- Transfers to Pima County City's wastewater treatment plants and conveyance system
- Grants City right to use 90% of effluent
- Grants County right to use 10% of effluent
- Grants City of Tucson land use at Ina Road WPCF for reclaimed water operations

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SAWRSA (1982)

- Southern Arizona Water Rights Settlement Act
  - To protect water resources in Upper Santa Cruz River basin
  - Secretary of Interior receives 28,200 AF/yr (plus evaporation losses)

36

Supplemental IGA (2000)

- Established conservation effluent pool (up to 10,000 AF/yr)
- Reopens Randolph Park WRF
- Restricts Pima County's uses of effluent water
- Established SAWRSA effluent water rights

37

Wheeling Agreement (2003)

- Governs reclaimed water transactions between Pima County and City of Tucson

38

Managed Recharge (2003)

- Governs recharge of effluent into Lower Santa Cruz Managed Recharge Project and associated credits
- Participants
  - Town of Marana
  - Cortaro-Marana Irrigation District
  - Avra Valley Irrigation and Drainage District
  - Flow Wells Irrigation District
  - Metro Water*
  - Oro Valley*
  - Pima County*
  - City of Tucson*

*with credits

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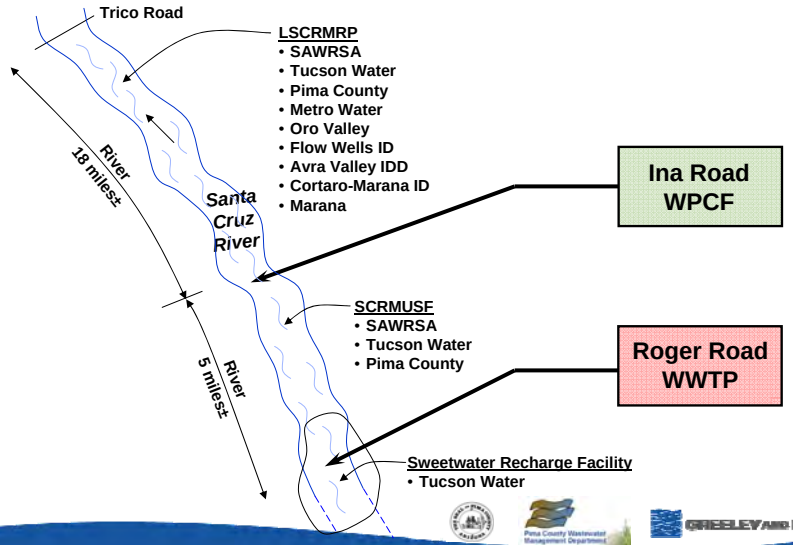
Effluent Rights

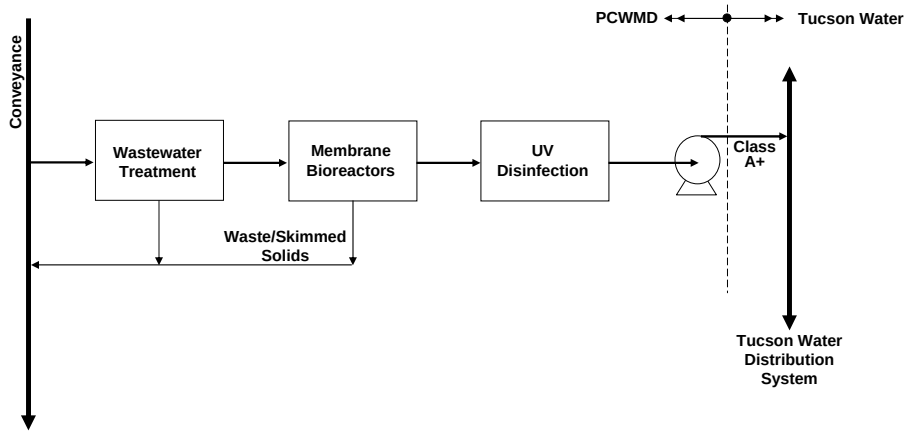


40

Current / Future Reclaimed Water Treatment Operations

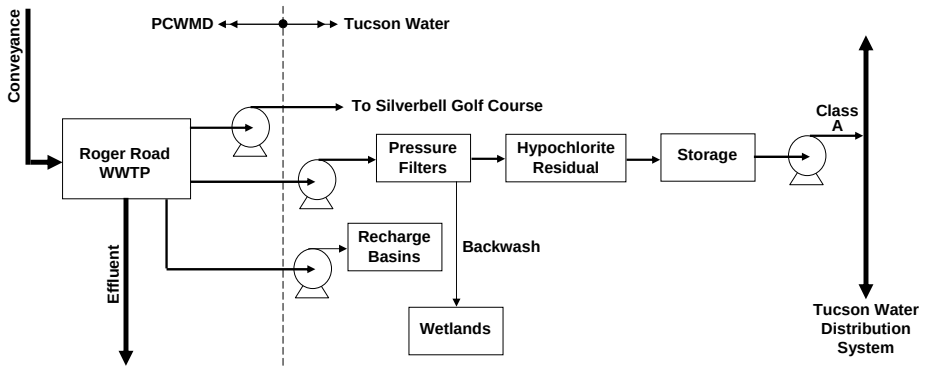
Jerry Bish

Randolph Park WRF



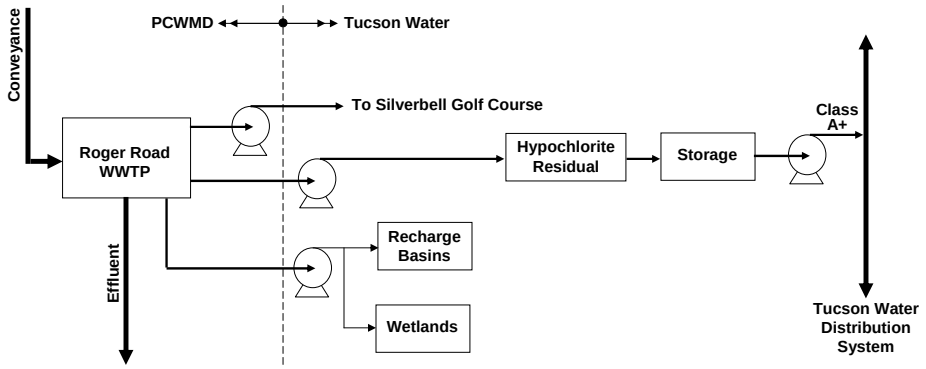
42

Sweetwater Facilities (Existing)



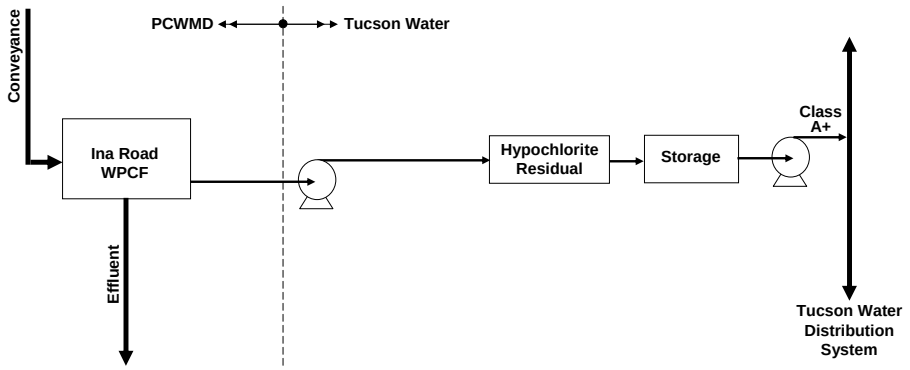
43

Sweetwater Facilities (Future)



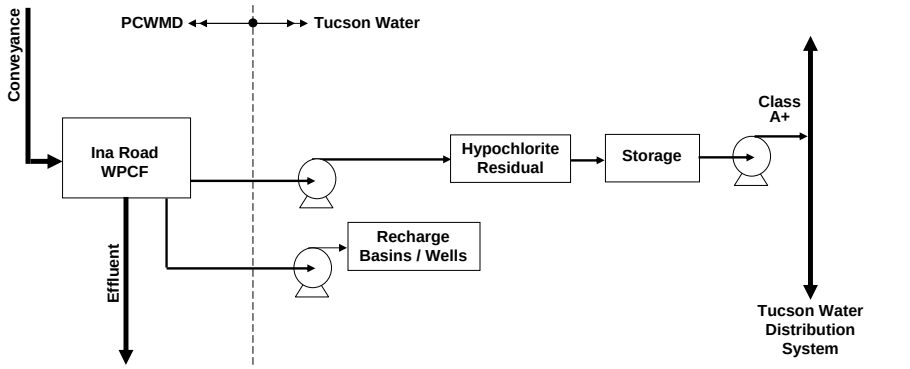
44

Ina Road Facilities (Future?) (1)



45

Ina Road Facilities (Future?) (2)



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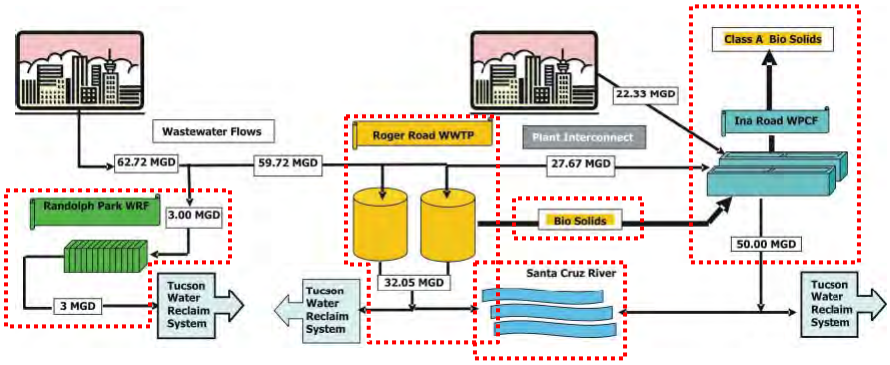
Wastewater Treatment Options / Impacts

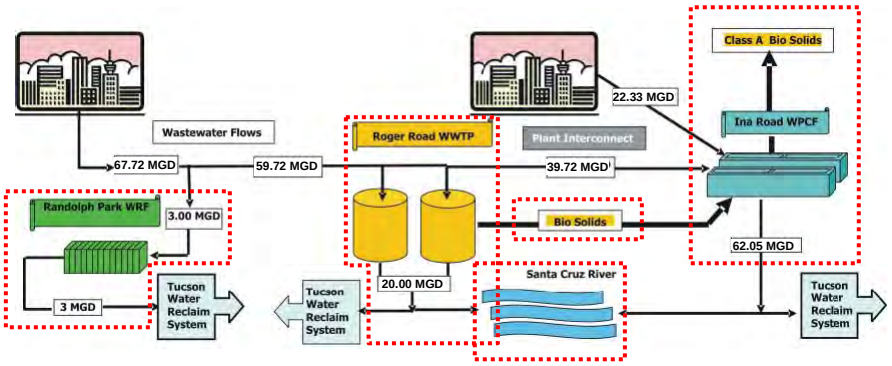
Gordon Culp

Existing Plan Schematic



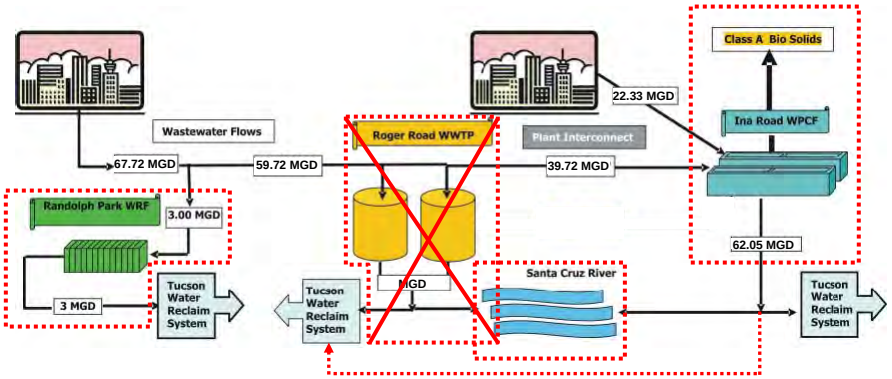
48

Transfer Some Schematic



49

Transfer All Schematic



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Transfer Flow Issues

- What are environmental impacts?
  - Sweetwater Wetlands
  - Groundwater recharge
  - Santa Cruz River habitat
- How will reclaimed water needs be provided?
  - From where?
  - By whom?
- New conveyance system – size/route

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Conveyance Issues/Options

- Existing Plan:
  - Roger Road WWTP
  - Ina Road WPCF
  - Randolph Park WRF
- Transfer Some:
  - Roger Road WWTP (downsized)
  - Ina Road WPCF (expanded)
  - Randolph Road WRF
- Transfer All:
  - Ina Road WPCF (expanded significantly)
  - Randolph Road WRF

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Plant Interconnect Details

Roger Road sewer elevation	2250 feet
Ina Road sewer elevation	2192 feet
Available hydraulic head	58 feet
Length between plants	24,900 feet or 4.72 miles

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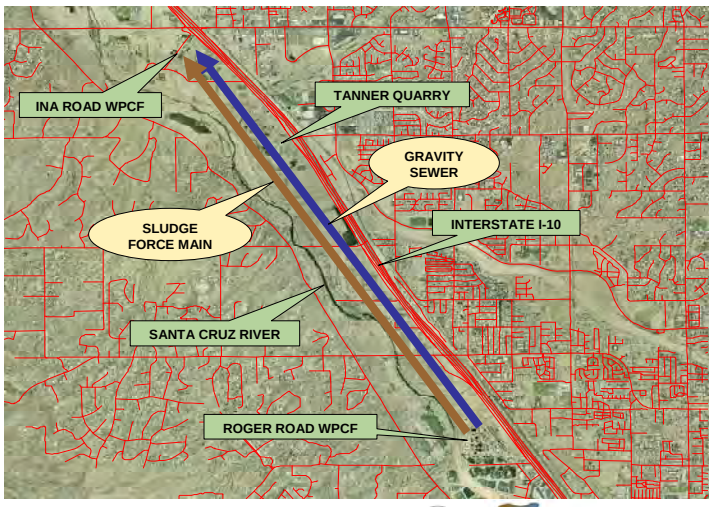
Existing/Transfer Some



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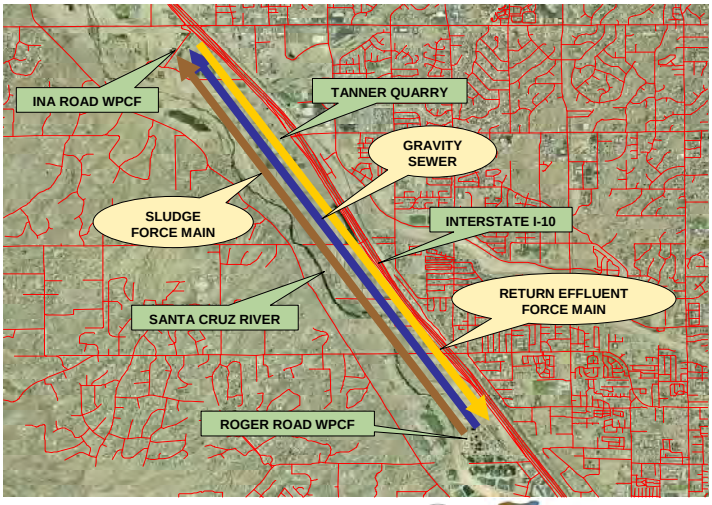
Transfer Some



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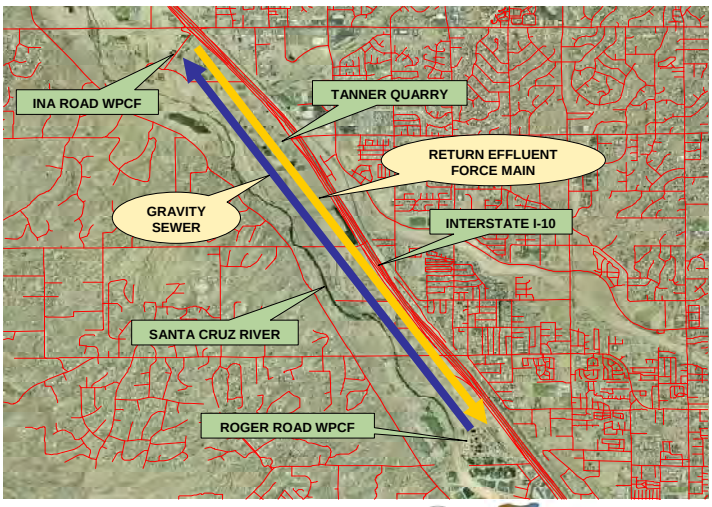
Transfer All (1)



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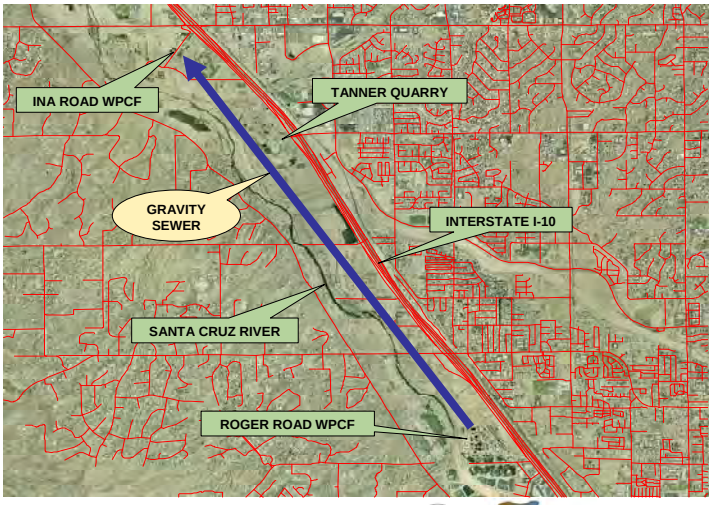

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Pima County Wastewater Management Department

GREELEY AND HANSEN

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Underground Storage Recharge / Recovery Considerations

Mark Cross

Underground Storage and Recovery

- Store water in aquifer for subsequent recovery
- Annual or longer-term storage – Santa Cruz River managed recharge
- Seasonal storage and recovery – Sweetwater Facility

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Benefits of Underground Storage and Recovery

- Soil Aquifer Treatment (SAT)
- Blending with groundwater
- Cost-effective storage
- Recover water when needed

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Recharge Methods for Underground Storage

- Infiltration in stream channel
- Infiltration in constructed basins
- Injection wells

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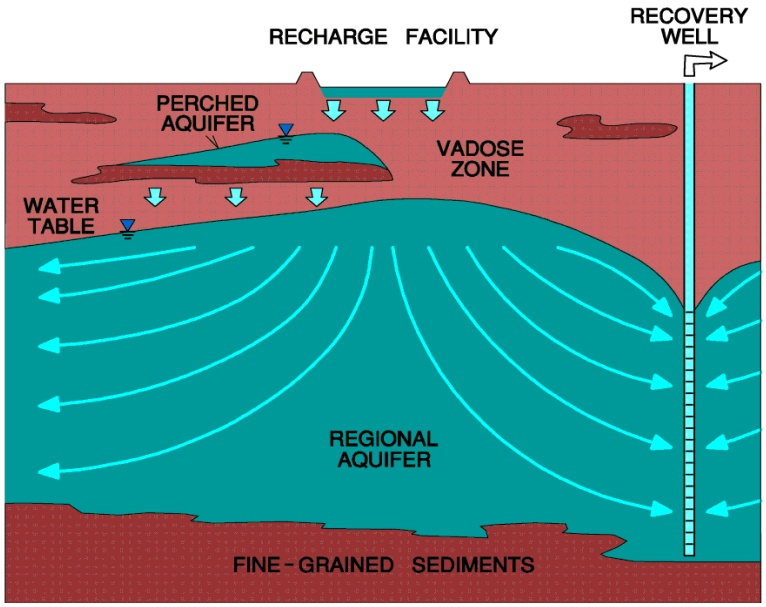

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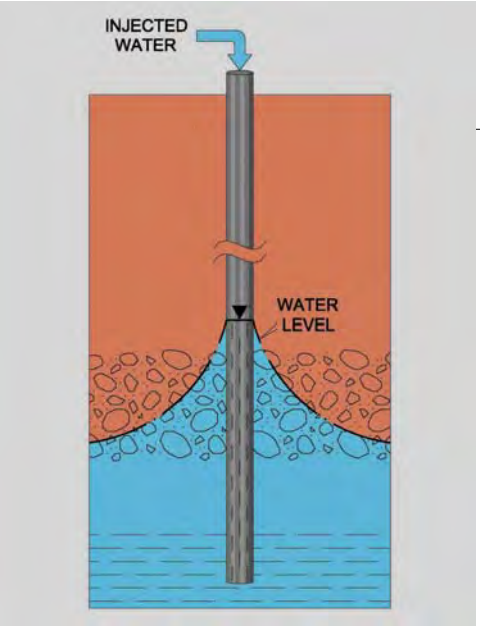

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Existing Storage and Recovery Operations

- Sustained recharge downstream from Roger Road WWTP
- Shallow groundwater levels along river and accrual of storage credits
- Seasonal storage and recovery at Sweetwater Facility

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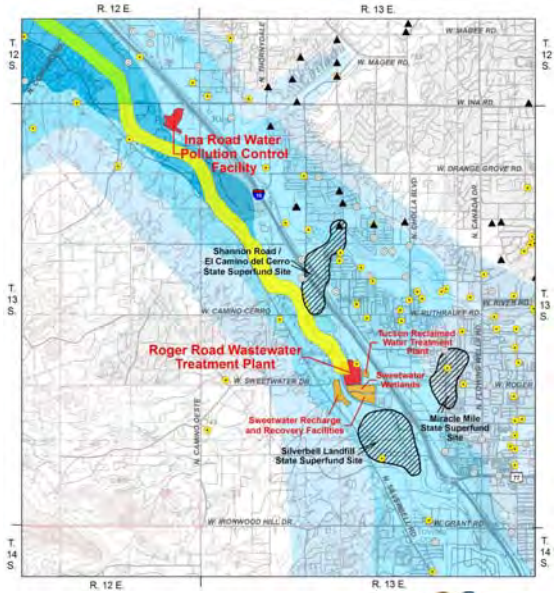
Depth to Groundwater Level



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Transfer Some Roger Road WWTP Capacity to Ina Road WPCF

- No discharge to river at WWTP outfall
- Effects on riparian habitat
- Changes in groundwater levels
- Changes in storage credits for managed recharge projects

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Changes in Groundwater Levels

- Decline in water levels
- Potential effects on productivity of shallow wells
- Changes in groundwater movement and contaminant migration
- Potential effects on remedial actions at State Superfund Sites

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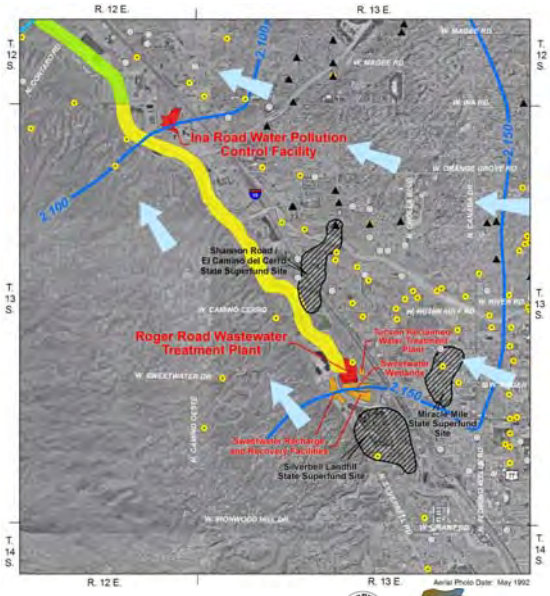
Groundwater Level Altitudes



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Transfer All Roger Road WWTP Capacity to Ina Road WPCF

- Implications of no discharge to river at Roger Road WWTP outfall
- Construct pipeline to Sweetwater Facility or construct new storage and recovery facility near Ina Road WPCF

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Sweetwater Recharge and Recovery Facility

- Meets critical need to maximize effluent reuse
- Proven facility; works well
- Favorable hydrogeologic conditions
- Established outdoor laboratory for collaborative research
- Isolation from potable supply system

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Conceptual Consideration of New Storage and Recovery Facilities

- Avoid need for pipeline to Sweetwater Facility
- Need suitable site of at least 40 to 50 acres
- Favorable hydrogeologic conditions
- Compatible with adjacent land and water uses

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Multiple Benefit Underground Storage Facilities

- Primary purpose is storage
- Recreational, educational, and (or) environmental benefits
- Some allowance by ADWR for less efficient water storage

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Summary of Considerations for Transfer of Capacity to Ina Road WPCF

- Changes in groundwater levels
- Changes in directions of groundwater movement
- Changes in credits from managed recharge projects
- Accommodation of seasonal storage and recovery needs

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Discussion / Summary

Andy Richardson

Pima County Wastewater
Management Department

GREELEY AND HANSEN

Workshop #3A Meeting Notes
Stakeholder and Regulatory Requirements

1. The Stakeholder and Regulatory Requirements Workshop for Pima County Regional Optimization Master Plan was held on June 21, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
PCWMD Staff
Tom Berry
Ed Curley
James Doyle
Frank Gall
Byron McMillan
John Munden
Glen Peterson
Jeff Prevatt
Helen Rhudy
Ron Riska, Project Manager
Ken Weber

Legal
Harlan Agnew
Barbara McMurray
Chuck Wesselhoft

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Kevin Conway
Gordon Culp
Ramesh Narasimhan
Andrew Richardson

2. Major topics of the workshop were:

- Workshop #3A: Stakeholder and Regulatory Requirements Workshop
  - ► Identify Key AZPDES, APP, Reclaimed Water, and Air Quality issues that impact facility planning for each of the major facilities (Roger Road WWTP, Ina Road WPCF, Green Valley WWTP, Avra Valley WWTP and other Pima County wastewater facilities.)
  - ► Identify Other Key Permitting and Environmental Considerations/Issues.
  - ► Identify Fatal Flaws
  - ► Develop a Strategy and Agenda Items for Future Regulatory Agency and Stakeholder Meetings.

Handouts were provided to each attendee, which included presentation slides used during the workshop. Contents of these handouts are not included with these notes; however, comments on the handouts are recorded within the notes.

Throughout the workshop, notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, opened the workshop with welcoming remarks for all participants. Although some may think that regulatory issues may be dry subject, it is what drives the County to upgrade facilities and expend considerable capital in improvements. Therefore, we need to understand the implications of the regulatory issues. For the County to best understand the regulatory drivers, all participants in the Workshop are encouraged to participate.

4. Andy Richardson defined his role as facilitator, which is to move the group through the agenda, encourage participation from all in the room, and develop consensus for follow-up actions. Further, it was offered that with regulatory issues there may be three pathways to follow. First, identify the specific issues as defined by the regulations and proceed with compliance. Second, identify the specific regulatory issues that impact the County, evaluate whether the County agrees with the regulations (For example, evaluate if the regulation is supported by sound science or not?) and if not litigate against compliance. Third, review the regulations and determine if there is a middle ground that can be discussed and negotiated with the regulators those results in a benefit to the County, but achieves the results that the regulators seek. These approaches will be explored during the Workshop.
There is the question of what quality of water will be provided to Tucson Water. How will the reclaimed water system be accommodated in the future operation or do we do it now. John Munden reminded the group that there are the various effluent allocations that must be addressed as part of the reclaimed water issue.
Agenda, ground rules and objectives of the workshop were presented and covered on pages 1 through 4 of the handouts

5. Jerry Bish provided specifics on the variances in the AZPDES permits at Roger Road WWTP and Ina Road WPCF. The current variances are for ammonia toxicity and copper limitations. While the copper levels are above permits levels, the County is applying for a variance to the copper limits, because the background levels in the groundwater supply are high. Ammonia toxicity compliance will be met through nitrogen removal processes in the upgraded wastewater treatment

plants by 2014/2015. The January 2007 letter required by ADEQ is to describe compliance strategy and approach.
An overview of the treatment options under consideration in the plan – existing plan, transfer some and transfer all to Ina Road WPCF. If the transfer all option is selected then the compliance date for ADEQ will be January 30, 2015. Each of the options will include consideration of the reclaimed water alternatives developed in Workshop #2 on Water Reuse.
Permit variances and treatment options were covered on pages 4 through 9 of the handout.

6. Ramesh Narasimhan presented the key current permitting issues by facility. One major issue for the future facilities is BADCT compliance and its cost implications (filtration/UV or filtration /ozone or use of SAT). Other concerns are APP and Air Quality setback requirements, future WET testing issues, TMDL for dissolved oxygen (DO) in the Santa Cruz River (not impaired for DO), phosphorus limits, total dissolved solids in effluent from the use of CAP water for irrigation, emergency basins at the plants (none at Roger Road WWTP), testing for emerging contaminants, copper translator studies, total organic carbon and future reclaimed water regulations (Arizona has the highest standard in the nation).
Permit issues and concerns were covered on pages 9 through 25 of the handout. Matrices with permit detail and issues for each of Pima County wastewater facility are included at the back of the handout.

7. Harlan Agnew and others discussed Arizona NPDES primacy, recent litigation and implications. The 9th circuit court of appeals has upheld the decision to withdraw primacy from ADEQ. If EPA files another appeal to this decision, the decision could be stayed, meaning ADEQ retains primacy until a higher court decides. Harlan Agnew indicated that if primacy is returned to EPA, that the current permits issued by ADEQ would not be in effect and the last permits issued by EPA would govern. Permits will mostly likely be redone if EPA assumes permit responsibility. . Due to this uncertainty, both EPA and ADEQ will be invited to participate in the regulatory agency workshop.

8. A recent Supreme Court ruling raises the question if the Santa Cruz River is navigable water of the US and subject to the requirements of the NPDES permit process. If the Santa Cruz is not subject to the NPDES, it is possible that reuse would become the driver to determine wastewater treatment levels.

9. The Harding Lawson study addresses habitat impacts along the Santa Cruz River, The study indicates that major storms strip the vegetation from the river bed and channel. A briefing to

review this study findings will be scheduled by the County for the Project team and Tucson Water.
Another briefing will be provided on the Tres Rios Del Norte habitat and ecosystem restoration project. The Tres Rios del Norte Project may address the public's concerns over riparian habitat at the discharge of the treatment plants. PCWMD will include habitat issues in the public meeting process

10. Pima County approached ADEQ regarding use of Soil Aquifer Treatment (SAT) for compliance with new pathogen disinfection provisions under the APP Rules at two of their outlying facilities.. This request was preliminarily denied and ADEQ directed PCWMD to use filtration/UV technologies that meet the standards at the end of the pipe. The basis of this action was understood to be policy and guidance, not Rule. As a follow-up a request was made by Pima County legal for the disinfection guidance document to support that decision.

11. Jeff Prevatt opined that only two laboratories were certified in Arizona to perform whole effluent toxicity (WET) testing. Neither of these labs are in the Tucson area. Currently it takes 3 to 6 months to get lab results, which is too long for making any meaningful process changes. There is a need to perform these tests in-house. It would take up to a year to get certified and approved to perform the tests. Pima County needs to investigate in-house WET testing.

12. Costs and benefits of filtration, UV, and ozonation for disinfection need to be considered along with treatment related effluent by-products produced by these processes. The County has three treatment plants on the verge of making a decision of UV versus ozone.

13. Potential use of higher levels of chlorination/de-chlorination to meet BADCT disinfection requirements should be considered (with and without filtration). Reduced analytical method interferences on chlorine residual detection are anticipated once N-deN treatment is implemented.

14. ADEQ has a policy that only one class of effluent can be discharged from a treatment plant. The policy language has not been seen. A copy will need to be obtained to determine if a dual class of effluent can be discharged from a facility.

15. Mike Bunch asked how security strategies will be handled in the master plan. The response was that fencing, security berms and other features will be identified on the footprint of the facilities, but specific details will not be provided because of the nature of keeping the security information private.

16. Avra Valley WWTP is a 4 mgd plant, not a 6.2 mgd facility. Spray irrigation at this facility does not does not percolate well, but runs off near Tucson Water's well fields and across other people's property. There is a need to develop a strategy for effluent disposal for outlying facilities.

17. Studies on emerging contaminants by David Walker have just gotten funding to test UV and ozone effectiveness in reducing contaminant levels. Results from these studies would be useful in addressing UV or ozone treatment technologies. Phoenix has determined that SAT removes contaminants to some degree.

18. With the group participation consensus was reached on the following key issues that need to be discussed with the regulatory agencies:

    - SAT and BADCT criteria (microbial treatment, disinfection)
    - Setback Requirements
    - AZPDES – copper, ammonia toxicity testing, chlorine analytical methodology, primacy, elimination of parameters where testing procedures or detection limits are uncertain (Jeff's list)
    - Regulation of wetlands
    - Air Quality permit modifications – HAP, MACT and BAT issues and emission caps
    - Different qualities of effluent from a single facility
    - Consistency with PAG 208 Plan

19. An archaeological survey will be required for new construction at Ina Road WPCF. Lack of this survey in the past has delayed projects up to one year. This survey should be launched now.

20. PCWMD agreed to meet with Phoenix Valley cities including SROG on BADCT and SAT for APP compliance. Mike Gritzuk will contact City of Phoenix to begin this process.

21. There is available property at I-10 and Ina Road adjacent the existing plant. This property would offer additional setback or buffer for new facilities. The County should look into purchase of this parcel.

22. Harlan Agnew will lead internal strategy discussions to set priorities on regulatory issues, develop a draft agenda for the upcoming Stakeholder meetings with Phoenix Valley cities and meet with the water quality groups of area mines.

23. Andy Richardson with assistance of the group developed a list of questions for discussion with Tucson Water in Workshop #3B. Questions are included in the attached flip chart notes.

24. Mike Gritzuk thanked the group for their participation in a lively and interesting workshop.

25. Andy Richardson previewed the next two workshops both are scheduled for July 12, 2006. Workshop #5 is on the Roger Road WWTP treatment system and Workshop #6 is on the Ina Road WPCF treatment system.

Agenda
Workshop #3A – Stakeholder and Regulatory Requirements
June 21, 2006

Time	*Topic*	*Presenter*	*Pg*
7:30 am	*Continental Breakfast – Rio Nuevo Upstairs Conference Room, 52 W. Congress*		
8:00 am	Opening Session		
	• Welcoming Remarks	Mike Gritzuk	1
	• Overview of Agenda	Andy Richardson	2
	• Purpose and Objectives		
8:15 am	Overview of Facilities	Jerry Bish	4
	• January 2007 ADEQ Permit Requirements		
	• Current and Ongoing Projects		
	• Potential Future Projects		
8:30 am	Summary of Permitting Criteria by Facility	Ramesh Narasimhan	9
	• Review Summary Permit Matrices		
	• Reclaimed Water Permits		
	• Aquifer Protection Permits		
	• AZPDES Permits		
	• Air Quality Permits		
	• Schedule Considerations		
	• Anticipated Near / Long Term Water Quality Issues		
	• Future Water Quality Considerations – Emerging Contaminants		
9:45 am	Break		
10:00 am	Key Water Quality Issues	Ramesh Narasimhan	18
	• BADCT Criteria		
	• Disinfection Processes		
	• Ammonia Toxicity		
	• Reclaimed Water Treatment Goals		
	• Recharge/Recovery Considerations		
	• Emerging Contaminants		
	• Cogeneration Process Technology Considerations		
	• Stakeholder Considerations – Potential Impacts on Habitat/Wildlife		
11:20 am	Other Permits/Considerations	Ramesh Narasimhan	23
	• Storm Water		
	• CMOM		
	• GASB 34		
	• Army COE 404		
	• Dam		
	• Forest Service		
	• Design Phase Permits/Approvals		
	• Construction Phase Permits/Approvals		
11:50 am	Summary / Wrap-Up	Andy Richardson	25
	• Comment by Group		
	• Closing Remarks	Mike Gritzuk	
12:00 pm	Lunch		

Flip Chart Notes – June 21, 2006

Overview

- PCWWM will be conducting metals translator studies to justify a higher limit for copper. This appears to be the preferred strategy for copper compliance as opposed to treatment.
- Based on verbal clarifications with ADEQ, Mike Gritzuk indicated that the term "initial engineering study" means a letter to ADEQ describing the compliance strategy and approach. This will not impact consultant's time lines for completion of the study.
- If only one plant at Ina Road is the selected option (Roger Road eliminated), the compliance schedule date becomes January 30, 2015
- The 9th circuit court if appeals has upheld the decision to withdraw primacy from ADEQ. If EPA files another appeal to this decision, the decision could be stayed meaning ADEQ retain primacy until a higher court reaches a decision. If primacy is returned to EPA, that the current permits issued by ADEQ, the last permits issued by EPA would govern.
- A Supreme Court decision may impact whether the Santa Cruz River is *Waters of the US* and thus affect its status as a regulated body.
- Project will need to determine what is the critical regulatory driver as far as effluent water quality standards (Reuse, surface discharge, APP?).
- Three areas of emphasis for communicating findings from the project with key stakeholders (Tucson Water) are workshops, Stakeholder interview process and the public involvement program
- For Marana, Oro Valley, and Metro Water; the workshops (these organizations have been invited) and public meetings will be used to communicate project findings.

Key Water Quality and Permitting Issues

- Obtain BADCT policy/guidance document for disinfection/microbial treatment criteria.
- Setback limits for both APPs and air quality permits are a consideration in the facility design parameters and costs (particularly at Ina Road WPCF).
- A suggestion was made to acquire "Starbucks' property" to meet setback criteria for the Ina Road WPCF.
- Several issues for WET test: Only two certified labs in State; timing of results and sampling is an issue – At this time Pima County does not control ammonia toxicity and implementation procedures.
- Consider "EPA nation-wide WET testing implementation" in Texas
- Although ammonia limit on Santa Cruz River does not currently exist, a 2 mg/.L is anticipated in ongoing triennial review.

- *Archeological survey - start now at Ina Road WPCF
- Assess possible air quality limits on DBPs and impacts
- Pima County is conducting a study on endocrine disruptors looking at different water sources
- What are the effects of ozone and UV on these containmants?
- *Reach out for research to WestCAS
- *Consider potential future TMDL for dissolved oxygen
- Low level chlorine detection a problem
- *Need to obtain list of "non-detected" parameters out of permit; follow up with Jeff Prevatt

Agenda Items for Regulatory Agency Meetings

- Filtration and UV light or SAT to meet BADCT??
- Phosphorus (timing and Tres Rios "lakes")
- ADEQ one reuse water class per plant by policy – need documentation
  - Can we have two water qualities?
    - Surface Discharge
    - Tucson Water Reuse
- TMDL for dissolved oxygen
- List of non-detected parameters to be removed from permit
- WET testing
- Setback limits for APP and air quality
- "Scalping" plants with biosolids issue

Key Issues

- Loss of habitat/riparian system – may not be an issue
- Need a briefing on Tres Rios del Norte study and Harding Lawson study
- Habitat assessments already conducted
- Order of upcoming meetings – 1) PCWMD Board, 2) Tres Rios del Norte meeting, 3) then public
- How will ADEQ regulate Tres Rios del Norte "lakes"?
- NDMA, Pima County would like to participate in the development of method and in regional studies

Questions for Tucson Water

- Tucson Water needs supply beyond 2020
- 1) What is their projection of when TDS from CAP water will be an issue? Also impact from TDS build-up from recharge?
- 2) When does the yellow become reclaimed water?
- 3) When will Tucson Water engage the public on this issue?
- 3) Participate in concurrent research efforts?
- 4) What is the schedule for chloramine conversion?

- 5) Participation in a state-wide meeting on SAT
- 6) Perchlorate levels in CAP water is being tracked by Tucson Water
- 7) TOC levels
- 8) Briefing for Tres Rios del Norte
- 9) Pipe to Avra Valley plans

Action Items

- Meet with SROG group (Mike Gritzuk, Greeley and Hansen project team and Pima County)
- Internal strategy development (Harlan Agnew, Ed Curley)
- Meet with mines on BADCT (Harlan Agnew)
- Meet ADEQ with priorities (Mike Gritzuk)
- Review WestCAS task groups (WET, triennial review/ammonia toxicity, nutrients) and have Pima County participate (Jeff Prevatt/Byron McMillan)
- Harlan Agnew to develop draft agenda for regulatory agencies

Avra Valley WWTF

- Use for spray irrigation a concern on groundwater quality; Tucson Water does not want it to impact wells
- Should Pima County, in outlying facilities, market reclaimed water?
- Craft strategy for effluent disposal for outlying facilities
- Expansion beyond 4 mgd will depend on growth

Pima County
Regional Optimization
Master Plan

Workshop #3A
Stakeholder and Regulatory Requirements

June 21, 2006

Workshop Presenters

- Mike Gritzuk — Welcome/Closing
- Andy Richardson — Facilitator
- Jerry Bish — Overview
- Ramesh Narasimhan — Permit/Regulation

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop Objectives
- Overview of Facilities
- Aquifer Protection Permits
- AZPDES Permits
- Reclaimed Water Permits
- Air Quality Permits
- Recharge / Recovery Permits
- Other Permits
- Closing

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

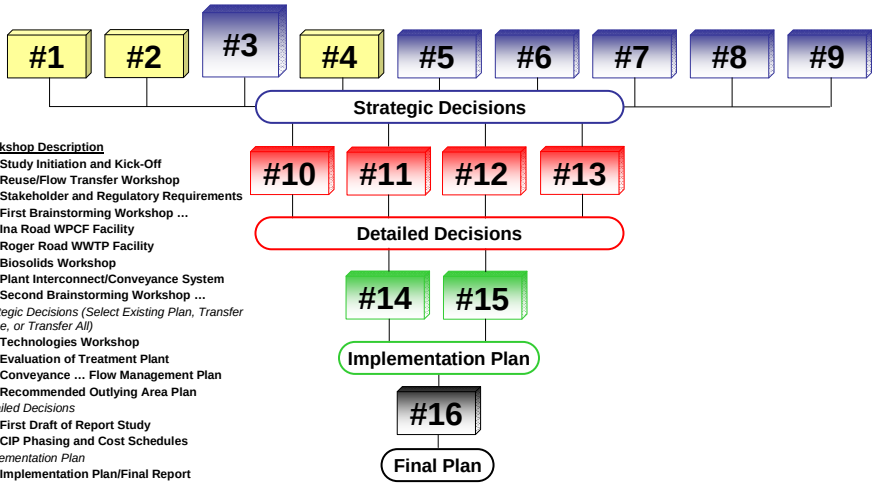
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop Objectives

- January 2007 ADEQ letter compliance
- Review current permits
- Identify regulatory issues
- Reuse regulation impacts/considerations
- Regulatory impact of reduced discharge from Roger Road on Santa Cruz River
- Review future regulatory requirements

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Overview of Facilities

Jerry Bish

AZPDES Permit – Roger Road WWTP

- Variances
  - Ammonia toxicity
    Variance until January 30, 2015
  - Copper limitations
    Variance until January 30, 2011

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AZPDES Permit – Roger Road WWTP

- Ammonia toxicity terms/conditions
  - By January 30, 2007
    - Complete engineering design review
      - Upgrade or replace
    - Document selected construction option
    - Submit documenting letter to ADEQ
  - By January 30, 2011
    - Award contract for construction
  - By January 30, 2015
    - Treatment of effluent to non-toxic ammonia levels

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AZPDES Permit – Roger Road WWTP

- Copper limitations
  - Interim limit daily maximum: 25 µg/L
  - By January 30, 2011
    - Comply with copper standard
      - Daily maximum: 16 µg/L
      - Monthly average: 12 µg/L

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AZPDES Permit – Ina Road WPCF

- Variances
  - Ammonia toxicity
    Variance until January 30, 2014
  - Copper limitations
    Variance until December 31, 2010

16

AZPDES Permit – Ina Road WPCF

- Ammonia toxicity terms/conditions
  - By February 1, 2007
    - Complete initial engineering study
    - Recommendation for upgrading Ina Road WPCF
    - Submit documenting letter to ADEQ
  - By December 31, 2010
    - Award contract for construction
  - By January 30, 2014
    - Treatment of effluent to non-toxic ammonia levels

17

AZPDES Permit – Ina Road WPCF

- Copper limitations
  - Interim limit daily maximum: 30 µg/L
  - By December 31, 2010
    - Comply with copper standard
      - Daily maximum: 16 µg/L
      - Monthly average: 12 µg/L

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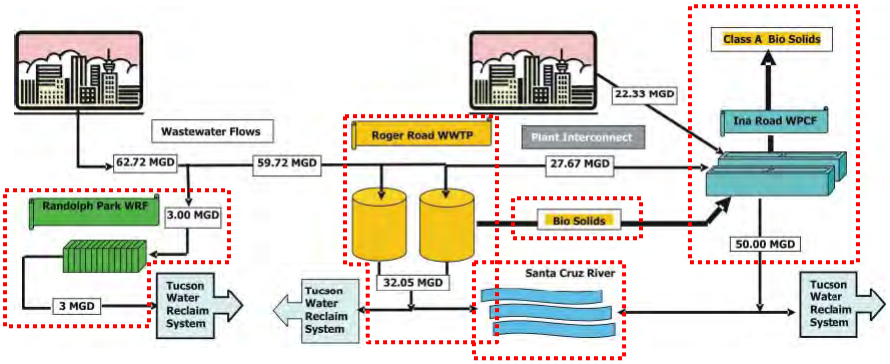
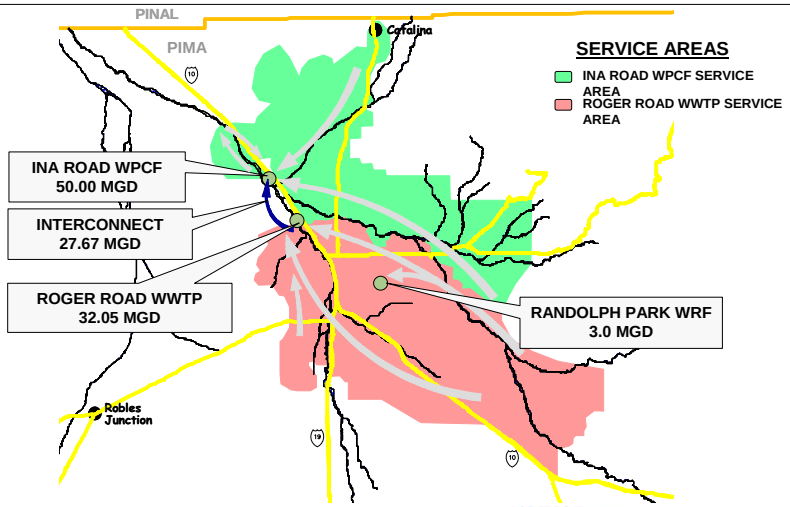
Existing Plan Schematic



19

Existing Plan (2030)



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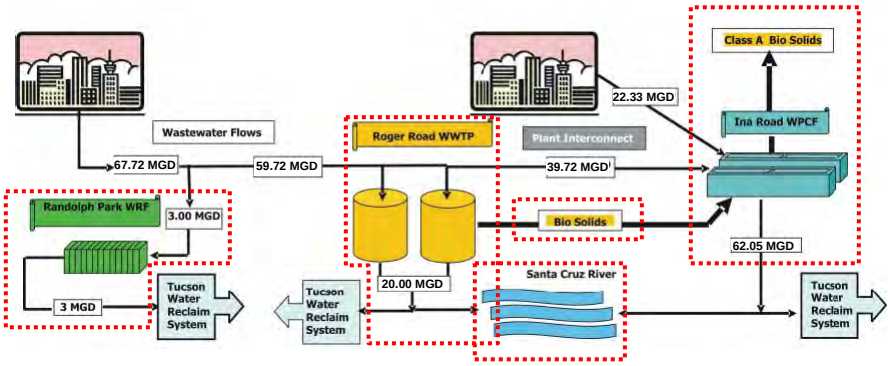
Transfer Some Schematic



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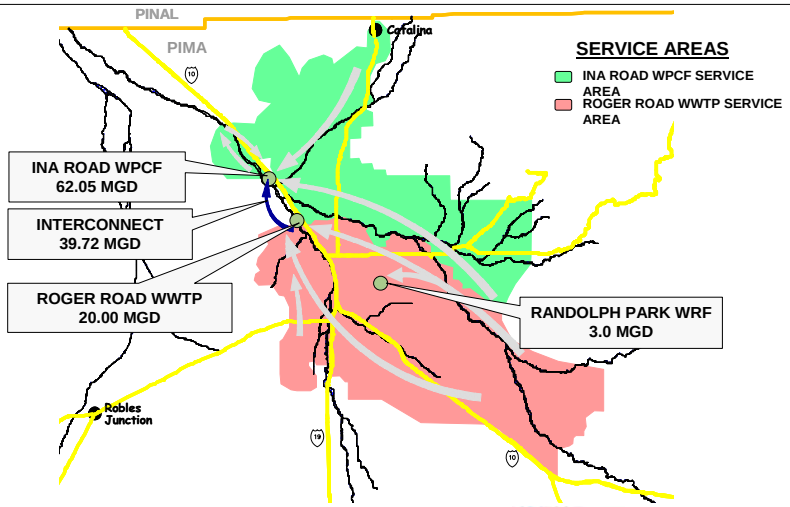
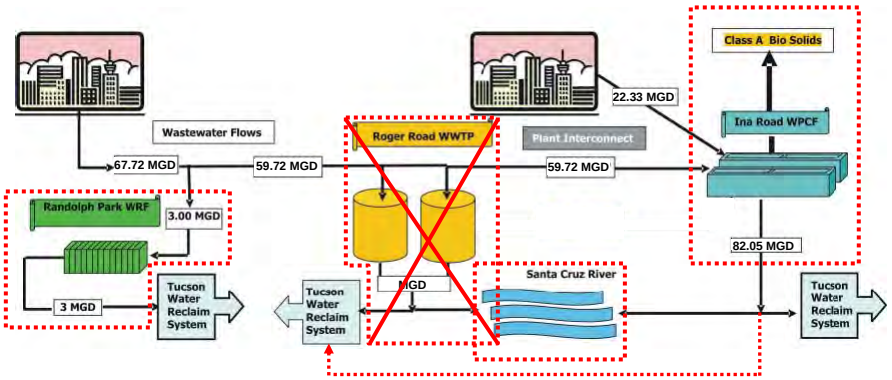


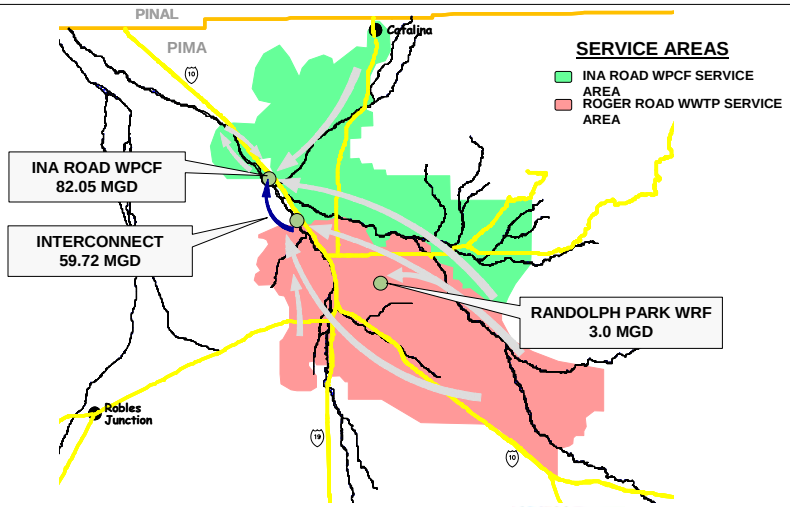
22

Transfer All Schematic



23

Transfer All (2030)



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Current / Ongoing Projects

- Ina Road BNRAS
- Outlying facilities
  - Avra Valley WWTP
  - Corona de Tucson WWTP
  - Marana WWTP
  - Green Valley WWTF

25

Potential Future Projects

- Existing Plan:
  - Roger Road WWTP (upgrade/downsize)
  - Ina Road WPCF (expand)
  - Randolph Park WRF
- Transfer Some:
  - Roger Road WWTP (upgrade/downsize significantly)
  - Ina Road WPCF (expand)
  - Randolph Park WRF
- Transfer All:
  - Ina Road WPCF (expand significantly)
  - Randolph Park WRF

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Summary of Permitting Criteria by Facility

Ramesh Narasimhan

Goals and Objectives

- Present and discuss current and future permitting issues
  - Integrate with current and planned improvements
- Outline timelines (establish deadlines) to meet permitting requirements
- Identify fatal flaws
- Identify needs of all stakeholders

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Goals and Objectives *(continued)*

- Identify key issues needed to develop an optimal permitting strategy
  - Develop agenda for workshop with agencies
- Assess consistency with the 208 plan prepared by Pima Association of Governments

29

APP, AZPDES, Reclaimed Water, and Air Quality Permits

- Key issue development by facility
  - Matrices developed for each facility
    - Roger Road WWTP
    - Ina Road WPCF
    - Avra Valley WWTF
    - Green Valley WWTF

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ROGER ROAD WWTP

Aquifer Protection Permit – Effective 5/26/05

- Key Issues
  - POC location for well 12 replacement
  - Compliance with setback limits
  - Permit reopeners
  - BADCT: need to filter vs. SAT
  - Use of CAP water by Tucson Water
- Schedule Considerations
  - Replacement well
  - Permit modifications

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ROGER ROAD WWTP

Aquifer Protection Permit – Effective 5/26/05 *(continued)*

- Key Standards/Limits
  - POC location
  - Safety factors
  - Interim nitrate AQL
  - Near mid-term, and future contaminant considerations

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ROGER ROAD WWTP
AZPDES Permit – Effective 3/2/06 to 3/2/11

- Key Issues
  - Ammonia toxicity
  - Copper variance
  - Chlorine monitoring method and metal translator studies
  - Minimum flows
- Schedule Considerations
  - Compliance for ammonia, copper compliance
  - Chlorine method and metal translators studies

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ROGER ROAD WWTP
AZPDES Permit – Effective 3/2/06 to 3/2/11 *(continued)*

- Key Standards/Limits
  - Interim copper level
  - Current and future standards: Cr VI, Cu, Cl_2
  - Toxicity tests, results and follow-up actions

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ROGER ROAD WWTP
Reclaimed Water Permit – Eff. 4/29/04 to 4/20/09

- Key Issues
  - Need to upgrade entire facility to higher class??
  - Usage/replacement of Tucson Water facility
- Schedule Considerations
  - Renewal
- Key Standards/Limits
  - Class B/B+ (Pima County uses)
  - Class A/A+ (Tucson Water uses)
  - Enhanced future standards not expected
  - Other future issues
    - Microbial fouling, UV efficiency, salinity, CAP water importation

35

ROGER ROAD WWTP
Air Quality Permit – 5-year term expires 2010

- Key Issues
  - Synthetic minor source for NO_x and CO
  - Minor source for other criteria pollutants
  - Permitted equipment includes 9 IC engines, WWTP, scrubbers
  - No issues with opacity testing, sulfur content
- Schedule Considerations
  - Permit reopeners
  - Emission modeling

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ROGER ROAD WWTP

Air Quality Permit – 5-year term expires 2010 *(continued)*

- Key Standards/Limits
  - Potential to emit
  - Plant expansion potential for triggering major source
  - H_2S limits at fence line

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INA ROAD WPCF

Aquifer Protection Permit – Effective 2/26/02

- Key Issues
  - Archeological implications
  - Permit reopeners
  - BADCT: need to filter vs. SAT
  - Use of CAP water by Tucson Water
- Schedule Considerations
  - Pesticides and PCB monitoring
  - Permit modifications

38

INA ROAD WPCF

Aquifer Protection Permit – Effective 2/26/02 *(continued)*

- Key Standards/Limits
  - Point of compliance (POC) location
  - Near to mid-term contaminant considerations
    - Fecal coliforms or E. coli, TOC, THMs, HAAs, bromate, arsenic
  - Future contaminant considerations
    - Salinity, endocrine disruptors, pharmaceuticals, NDMA

39

INA ROAD WPCF

AZPDES Permit – Effective 1/2/06 to 1/2/10

- Key Issues
  - High ammonia levels
  - Chlorine and copper exceedances
- Schedule Considerations
  - Compliance for ammonia, copper toxicity, and chlorine
  - BNRAS upgrade

40

INA ROAD WPCF

AZPDES Permit – Effective 1/2/06 to 1/2/10 *(continued)*

- Key Standards/Limits
  - Current standards and ranges for Cr VI, Cu, Cl_2, cyanide, Pb, Ag, phthalate
  - Toxicity tests, results and follow-up actions
  - Future contaminant considerations

41

INA ROAD WPCF

Reclaimed Water Permit – Effective 1/6/04 to 1/6/09

- Key Issues
  - Need to upgrade to higher class??
  - Microbial fouling in distribution system
  - Reuse customers
- Schedule Considerations
  - Renewal

42

INA ROAD WPCF

Reclaimed Water Permit – Effective 1/6/04 to 1/6/09 *(continued)*

- Key Standards/Limits
  - Two treatment trains: Class B (25 MGD), Class B+ (12.5 MGD)
  - Enhanced future standards not expected
  - Benefits of upgrading Class
  - Future salinity issues

43

INA ROAD WPCF

Air Quality Permit – 5-year term expires 2010

- Key Issues
  - Major source for NO_x and CO
  - Minor source for other criteria pollutants
  - Permitted equipment include 7 large IC engines and plant processes
  - No issues with opacity testing, sulfur content, H_2S limits
- Schedule Considerations
  - Future expansions may trigger >25 tons/year HAP criteria
  - Emission modeling

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INA ROAD WPCF

Air Quality Permit – 5-year term expires 2010 *(continued)*

- Key Standards/Limits
  - Potential to emit
  - H_2S fence line criteria
  - Costs and benefits of upgrading cogeneration vs. power from TEP

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AVRA VALLEY WWTF

Aquifer Protection Permit – Effective 8/23/03

- Key Issues
  - Future disinfection considerations
  - Primarily a recharge facility
- Schedule Considerations
  - Emergency overflow basin use reporting
- Key Standards/Limits
  - Near to mid-term contaminant considerations
  - Future contaminant considerations

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AVRA VALLEY WWTF

AZPDES Permit – Effective 8/22/04 to 8/22/08

- Key Issues
  - Future disinfection technology
  - Dechlorination impacts
  - Emergency discharge to Black Wash
- Schedule Considerations
  - Trace substances monitoring status
- Key Standards/Limits
  - Current and future standards
  - Toxicity tests, results and follow-up actions

AVRA VALLEY WWTF

Reclaimed Water Permit – Eff. 7/30/04 to 7/30/09

- Key Issues
  - Reclaimed water uses
  - 6.2 MGD expansion ongoing -- includes UV, filtration
- Schedule Considerations
  - Renewal
- Key Standards/Limits
  - Class A+ with expansion/upgrades
  - Enhanced future standards not expected
  - Other future issues (fouling, UV efficiency, salinity)

GREEN VALLEY WWTF
Aquifer Protection Permit – Effective 7/1/03

- Key Issues
  - Permit reopeners
  - Operation is permitted as two separate facilities
- Schedule Considerations
  - No compliance schedule issues
- Key Standards/Limits
  - POC location
  - BNROD limits
  - Near to mid-term contaminant considerations
  - Future contaminant considerations

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GREEN VALLEY WWTF
AZPDES Permit – Effective 8/22/04 to 8/22/08

- Key Issues
  - Future disinfection
  - Emergency backup storage
- Schedule Considerations
  - Trace substances monitoring status
- Key Standards/Limits
  - Current and future standards
  - Toxicity tests, results and follow-up actions

50

GREEN VALLEY WWTF

Reclaimed Water Permit – Eff. 12/28/04 to 12/28/09

- Key Issues
  - No major issues
- Schedule Considerations
  - Renewal
- Key Standards/Limits
  - Class B (WWTF 2.1 MGD)
  - Class A+/B+ (BNROD 2.0 MGD; with/without filters)
  - Enhanced future standards not expected
  - Other future issues (microbial fouling, UV efficiency, salinity)

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GREEN VALLEY WWTF

Air Quality Permit – 5-year term expired 2005

(administratively continued)

- Key Issues
  - Synthetic minor source for NO_x and CO
  - Minor source for other criteria pollutants
  - Permitted equipment
  - No issues with opacity testing, sulfur content, H_2S limits
- Schedule Considerations
  - Emission modeling
- Key Standards/Limits
  - Potential to emit
  - H_2S fence line criteria

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Key Water Quality Issues

Ramesh Narasimhan

Key Issue: Coliforms and Microbial Treatment

- Non-detect compliance criteria for fecal coliform and E. coli anticipated under future APPs
- Plants may need filtration to meet new limits
  - Type of filtration
  - Impact of potential UV system efficiency

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Key Issue: Coliforms and Microbial Treatment *(continued)*

- Or consider SAT and alternate POC for compliance with more stringent microbial standards

55

Key Issue: Disinfection Process

- Use of chlorine periodically results in problems historically due to ineffective dechlorination (Roger Road WWTP and Ina Road WPCF)
- Monitoring <20 ppb chlorine poses analytical challenges due to interference
- Excess sodium bisulfite, used to dechlorinate, causes DO sag in river

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Disinfection Issues *(continued)*

- Consider use of ozone and/or UV for disinfection, with limited use of chlorine
  - UV and ozonated by-products a potential concern (e.g., bromate)
  - Ozone is complex process
  - Pretreatment critical to UV effectiveness
  - Additional pretreatment likely required for advanced disinfection

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Disinfection Issues *(continued)*

- THMs and HAAs not a current problem (likely because of low organic precursors and high ammonia levels)
  - Future standard will be 80 ppb
  - May be an issue if chlorination is used for effluent disinfection and CAP water is used in Tucson's water supply
- After NdeN is implemented
  - Reduced impacts from analytical interference anticipated
  - Better control of dechlorination process anticipated

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Key Issue: Ammonia Toxicity

- NdeN to reduce ammonia levels to <2 mg/L
- If chlorine is used as disinfectant
  - Residual ammonia after NdeN will be consumed to form chloramines
  - Free chlorine is available and is more powerful disinfectant
  - With UV/ozone, residual
- Current levels of residual ammonia may impact dechlorination effectiveness
  - Effectiveness of ORP feedback sensors for controlling chlorination/dechlorination

59

Key Issue: Change in Habitat

- Reduced flow in effluent dependent receiving stream at Roger Road WWTP
  - Loss of riparian ecosystem
  - Need to consider public concerns
- Conduct habitat assessment studies
- Perform public and stakeholder outreach activities
  - Game and Fish, Fish and Wildlife, PAG, Defenders of Wildlife, local interest groups, etc.

60

Phosphorus

- Numeric targets currently proposed for lakes and reservoirs in Arizona
  - Driver is Chlorophyll-a concentration
  - Total phosphorus considered as additional evidence of nutrient related impairment
- Nutrient targets for impaired streams also currently imposed
- No such standards anticipated in near future for County's receiving stream
- Removal may be desirable if costs are minimal

61

Total Organic Carbon

- Potential issue for recharge/injection sites
  - Other states have more stringent standards (e.g., California)
  - Advanced treatment (GAC/enhanced coagulation) to be considered in future?

62

Emerging Contaminants
(Potential APP Issues)

- Endocrine disruptors/pharmaceuticals
  - UV or ozone treatment
  - Requirements for photo degradation and biodegradation of pharmaceuticals to be investigated
- NDMA
  - 20 ng/L action level in California
  - Assess presence
  - Applicable treatment – UV oxidation

63

Emerging Contaminants
(Potential APP Issues) *(continued)*

- Perchlorate
  - List 1 UCMR – AZ action level of 14 ppb
  - Perform sampling
- Salinity (also potential reclaimed water issue)
  - Consider use of CAP water by Tucson
- Arsenic
  - 10 ug/L

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Reclaimed Water Issues

- Standards for reuse not expected to soon change
  - AZ among highest standards in the country
- Microbial fouling and release
- UV system efficiency
- Salinity buildup
- Chlorine residuals
- Turbidity
- Consider differences in treatment needs between PCWMD effluent and Tucson Water reclaimed water

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Recharge / Recovery Permits

- ADWR recharge/recovery permitting activities would be a joint effort between PCWMD and City of Tucson
- Need to meet City of Tucson's future needs
  - Flow requirements by site
  - Develop congruent timelines
  - Treatment and quality standards and impacts on potable supplies (TOC, etc.)

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Other Permits / Considerations

Ramesh Narasimhan

Other Permits

- Storm Water
  - Modify permit to reflect plant upgrades
    - General
    - Individual
- Army COE 404 (KERP)
- Dam
  - Update to reflect plant upgrades (Avra Valley, Green Valley)
- Forest service
  - Update to reflect plant upgrades (Mt. Lemmon)

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Other Permits *(continued)*

- Design phase permits and approvals
  - Coordinate through appropriate agency
  - Potential permits
    - Fire access
    - Fire Department Chemical Storage, Hazardous Material Management Plan
    - Building Permit (plan approval)
    - Right-of-Way Work Permit for sewer lines and reclaimed water lines
    - Recharge Well Permit
    - Well Drilling Permit
    - Dry Well Registration/Permit
    - AZPDES (general) Construction Storm Water NOI

AAC Setback Requirements

- 1,000 feet without noise, odor and aesthetic controls

AAC Setback Requirements

- With Controls
  - <50 db at fence
  - Enclosed odor producing components
  - Odor scrubbers on vents
  - Fencing – match surroundings

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Other Permits *(continued)*

- Construction phase permits and approvals
  - Earth Moving Permit
  - Approval to Construct (ATC)
  - Archeological Assessment
  - Environmental Assessment (federal funding)
  - Spill Prevention, Control, and Counter Measures Plan

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Other Permits *(continued)*

- Construction phase permits and approvals *(continued)*
  - AZ Protected Native Plants and Wood Removal Application (if needed)
  - Approval of Construction
    - Interim permit to operate
    - Final approval of construction
  - Risk Management/Process Safety Management Plan
  - RCRA Hazardous Waste Compliance (if needed, depending on process)

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Summary

Andy Richardson

Pima County Wastewater
Management Department

GREELEY AND HANSEN

Workshop #3B Meeting Notes
Stakeholder and Regulatory Requirements

1. The Stakeholder and Regulatory Requirements Workshop for Pima County Regional Optimization Master Plan was held on June 21, 2006 after Workshop #3A. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
PCWMD Staff
Tom Berry
Ed Curley
James Doyle
Frank Gall
Byron McMillan
Jeff Prevatt
Helen Rhudy
Ron Riska, Project Manager
Ken Weber
Legal
Harlan Agnew
Barbara McMurray
Chuck Wesselhoft

TUCSON WATER
Tucson Water Staff
Jeff Biggs
Karen Dotson
John Kmiec
Melodee Loyer
Mark Seamans
Tim Thomure
Wally Wilson
Alan Forrest, CH2M Hill
Ken Thompson, CH2M Hill

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Kevin Conway
Gordon Culp
Ramesh Narasimhan
Andrew Richardson

2. Major topics of the workshop were:

- Workshop #3B: Stakeholder and Regulatory Requirements Workshop
  - ► Identify and understand Tucson Water's Reclaimed Water System operational and regulatory issues to develop mutually beneficial strategies.
  - ► Obtain information on Tucson Water's Recharge/Recovery operations and permits to identify key interface issues between the two agencies.
  - ► Provide Tucson Water with an overview of some of the key regulatory challenges that PCWMM is facing regarding AZPDES, APP, Reclaimed Water, and Air Quality issues that will impact facility planning for each of the major facilities (Ina Rd. WWTP, Roger Rd. WWTP).
  - ► Develop a strategy and agenda for future regulatory agency and stakeholder meetings.

Handouts were provided to each attendee, which included presentation slides used during the workshop. Contents of these handouts are not repeated in these notes; however comments on the handouts are recorded within the notes.

Throughout the workshop, notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, opened the workshop by recognizing presence and thanking Tucson Water for use of the meeting room. He indicated that the topics of the morning workshop were stimulating and hoped that the afternoon workshop would be as stimulating. Finally, he invited everyone to participate in the discussions on regulatory issues.

4. Andy Richardson defined his role as facilitator to move the group through the agenda and to encourage participation from all in the room. The purpose of this workshop is to identify key operational and permitting issues relating to the reclaimed water system and recharge/recovery facilities that impact PCWWM's facility planning and regulatory efforts. Other objectives include developing unified permitting strategies and answering questions relating to future water quality issues.
A brief summary of Workshop #3A was provided which indicated three areas for collaboration with Tucson Water – 1) treatablity studies, 2) stakeholder process, and 3) public involvement. Also, there were nine questions developed in Workshop #3A for discussion with Tucson Water. The questions and the subsequent answers by Tucson Water are provided in item 12 below. Tucson Water was invited to participate in meetings with the Phoenix Valley cities including SROG on regulatory issues. Lastly, issues of ADEQ primacy and the recent Supreme Court ruling on navigable waters (NPDES permits) for the Santa Cruz River were presented.
The agenda, ground rules and objectives of the workshop were presented and covered on pages 1 through 4 of the handout.

5. Jerry Bish provided specifics on the variances in the AZPDES permits at Roger Road WWTP and Ina Road WPCF. The current variances are for ammonia toxicity and copper limitations. While the copper levels are above permits levels, the County is applying for a variance to the copper limits, because the background levels in the groundwater supply are high. Ammonia toxicity compliance will be met through nitrogen removal processes in the upgraded wastewater treatment plants by 2014/2015. The January 2007 letter required by ADEQ is to describe compliance strategy and approach.

An overview of the treatment options under consideration in the plan – existing plan, transfer some and transfer all to Ina Road WPCF was presented. If the transfer all option is selected then the compliance date for ADEQ will be January 30, 2015. Each of the options will include consideration of the reclaimed water alternatives developed in Workshop #2 on Water Reuse. Tucson Water asked if they could have access to the 12.5 mgd BNRAS effluent at Ina Road WPCF before 2015. There was a statement made that the plant permit may preclude this because it is based on a blend between the HPO and BNRAS, but is worth an investigation Tucson Water willing to take some BNRAS to help with Roger Road downtime.
Permit variances and treatment options were covered on pages 4 through 9 of the handout.

6. Karen Dotson provided an overview of Tucson Water's reclaimed water system indicating that Tucson Water has one of the largest community reclaimed water systems in the United States. Tucson Water holds a general reuse permit from ADEQ and delivers reclaimed water to about 600 sites, including: 14 golf courses; 32 parks; 40 schools and more than 300 single family homes. The University of Arizona is currently the only non irrigation use.
Tucson Water's reclaimed water production facilities at Roger Road near I-10 are wrapped around and are conjoined with the Roger Road WWTP, and have been filtering and disinfecting treated wastewater for 19 years. The facilities produce Class A effluent but would like to produce all Class A+ (total nitrogen below 10mg/L) effluent in the future due to ADEQ concerns, public exposure, and additional operational requirements during spills and leaks. Class A water requires lining of ponds on golf courses, whereas A+ would not. Also, if there is a main break with Class A water is a larger deal with requirements for containment and regulatory reporting that would not be required for A+ water.
The reclaimed water facility consists of recharge basins, recovery wells and a filtration plant. These facilities produce low turbidity water to meet Class A standards. Generally a blend of the two sources is used in the reclaimed water system. The recharge/recovery process has been effective in reducing TOC levels.
Tucson water indicated that they would be willing to fight WET testing criteria.

7. Wally Wilson provided an overview of the various recharge and recovery permits used by Tucson water and summarized the capacities of their filtration and recharge/recovery facilities. The filtration facility handles 10 mgd and the recharge/recovery facilities are being re-rated to 13,000 AF/yr. Currently the recharge basins has a nitrogen (N) concentration of 16 mg/L in with 6 to 12 mg/L of N out of the recovery wells.
The underground water storage facility permits expire in 2008 and are renewable for 20 years.
If all the effluent is produced at Ina Road WPCF, a 36-inch main would be required between Ina Road WPCF and Sweetwater to meet the demands of the reuse system.

Constructed recharge would bring up a lot of permitting issues. Lots of demonstration would be required and there would be Corp of Engineers 404 permit process to deal with. Other options would be less complex to meet current needs.
Tucson Water owns about 100 acres at Roger Road.
Tucson Water provided a handout at the workshop that summarized the current Tucson Water Recharge and Recovery Permits.

8. Ramesh Narasimhan presented the key current permitting issues for Roger Road WWTP and Ina Road WPCF. One major issue for the future facilities is BADCT compliance and its cost implications (filtration/UV or filtration /ozone or use of SAT). Other concerns are, TMDL for dissolved oxygen (DO) in the Santa Cruz River (not impaired for DO), phosphorus limits, total dissolved solids in effluent from the use of CAP water for irrigation, testing for emerging contaminants, total organic carbon and future reclaimed water regulations.
Permit issues and concerns were covered on pages 10 through 19 of the handout. Matrices with permit detail and issues for each of Pima County wastewater facility are included at the back of the workshop handout.

9. Ken Thompson stated that many sources show that coliform goes to zero in about 10 feet of SAT. So, no defect for coliform in APP is not special. Will bring data to ADEQ meeting, if helpful.

10. Salinity of potable water will increase as CAP use increases. Community believes TDS is an important parameter.

10. With the group participation consensus was reached on the following key issues that need to be discussed jointly with the regulatory agencies:

    a. SAT and BADCT criteria (microbial treatment, disinfection)
    b. Regulation of wetlands
    c. Air Quality permit modifications – HAP, MACT and BAT issues and emission caps
    d. Different qualities of effluent from a single facility
    e. Consistency with PAG 208 Plan

    Mike Gritzuk will take the lead in contacting the Phoenix Valley cities including SROG, ADEQ.
    Harlan Agnew will develop the draft agenda for the meetings

11. Melodee Loyer indicated that the Reuse Subcommittee for this project had only focused on options that featured a single Class or Quality of water from a particular facility. The options

discussed at the meeting were new to Tucson Water and will be further reviewed by Tucson Water.

12. A group discussion followed regarding the substantial benefits to PCWMM of producing effluent with different levels of treatment. High quality effluent for Tucson Water Reuse and lesser qualities for surface discharges and other types of reuse. The Master Plan will consider levels of treatment necessary to meet criteria based on regulatory drivers and costs. High Quality treatment for surface water discharge appears unnecessary to PCWWM. Subcommittee will need to address options with a lesser quality water.

13. The following responses were provided by Tucson Water to PCWMM questions:

- 1) What is their projection of when TDS from CAP water will be an issue? Also impact from TDS build-up from recharge? *Response: "Clean Water" program is in place. Brine disposal will consist of evaporation plants. Tucson water owns 100 acres at Roger Road for an RO facility and ponds to control TDS.*
- 2) When does the yellow become reclaimed water? *Response: After 2014, maybe much later, depends on growth.*
- 3) When will Tucson Water engage the public on this issue? Response: *At year 2013, 450 mg/L TDS is estimated from recovery wells at which time public is engaged and blending/treatment will be used to keep at this level; 600 mg/L could be a cap.*
- 3) Participate in concurrent research efforts? *Response: Tucson Water agreed to participate in joint research efforts on pharmaceuticals/endocrine disruptors.*
- 4) What is the schedule for chloramine conversion? *Response: No conversion planned at this time and is not desirable. Will reevaluate if necessary in the future (to comply with DBP limits).*
- 5) Participation in a state-wide meeting on SAT? *Response: Tucson Water agreed to participate in this meeting.*
- 6) Perchlorate levels in CAP water is being tracked by Tucson Water. *Response: Tucson Water is monitoring for perchlorate; Do not see as an issue (will share data with PCWWM)*
- 7) TOC levels: *Response: 3 mg/L TOC in recharge; 1 mg/L out of recharge, will treat if level increases prior to injection.*
- 8) Briefing for Tres Rios del Norte: *Response: Tucson Water will attend the debriefing on this project*
- 9) Pipe to Avra Valley plans: *Response; Will wait until 2014 to have the conversation about this issue.*

Agenda
Workshop #3B – Stakeholder and Regulatory Requirements
June 21, 2006

Time	*Topic*	*Presenter*	*Pg*
1:00 pm	*Rio Nuevo Upstairs Conference Room, 52 W. Congress*		
1:30 pm	Opening Session		
	• Welcoming Remarks	Mike Gritzuk	1
	• Overview of Agenda	Andy Richardson	2
	• Summary of #3A Workshop		
	• Purpose and Objectives		
1:45 pm	Overview of Facilities Impacting Tucson Water	Jerry Bish	5
	• January 2007 ADEQ Permit Requirements		
	• Current and Ongoing Projects		
	• Potential Future Projects		
2:00 pm	Reclaimed Water Permits	Karen Dotson/Ramesh Narasimhan	10
	• Reclaimed Water Permits		
	• Aquifer Protection Permits		
	• AZPDES Permits		
	• Schedule Considerations		
	• Anticipated Near, Mid and Long Term Reclaimed Water Quality Issues		
	• Future Water Quality Considerations – Emerging Contaminants		
2:45 pm	Recharge / Recovery Permits	Wally Wilson	14
	• Key Permitting Issues		
	• Flow Criteria and Requirements		
	• Schedule for Permit Renewal / Modifications		
	• Stakeholder Considerations		
3:00 pm	Key Water Quality Issues	Ramesh Narasimhan	15
	• BADCT Criteria		
	• Disinfection Processes		
	• Reclaimed Water Treatment Goals		
	• Recharge/Recovery Considerations		
	• Emerging Contaminants		
	• Stakeholder Considerations – Potential Impacts on Habitat and Wildlife		
	• Anticipated Future Reclaimed Water Standards		
4:00 pm	Summary / Wrap-Up	Andy Richardson	19
	• Comment by Group		
	• Closing Remarks	Mike Gritzuk	
4:15 pm	Adjourn		

Pima County
Regional Optimization
Master Plan

Workshop #3B
Stakeholder and Regulatory Requirements

June 21, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Jerry Bish	Overview
Ramesh Narasimhan	Permit/Regulations
Karen Dotson	Tucson Water Permits
Wally Wilson	Tucson Water Permits

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop Objectives
- Overview of Facilities Impacting Tucson Water
- Reclaimed Water Permits
- Recharge / Recovery Permits
- Overview of Key Issues from Other Permits
- Closing

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

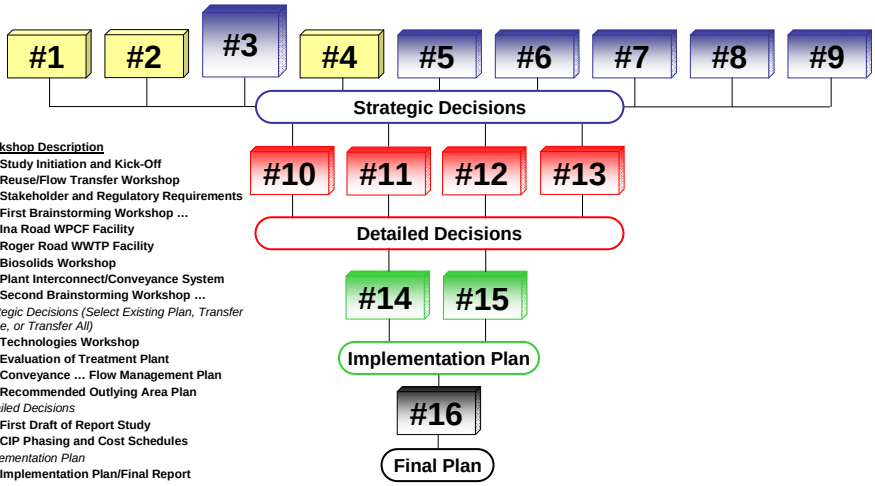
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop #3A Summary

- Review outcomes of Workshop #3A impacting reclaimed water

11

Workshop Objectives

- January 2007 ADEQ Letter Compliance
- Review Current Permits
- Identify Regulatory Issues
- Reuse Regulation Impacts/Considerations
- Regulatory Impact of Reduced Discharge from Roger Road on Santa Cruz River
- Review Future Regulatory Requirements

12

Overview of Facilities Impacting Tucson Water

Jerry Bish

AZPDES Permit – Roger Road WWTP

- Variances
  - Ammonia toxicity
    Variance until January 30, 2015
  - Copper limitations
    Variance until January 30, 2011

14

AZPDES Permit – Roger Road WWTP

- Ammonia toxicity terms/conditions
  - By January 30, 2007
    - Complete engineering design review
      - Upgrade or replace
    - Document selected construction option
    - Submit documenting letter to ADEQ
  - By January 30, 2011
    - Award contract for construction
  - By January 30, 2015
    - Treatment of effluent to non-toxic ammonia levels

15

AZPDES Permit – Roger Road WWTP

- Copper limitations
  - Interim limit daily maximum: 25 µg/L
  - By January 30, 2011
    - Comply with copper standard
      - Daily maximum: 16 µg/L
      - Monthly average: 12 µg/L

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AZPDES Permit – Ina Road WPCF

- Variances
  - Ammonia toxicity
    Variance until January 30, 2014
  - Copper limitations
    Variance until December 31, 2010

17

AZPDES Permit – Ina Road WPCF

- Ammonia toxicity terms/conditions
  - By February 1, 2007
    - Complete initial engineering study
    - Recommendation for upgrading Ina Road WPCF
    - Submit documenting letter to ADEQ
  - By December 31, 2010
    - Award contract for construction
  - By January 30, 2014
    - Treatment of effluent to non-toxic ammonia levels

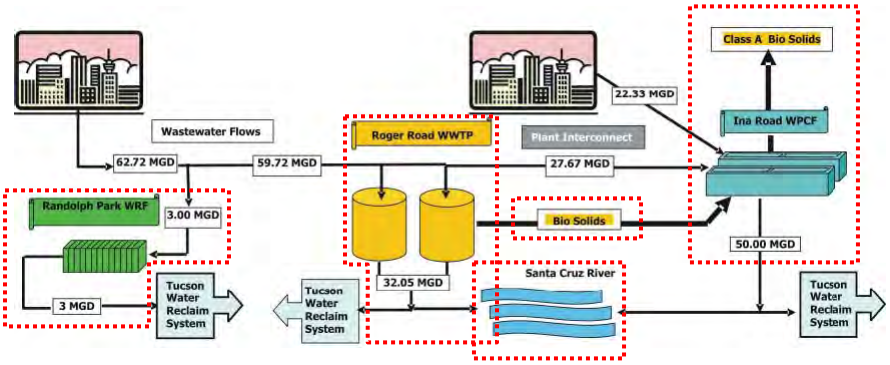
18

AZPDES Permit – Ina Road WPCF

- Copper limitations
  - Interim limit daily maximum: 30 µg/L
  - By December 31, 2010
    - Comply with copper standard
      - Daily maximum: 16 µg/L
      - Monthly average: 12 µg/L

19

Existing Plan Schematic



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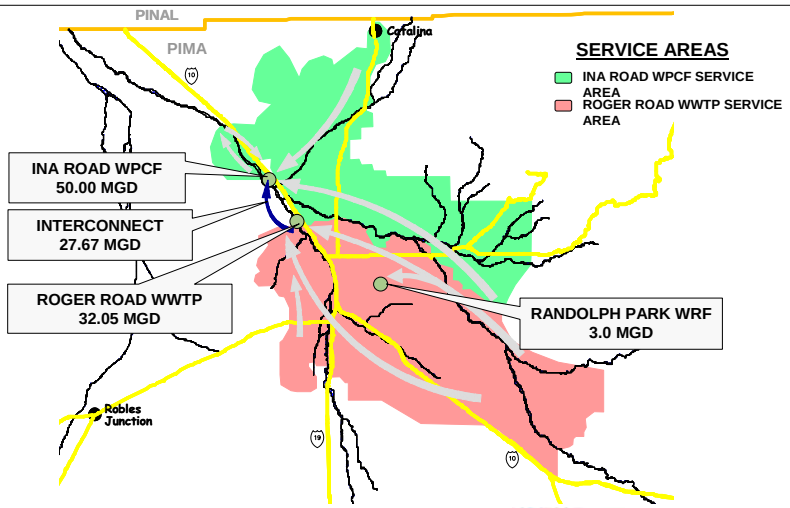
Existing Plan (2030)



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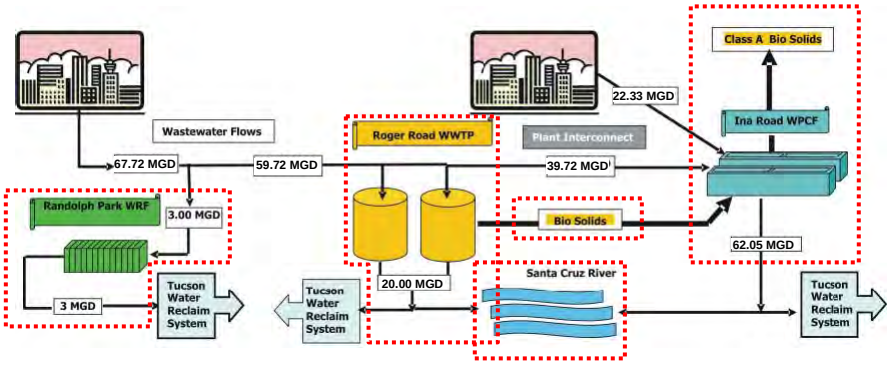
Transfer Some Schematic



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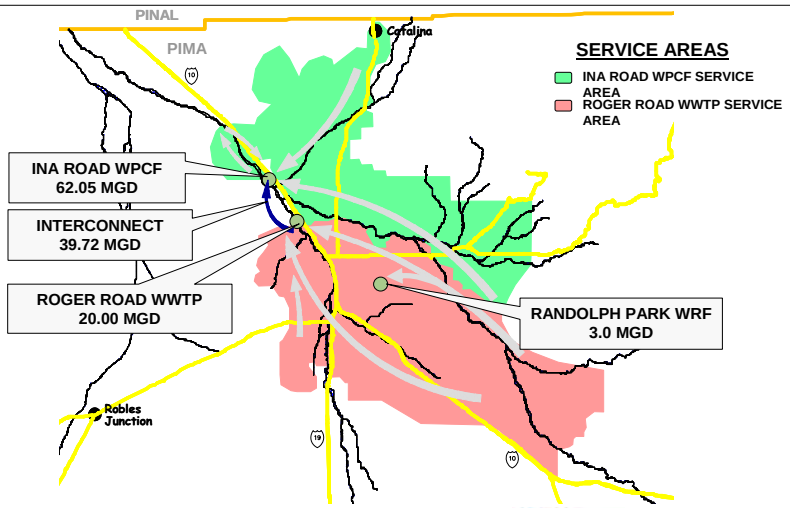

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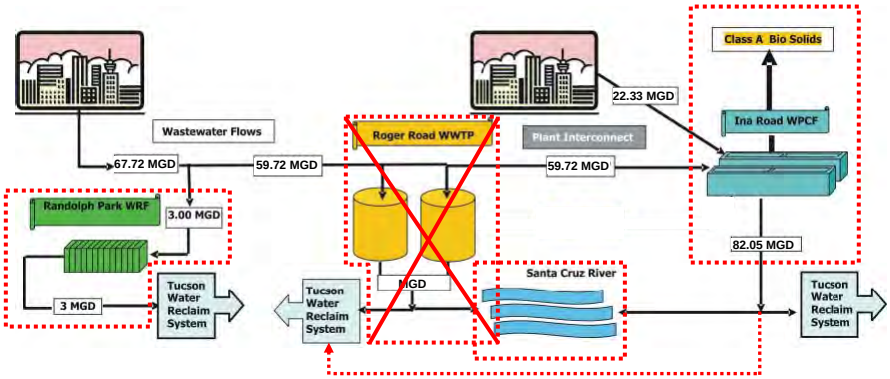
Transfer All Schematic



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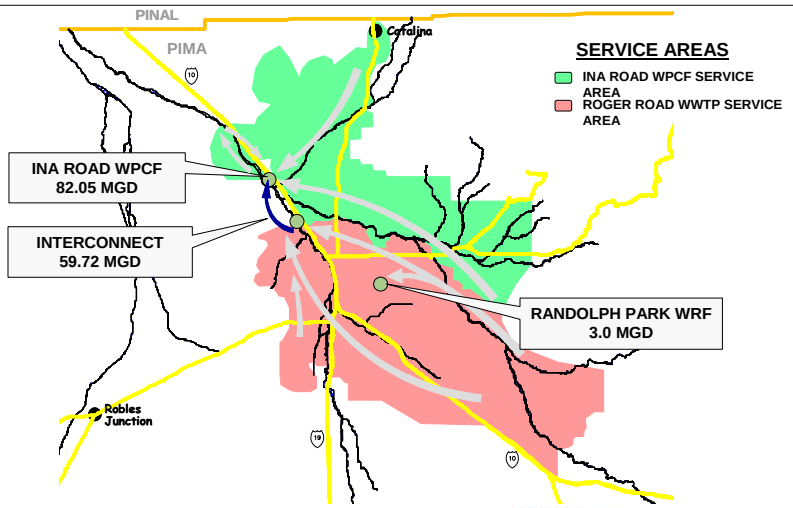
Transfer All (2030)



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Current / Ongoing Projects

- Ina Road BNRAS
- Outlying facilities
  - Avra Valley WWTP
  - Corona de Tucson WWTP
  - Marana WWTP
  - Green Valley WWTF

26

Potential Future Projects

- Existing Plan:
  - Roger Road WWTP (upgrade/downsize)
  - Ina Road WPCF (expand)
  - Randolph Park WRF
- Transfer Some:
  - Roger Road WWTP (upgrade/downsize significantly)
  - Ina Road WPCF (expand)
  - Randolph Park WRF
- Transfer All:
  - Ina Road WPCF (expand significantly)
  - Randolph Park WRF

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Pima County Wastewater Management Department

GREELEY AND HANSEN

NCS

Reclaimed Water Permits

Karen Dotson / Ramesh Narasimhan

Goals and Objectives

- Present and discuss current and future permitting issues
  - Integrate with current and planned improvements
- Outline timelines (establish deadlines) to meet permitting requirements
- Identify needs of all stakeholders
- Identify key issues needed to develop a uniform permitting strategy

29

APP, AZPDES, Reclaimed Water, and Air Quality Permits

- Key issue development by facility
  - Matrices developed for each facility
    - Roger Road WWTP
    - Ina Road WPCF

30

ROGER ROAD WWTP
Reclaimed Water Permit – Eff. 4/29/04 to 4/20/09

- Key Issues
  - Need to upgrade entire facility to higher class??
  - Usage/replacement of Tucson Water facility
- Schedule Considerations
  - Renewal
- Key Standards/Limits
  - Class B/B+ (Pima County uses)
  - Class A/A+ (Tucson Water uses)
  - Other future issues
    - Microbial fouling, UV efficiency, salinity, CAP water importation

31

ROGER ROAD WWTP
Aquifer Protection Permit – Effective 5/26/05

- Key Issues
  - POC location for well 12 replacement
  - Compliance with setback limits
  - Permit reopeners
  - BADCT: need to filter vs. SAT
  - Use of CAP water by Tucson Water
- Schedule Considerations
  - Replacement well
  - Permit modifications

32

ROGER ROAD WWTP

Aquifer Protection Permit – Effective 5/26/05 *(continued)*

- Key Standards/Limits
  - POC location
  - Safety factors
  - Interim nitrate AQL
  - Near mid-term, and future contaminant considerations

ROGER ROAD WWTP

AZPDES Permit – Effective 3/2/06 to 3/2/11

- Key Issues
  - Ammonia toxicity
  - Copper variance
  - Chlorine monitoring method and metal translator studies
  - Minimum flows
- Schedule Considerations
  - Compliance for ammonia, copper compliance
  - Chlorine method and metal translators studies

ROGER ROAD WWTP

AZPDES Permit – Effective 3/2/06 to 3/2/11 *(continued)*

- Key Standards/Limits
  - Interim copper level
  - Current and future standards: Cr VI, Cu, Cl_2
  - Toxicity tests, results and follow-up actions

35

INA ROAD WPCF

Reclaimed Water Permit – Effective 1/6/04 to 1/6/09

- Key Issues
  - Need to upgrade to higher class??
  - Microbial fouling in distribution system
  - Reuse customers
- Schedule Considerations
  - Renewal

36

INA ROAD WPCF

Reclaimed Water Permit – Effective 1/6/04 to 1/6/09 *(continued)*

- Key Standards/Limits
  - Two treatment trains: Class B (25 MGD), Class B+ (12.5 MGD)
  - Benefits of upgrading Class
  - Future salinity issues

37

INA ROAD WPCF

Aquifer Protection Permit – Effective 2/26/02

- Key Issues
  - Archeological implications
  - Permit reopeners
  - BADCT: need to filter vs. SAT
  - Use of CAP water by Tucson Water
- Schedule Considerations
  - Pesticides and PCB monitoring
  - Permit modifications

38

INA ROAD WPCF

Aquifer Protection Permit – Effective 2/26/02 *(continued)*

- Key Standards/Limits
  - Point of compliance (POC) location
  - Near to mid-term contaminant considerations
    - Fecal coliforms or E. coli, TOC, THMs, HAAs, bromate, arsenic
  - Future contaminant considerations
    - Salinity, endocrine disruptors, pharmaceuticals, NDMA

39

INA ROAD WPCF

AZPDES Permit – Effective 1/2/06 to 1/2/10

- Key Issues
  - High ammonia levels
  - Chlorine and copper exceedances
- Schedule Considerations
  - Compliance for ammonia, copper toxicity, and chlorine
  - BNRAS upgrade

40

INA ROAD WPCF

AZPDES Permit – Effective 1/2/06 to 1/2/10 *(continued)*

- Key Standards/Limits
  - Current standards and ranges for Cr VI, Cu, Cl_2, cyanide, Pb, Ag, phthalate
  - Toxicity tests, results and follow-up actions
  - Future contaminant considerations

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Recharge / Recovery Permits

Wally Wilson

Key Water Quality Issues

Ramesh Narasimhan

Key Issue: Coliforms and Microbial Treatment

- Non-detect compliance criteria for fecal coliform and E. coli anticipated under future APPs
- Plants may need filtration to meet new limits
  - Type of filtration
  - Impact of potential UV system efficiency

44

Key Issue: Coliforms and Microbial Treatment *(continued)*

- Or consider SAT and alternate POC for compliance with more stringent microbial standards

45

Key Issue: Disinfection Process

- Use of chlorine periodically results in problems historically due to ineffective dechlorination (Roger Road WWTP and Ina Road WPCF)
- Monitoring <20 ppb chlorine poses analytical challenges due to interference
- Excess sodium bisulfite, used to dechlorinate, causes DO sag in river

46

Disinfection Issues *(continued)*

- Consider use of ozone and/or UV for disinfection, with limited use of chlorine
  - UV and ozonated by-products a potential concern (e.g., bromate)
  - Ozone is complex process
  - Pretreatment critical to UV effectiveness
  - Additional pretreatment likely required for advanced disinfection

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Reclaimed Water Issues

- Standards for reuse not expected to soon change
  - AZ among highest standards in the country
- Microbial fouling and release
- UV system efficiency
- Salinity buildup
- Chlorine residuals
- Turbidity
- Consider differences in treatment needs between PCWMD effluent and Tucson Water reclaimed water

48

Recharge / Recovery Permits

- ADWR recharge/recovery permitting activities would be a joint effort between PCWMD and City of Tucson
- Need to meet City of Tucson's future needs
  - Flow requirements by site
  - Develop congruent timelines
  - Treatment and quality standards and impacts on potable supplies (TOC, etc.)

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Total Organic Carbon

- Potential issue for recharge/injection sites
  - Other states have more stringent standards (e.g., California)
  - Advanced treatment (GAC/enhanced coagulation) to be considered in future?

50

Emerging Contaminants
(Potential APP Issues)

- Endocrine disruptors/pharmaceuticals
  - UV or ozone treatment
  - Requirements for photo degradation and biodegradation of pharmaceuticals to be investigated
- NDMA
  - 20 ng/L action level in California
  - Assess presence
  - Applicable treatment – UV oxidation

51

Emerging Contaminants
(Potential APP Issues) *(continued)*

- Perchlorate
  - List 1 UCMR – AZ action level of 14 ppb
  - Perform sampling
- Salinity (also potential reclaimed water issue)
  - Consider use of CAP water by Tucson
- Arsenic
  - 10 ug/L

52

Key Issue: Change in Habitat

- Reduced flow in effluent dependent receiving stream at Roger Road WWTP
  - Loss of riparian ecosystem
  - Need to consider public concerns
- Conduct habitat assessment studies
- Perform public and stakeholder outreach activities
  - Game and Fish, Fish and Wildlife, PAG, Defenders of Wildlife, local interest groups, etc.

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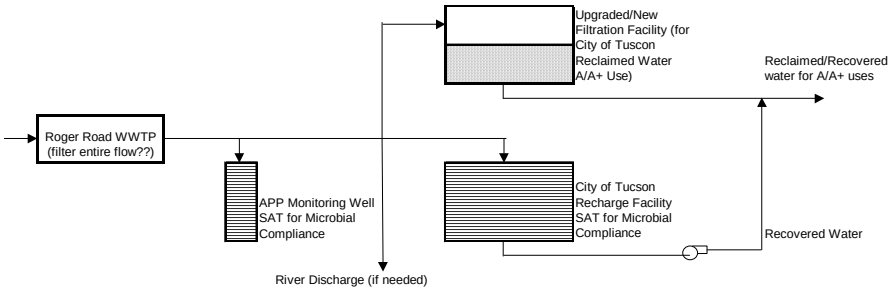
Roger Road WWTP Regulatory Scenarios



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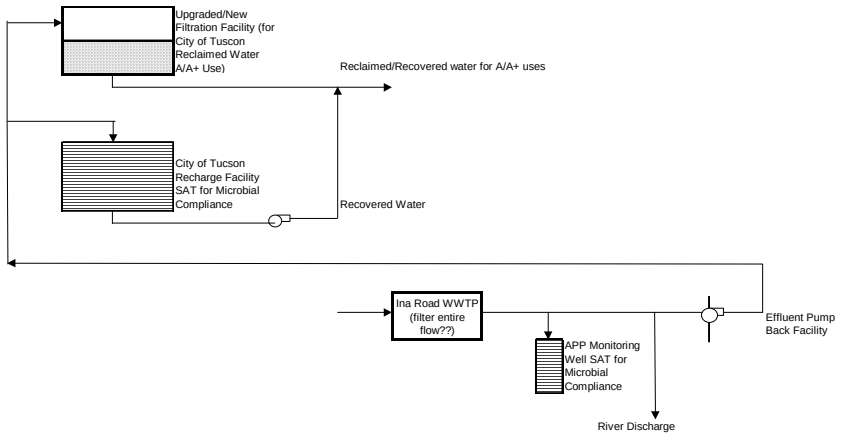
Ina Road WWTP Regulatory Scenarios



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Summary

Andy Richardson

Pima County Wastewater
Management Department

GREELEY AND HANSEN

Workshop #4 Meeting Notes
First Brainstorming (Preliminary Process Alternatives) Workshop and Background Data Review

1. The First Brainstorming (Preliminary Process Alternatives) Workshop and Background Data Review Workshop for Pima County Regional Optimization Master Plan was held on June 5, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Jackson Jenkins
PCWMD Staff
David Bartos
Ed Curley
James Doyle
Dennis Froehlich
Frank Gall
David Garrett
Michael Kostrzewski
Frank Luiz
Jing Luo
Pete Magaddino
John Munden
Jeff Nichols
Glen Peterson
Jeff Prevatt
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
Mandley Rust
Jack Van Riper
Ken Weber
Eric Wieduwilt
Legal
Harlan Agnew

TUCSON WATER
Tucson Water Staff
Karen Dotson
Melodee Loyer
Ralph Marra
Mark Seamans
Tim Thomure
Alan Forrest, CH2M Hill
Ken Thompson, CH2M Hill

METRO WATER DISTRICT
Tom Caito

PIMA ASSOCIATION OF GOVERNMENTS
C. Zucker

GREELEY AND HANSEN PROJECT TEAM
Orrie Albertson
Jerry Bish
Gordon Culp
Joe Popeck
Andrew Richardson
Anne Smith
Dave Stensel

2. Major topics of the workshop were:

- Workshop #4: First Brainstorming (Preliminary Process Alternatives) Workshop and Background Data Review
  - Background / Condition Assessment
  - Interview Summary
  - Initial Screening of WWT Processes
  - Wastewater Flow / Loadings
  - Side Stream Treatment
  - Process Discussion
  - Evaluation Criteria

Handouts were provided to each attendee which included presentation slides used during the workshop.

Throughout the workshop, a list of notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, opened the workshop with a few remarks. For this workshop the goals are to review the evaluation of Roger Road WWTP, reach agreement on the evaluation criteria, and review and narrow, if possible, the wastewater treatment process options to those with the most potential to meet future regulatory requirements. The workshop requires active participation by all in an effort to provide the best plan technically and economically for the community.

4. Andy Richardson defined his role as facilitator to move the group through the agenda and to encourage participation from all in the room. The purpose of this workshop is review the condition of Roger Road WWTP, agree on flow and loading projections, and focus on the probable treatment technologies and firm up the evaluation criteria for selection of the recommended option.
   Agenda, ground rules and objectives of the second workshop were presented and covered on pages 1 through 4 of the handout

5. Joe Popeck reviewed the condition of the Roger Road WWTP, starting with the rating forms and ranking criteria, and proceeding with a rating of each process and system element at the plant. The categories for condition evaluation were Structures, Equipment, Electrical and

Instrumentation and Control. In general the facility was well maintained and in satisfactory condition with a few exceptions considering its age. Except for the electrical service the facilities appear to be able, with continued good operational and maintenance practices, to perform for an additional 10 years or until new facilities are brought on line. The electrical system is not serviceable for the long term without significant modifications and upgrades.
There is a concern on the life of the biotower media. The media is near the end of its useful life, which may be extended by some modifications to the operation to reduce the biomass loading on the system. An initial report by others evaluating the biotower condition is that they are performing satisfactorily. A point was stressed that even though the tankage and equipment may be satisfactory for current service, in the future under the new regulatory requirements the existing systems may be too small or too large to serve an appropriate function, and they may need to be decommissioned and replaced with something more appropriate for the function of the new systems
The Condition assessment was covered on pages 4 through 14 in the handout.

6. Anne Smith provided a summary of the stakeholder interviews conducted to date. In general, those interviewed were cautiously optimistic that the master plan will provide the wastewater management department with a needed roadmap for the future. Conversely, there were concerns over stakeholder buy-in and on how the projects from the plan will be funded and constructed within the timeframe required by the State. Stakeholder interview comments were summarized into four categories – Planning, Stakeholder Buy-in, Decision making and Technical challenges. The stakeholder interview summary was covered on pages 15 through 17 of the handout.

7. Joe Popeck briefly introduced a listing of proven wastewater treatment processes that have successful track records in removing nitrogen. One workshop goal is to reduce the list of potential treatment processes to three or four, which will receive a more detailed examination with regard to their application at Roger Road WWTP and Ina Road WPCF. Processes that are eliminated from consideration will be for cause, which will be further documented after the workshop.
The initial screening of processes was covered on pages 17 and 18 of the handout.

8. Orrie Albertson reviewed the treatment options under consideration in the plan – existing plan, transfer some and transfer all to Ina Road WPCF. The development of flow and loading projections for use in the development of the treatment plant processes was explained. Loadings were derived from a reduction of laboratory data collected at the influent of the plant over the past 30 months. Trends and variations were noted and factored into loading projections. Flow data were taken from the joint task group findings on probable growth projections in the

metropolitan service areas. It was noted that peak and diurnal factors will be considered and that the loadings from the biosolids treatment at each facility will be accounted for. In addition any differences in loadings and flow variations between the two treatment facilities will be included in the evaluation. Harlan Agnew stated that the WET test will control the maximum limit of ammonia that will be allowable in the effluent.

For a complete treatment process analysis, additional laboratory data will be required at both Roger Road WWTP and Ina Road WPCF to confirm the influent parameters. These data include among primary effluent COD, SCOD, TKN, total phosphorous and others.

It was agreed that the wastewater concentration will be based on flows of 85 gcpd for the existing population and 60 gcpd for future population. It was also agreed that the hydraulic loads would be based on 85 gcpd on all population.

Flows and loadings developments were covered on pages 18 through 22 of the handout.

9. Orrie Albertson continued with a review of the treatment options at Roger Road WWTP and Ina Road WPCF with a summary of current and future flow data related to each plant. Each option included the continued use of Randolph Park WRF which treats approximately 3 mgd of flow. With each option general considerations and risks were presented.

   Treatment design options were covered on pages 22 through 24 of the handout.

10. Orrie Albertson began the presentation on wastewater treatment process alternatives with a review of the benefits of bioselection versus chemical addition, and the need to address phosphorous removal in the beginning rather than as an add-on at some future date. It is recognized that phosphorous removal may become part of future wastewater treatment requirements. It is uncertain, if or when, but the accommodation of biological phosphorous removal should be given consideration. Harlan Agnew indicated that California and EPA Region 9 are considering imposing phosphorous limits on wastewater treatment works.

    After the initial review of general treatment considerations, a detailed review of nutrient removal treatment alternatives flow sheets began with the Phoenix NdeN process (modified MLE), 4/5-stage Bardenpho process, AS/NTF process and BT/NAS process. Dave Stensel followed with a review of the Step BNR process, biological aerated filters (Biostyr, Biofor and Biocarbone) processes, integrated fixed film activated sludge process (IF/AS), moving bed reactor (MMBR) and membrane technology. Key factors, process concerns and considerations, and advantages and disadvantages of the processes were addressed for each technology during the presentation.

    The process technologies were covered on pages 25 through 55 in the handout.

11. Dave Stensel presented the rationale for sidestream treatment and the treatment processes currently used in these applications. Sidestream treatment is used to reduce the ammonia loads from the liquid streams of the dewatering processes and provide a more stable and effective wastewater nitrification treatment system. By using sidestream treatment aeration basins can be smaller, but system complexity increases with the additional treatment train. Alkalinity and carbon balances need to be evaluated with each of the sidestream processes. Sidestream treatment can be applied to any of the nutrient removal processes discussed in item 10. Sidestream treatment is not necessary as long as the sidestream impacts are addressed in the wastewater treatment system.
Sidestream treatment systems were covered in pages 55 through 63 in the handout.

12. Andy Richardson opened the floor to workshop group for general discussion on the treatment alternatives. Various issues were raised by the group:
    - How comfortable are we that the selected process will be adaptable in meeting future requirements?
    - How will the treatment alternatives work with the existing tankage?
    - What are the relative costs of each alternative?
    - Could Roger Road become a scalping plant?
    - Which alternatives require significant methanol addition?
    - Do some processes fit the existing facilities better than others?
    - Do the biotowers go away?
    - Do the existing tanks drive the process selection, or does the process drive selection?
    - What impact does future phosphorous removal have on the facilities needed to meet current regulations?

13. Dave Stensel and Orrie Albertson developed a list of questions from the group discussion for comparison of the alternatives. The questions included:
    - Can the process achieve a total nitrogen level less than 8 mg/L if the influent is 55 mg/L?
    - Does the process use high quantities of methanol?
    - Can the process be adapted to phosphorous removal?
    - What is the capital cost relative to the Bardenpho process?
    - Can the process be adapted to emerging contaminants removal technology?
    - Can the system use the biotowers at Roger Road WWTP?
    - Can the system use existing tankage?
    - Can process achieve turbidity less than 2 NTU?
    - Can the process be applied to the high purity oxygen (HPO) system at Ina Road WPCF?
    - What are O&M costs relative to Bardenpho?

Andy Richardson prepared a matrix of the eight wastewater treatment alternatives against the questions developed above. The matrix is provided on the attached "flip chart" notes.

14. With assistance from the group Dave Stensel and Orrie Albertson assigned a pass/fail, yes/no or average/low/high values to each process for each question on the matrix. Results of the exercise are provided in the attached "flip chart" notes. Comments during the value assignment exercise included:

- The Phoenix plant (modified MLE) was designed for biological phosphorous removal in the first stage. By turning a valve and making the first stage anaerobic the effluent P value went from 2.5 to 0.5 mg/L.
- Largest capacity of a membrane reactor is 30 mgd. Seattle is building a 36 mgd facility at a cost of $500 million. This was a political as well as a technical decision.
- Does the high purity oxygen facility at Ina Road WPCF work with any of the processes? In general, the high purity oxygen process inhibits nitrifying bacteria and is not compatible with nitrogen removal.
- In general, Zenon membrane facilities are more costly than Kubota membrane facilities. However, Zenon may be more favorable for large facilities.
- Using activated sludge with nitrifying trickling filter (AS/NTF) process at Roger Road WWTP the system could treat approximately 20 mgd. This allows 20 minutes residence time in the filters, which is a short time. Biological phosphorous (P) removal with this process is questionable. Would need to add alum or ferric chloride to meet P removal requirements. In general, there could be difficulty in meeting effluent standards with this process.
- Using the biotowers and nitrification activated sludge (BT/NAS) alum or ferric chloride would be required for P removal and significant methanol requirements are needed. This system could not treat 32 mgd without more towers and tankage, but could have lower life cycle costs at 20 mgd.
- With either Biostyr or Biofor utilizing an anoxic zone at the bottom and aerobic zone on top would emulate a MLE system. This would be followed by a second tower where methanol would be applied to meet effluent requirements. This system would require high first costs and high O&M costs.

15. From the matrix development and group discussion five (5) processes appear to have merit for additional study. These include Bardenpho, Step NdeN, IF/AS Kaldnes (KMT), MBR and Phoenix NdeN. The project team will address in a write-up why processes were eliminated from further consideration.

16. The use of existing tankage for each of the five remaining process options will be evaluated to determine how the existing tankage would be utilized with each process along with determining chemical and energy requirements for each. The analysis will include how the system would fit into the footprint of the plant. The Hydromantis process model will be used with identified processes in item 15 above to determine size of the system components necessary with each process at each facility. In addition, the question whether IF/AS works in hot weather will be evaluated along with other aspects of the system performance. Regarding risks it was suggested that using existing tankage at Roger Road WWTP would carry a higher risk than constructing new tankage at Roger Road WWTP

17. For the five alternatives remaining under consideration the advantages and disadvantages of each process for use at the Pima County facilities will be determined along with the order of magnitude costs and present worth. There was an expressed desire to have common wastewater treatment processes at the plants. This will be decided after each process at each plant is evaluated to determine the cost differential.

18. Tim Thomure offered that the Sweetwater reclaimed facilities could be expanded to 20 mgd. This assumes that the pressure filter system at the plant is no longer required.

19. Gordon Culp presented the revised criteria to evaluate options, not processes, and responses to comments from Workshop #1. There were several additional comments related to the evaluation criteria including:
    - Add salvage costs to the end of the life cycle costs to reflect true value,
    - Clarify meaning of community-wide impact for reuse potential,
    - Eliminate Employee Safety as a criteria (this is a given for all options),
    - Include evaluation of staffing for the facilities in operation in 2030
    - Cost sharing means which organization is most efficient at providing the service.
    - Add Operability as a criterion
    - Relocate noise and odor issues into public acceptability category

    A revised evaluation criteria category listing is provided on the attached “flip chart” notes

20. Gordon Culp began the discussion on weighting of the evaluation criteria. With a show of hands most of the workshop attendees favored weighting the criteria. The presentation continued with a discussion of what weights to assign to each category. The outcome of that discussion is provided on the attached “flip chart” notes.

21. Mike Gritzuk offered closing remarks by stating that the day was well spent. He was surprised that the number of treatment processes was narrowed down so quickly. In his opinion the workshop was a preliminary analysis of processes and that much more work was necessary to identify and defend the final process. Further, the treatment process, and the wastewater and reclaimed water option that best serves the community needs to be identified and fit into the timeframe given by the regulatory agency for advanced wastewater treatment systems to be in service in the years 2014 and 20015

22. Andy Richardson previewed the next workshop scheduled for June 21, 2006 on Regulatory Issues. Workshop #3 will be a one-half day workshop with Pima County Wastewater Management Department followed by one-half day workshop with Pima County Wastewater Management Department and Tucson Water to discuss current and future permits and regulations.

Agenda
Workshop #4 – First Brainstorming (Preliminary Process Alternatives) Workshop and Background Data Review
June 5, 2006

Time	Topic	Presenter	Pg
8:00 am	*Continental Breakfast – Tucson Main Library, Basement Meeting Rm, 101 N. Stone*		
8:15 am	Opening Session		
	• Welcoming Remarks	Mike Gritzuk	1
	• Overview of Agenda	Andy Richardson	2
	• Purpose and Objectives		
8:45 am	Background/Condition Assessments	Joe Popeck	4
	Stakeholder Interview Summary	Anne Smith	15
9:05 am	Initial Screening of Processes	Joe Popeck	17
9:15 am	Development of 2030 Flow and Loadings	Orrie Albertson	18
	• Existing Loadings		
	► Rogers Road Service Area		
	► Ina Road Service Area		
	• Future Loadings – Methodology		
	► Rogers Road Service Area		
	► Ina Road Service Area		
9:35 am	Data Needs	Orrie Albertson	21
9:45 am	Treatment Plant Design Options	Orrie Albertson	22
	• Rogers Road WWTP		
	• Ina Road WPCF		
10:00 am	Break		
10:15 am	Process Alternatives		
	• Bioselection	Orrie Albertson	25
	• MLE (Phoenix NDN Processes)		
	• Four/Five Stage (A_2O_2) Bardenpho (UCT Process)		
	• AS/NTF - DeN Filters w/MeOH		
	• BT/NAS - DeN Filters w/MeOH		
	• Step-Feed NdeN	Dave Stensel	28
	• IFAS Biostyr and Biofor		
	• IFAS Kaldnes (KMT)		
	• MBR (Membranes)		
12:15 pm	Lunch		
1:00 pm	Side-Stream Treatment	Dave Stensel	55
1:30 pm	Process Discussion	All	
2:30 pm	Break		
2:45 pm	Evaluation Criteria	Gordon Culp	63
	• Revised Criteria		
	• Evaluation Matrix		
	• Criteria Weighting		
4:40 pm	Summary / Wrap-Up	Andy Richardson	70
	• Comment by Group		
	• Closing Remarks	Mike Gritzuk	
5:00 pm	Adjourn		

Flip Chart Notes – June 5, 2006

Roger Road WWTP Condition Assessment

- With the concrete block baffles walls one-half of one chlorine contact tank cannot be taken out of service.
- Can media last another ten years?
  - Perhaps, but some things will be required to prolong the life.
- Electrical service was given an overall classification of "good"; how does that fit over next 10 years?
  - Good could last 15-20 years
  - Is it sized properly? Do not know yet, but probably no

Stakeholder Interviews

- What percent of interview have been conducted – report represents over 90 percent of the interviews

Data Needs

- Some concerns on getting samplers
- Sampling required at both plants
- Questions on 60/85 gpcd; 60 applied for wastewater constituent concentration of future growth – not flow
- How will the biosolids from Roger Road WWTP impact Ina Road WPCF's treatment capacity?
- Deal/look at impact of upstream WRFs and their solids discharges
- Ratios of constituent concentrations have varied over day; may need diurnal information

Process Alternatives

- Is future dissolved oxygen and phosphorus going to be taken into consideration, as well as, the impact of future TMDL? Yes
- Target level of 6.5 mg/L total nitrogen – ADEQ may use 9.0 mg/L
- IFAS: What is the useful life of the media? 8 to 10 years.

Process Discussion

- Consider future phosphorus removal – need to plan now
- Need to consider 1 to 2 mg/L of phosphorus as the future limit.
- Phosphorus could be a TMDL, California and EPA developing nutrient water quality standards
- Cooling tower customers would like less phosphorus
- If biological phosphorus (BioP) removal is required, best process is Bardenpho or MBR
- In going forward without $ considerations, would it be possible to bring back another process? Answer: Yes
- BioP removal is difficult with a MBBR process; include hydro on IFAS
- Is sidestream treatment still being looked at? Yes – look at process and see impact on sidestreams

- Do the five processes under consideration have an impact on the use of Roger Road WWTP? Answer: Yes, cannot use some of Roger Road WWTP process elements.

Questions for Pass/Fail

1. Can achieve less than 8 mg/L total nitrogen with an influent of 55mg/L of total nitrogen?
2. What about adaptability to remove emerging contaminants of concern (ECC)?
3. Is high methanol usage required? (to remove 50% or more of nitrogen)
4. Can use existing BioTowers at Roger Road WWTP
5. Is it flexible to BioP removal?
6. Are costs in the capital range of Bardenpho?
7. Can use existing tankage?
8. Can achieve turbidity less than 2 NTU
9. Can be applied with pure high purity oxygen (HPO)
10. O&M costs relative to Bardenpho

Process Pass/Fail

Question	*MLE*	*4/5Bardenpho*	*AS/NTF*	*BT/NAS*	*StepNdeN*	*Biostyr/Biofor*	*IF/AS*	*MBR*
1	F	P	P	F	P	P	P	P
2		P	F					
3		P	F	F	P	F	P	P
4	No	No	Yes	Yes	No	No	No	No
5		Yes	No	No	No	No	Yes	Yes
6		Yes	Yes	Yes	Yes	No	Yes	No
7		Yes	Yes	Yes	Yes	No	Yes	Yes
8		Yes	Yes	Yes	Yes	Yes	Yes	Yes w/o Filter
9		No	No	No	No	No	No	No
10		A	H	H	A	H	A+ to H	H

Key: F= fail P= pass A= average H= high

Recommended Processes to Take Forward

- 4/5 Stage Bardenpho
- MLE (Phoenix process)
- Step feed NdeN
- IFAS Kaldnes (KMT)
- MBR

Process Discussion

- First look at application of each plant process independently; if the same process ends up at all plants, that would be great
- Can IFAS be accepted in state?

- Need write-up on why processes were not brought forward
- Need capital and O&M costs and present worth costs on process brought forward
- There is some desire to have common processes at all plants
- Question on size at Roger Road and Sweetwater capacity at 20 mgd.

Evaluation Criteria

- Operator acceptability
- Should the County have a Plan "B"? Pick best that we can, any alternate would be ***enforcement***
- "Setback criteria" – Make sure it is in one of the evaluation criteria
- Clarify what is meant by "water reuse potential"; i.e., "community-wide impact of reuse potential", "wet" water use, or other.
- Next 4 to 6 weeks Pima County and Tucson Water will meet to work out some of the wastewater/water reuse issues
- Employee safety is a given – take off the evaluation list
- "Cost sharing potential" – Look at what this means – which agency is best suited to implement
- Staff utilization may be a criteria to add
- "Operability" added; includes utilization and ergonomics
- Make sure implementation is covered

Evaluation Matrix

- Operability should be weighted at 5
- Look at lowering constructability from 3 to 2
- Water reuse – look at lowering to a 4 or 3; consider holistic approach; Tucson Water says it should be a 5 – make 5
- Support of water providers in community; add to water reuse potential
- Water/wastewater optimization
- Look at moving some of the sub-criteria from environmental impact to public acceptance, odor for example

Criteria Weighting Agreed upon for Evaluation Matrix

Criteria	*Criteria Weight*	*Ranking*			*Weighted Ranking*		
		Existing Plan	*Transfer Some*	*Transfer All*	*Existing Plan*	*Transfer Some*	*Transfer All*
Cost	5						
Schedule	5						
Constructability	3						
Flexibility	4						
Environmental Impacts	4						
Water/Wastewater Optimization Water Reuse	5						
Public Acceptance	5						
System Operability	4						

Cost Sharing	3						
Effects Financing	3						
System Reliability	4						

Evaluation Matrix

- Put in order of highest weighted to lowest weighted criteria
- If phosphorus removal at Roger Road is an issue – further discuss sidestream treatment
- Space limitation at Randolph Park
- Roger Road has plenty of space
- Setback requirements?
- Constructability – need to know what is out there; need to be aware
- For use of existing tankage – need to know flow pattern
- Sometimes easy to build from start
- Discuss in “layman” terms why process dismissed

Pima County Wastewater Regional Optimization Plan Study

Workshop #4
First Brainstorming Workshop and Background Data Review

June 5, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Joe Popeck	Background/Condition Assessment Initial Screening of Processes
Anne Smith	Stakeholder Interview Summary
Orrie Albertson	Development of 2030 Flow and Loadings Data Needs Treatment Plant Design Options Process Alternatives
Dave Stensel	Process Alternatives Side-Stream Treatment
Gordon Culp	Evaluation Criteria

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop Objectives
- Background / Condition Assessment
- Interview Summary
- Initial Screening of WWT Processes
- Wastewater Flow / Loadings
- Side Stream Treatment
- Process Discussion
- Evaluation Criteria
- Closing

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

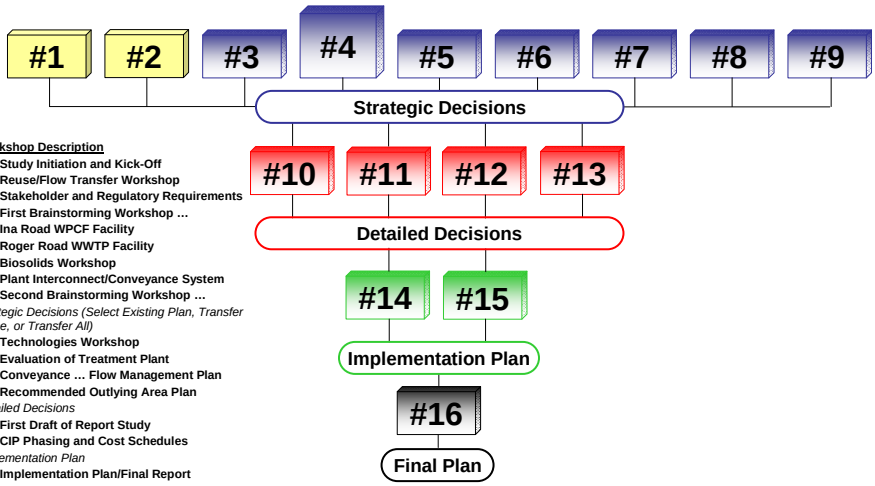
8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

9

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

10

Workshop Objectives

- Review condition assessments
- Agree on flow and loading projections
- Review WWT Design Options
- Brainstorm/discuss process alternatives
- Agree on viable process alternatives
- Agree on evaluation criteria
- Agree on criteria weighting

11

Pima County Wastewater Management Department

GREELEY AND HANSEN

Background / Condition Assessments

Joe Popeck

Condition Assessment

- Roger Road WWTP assessment team
  - Tim Greif – Civil and Instrumentation & Control
  - Andy Martin – Civil
  - Ron Zanko – Electrical

13

Condition Assessment

- Questionnaires
  - Equipment condition assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group:_____

_____

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: _____

_____

14

Condition Assessment

- Questionnaires
  - Structural condition assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure:_____

_____

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: _____

_____

15

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
STRUCTURAL:	
Poor	Older, excessive age related concrete or building structure weathering and deterioration, not properly sized for the function, may have safety related issues and excessive age related maintenance issues
Acceptable	Older, some normal age related concrete or building structure weathering, not exactly sized for the function but provides service and some additional age related maintenance issues
Good	Older, some normal age related concrete or building structure weathering, properly sized for the function and some additional age related maintenance issues
Excellent	Relatively new, sound concrete tankage or building structure, properly sized for the function and no significant maintenance issues

16

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
MECHANICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
ELECTRICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable, leaking, unacceptable odor
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions correctly, mfgr's recommended PM only, extremely reliable

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
CIVIL[1]:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable
(1) Piping, valves, and other appurtenant devices	

19

Condition Assessment

- Structures
  - Headworks – good
  - PST & PS – good
  - Bio-Towers PS – acceptable
  - Bio-Towers – good
  - Aeration Tanks – good

20

Condition Assessment

- Structures
  - Blower Building – good
  - Secondary Clarifiers – good
  - RAS PS – good
  - Chlorine Contact Basins – acceptable to poor

21

Condition Assessment

- Structures
  - Gravity Thickeners – acceptable to poor
  - Floatation Thickener Building – good
  - Anaerobic Digesters – good to acceptable

22

Condition Assessment

- Equipment
  - Sewage Screens & Equipment – good to acceptable
  - Pista Grit Mechanisms, Grit Pumps & Washers – good to acceptable
  - Odor Control Biofilter – good

23

Condition Assessment

- Equipment
  - PST Collector Mechanism – unknown
  - PS Pumps – good
  - Bio Tower Engine Driven Pumps – good to Acceptable
  - Bio Tower Motor Driven Pump – good

24

Condition Assessment

- Equipment
  - Bio Towers Flow Distributor – good
  - Bio Towers Media – acceptable to poor
  - Aeration Diffusers – acceptable to poor

25

Condition Assessment

- Equipment
  - Aeration Blowers – acceptable
  - FST Collector Mechanism – unknown
  - WAS Pumps – good

26

Condition Assessment

- Equipment
  - Chlorination – Dechlorination Equipment – good
  - Non-Potable Water Pumps – good
  - Effluent Pumps – acceptable to poor

27

Condition Assessment

- Equipment
  - Thickened Sludge Pumps – good
  - Center Drive Mechanisms – acceptable
  - Odor Control Systems – acceptable to poor

28

Condition Assessment

- Equipment
  - Sludge Gas Equipment, Waste Gas Burners, Gas Compressors – good
  - Heat Exchangers, Sludge Pumps, Roof Mounted Mixers – good

29

Condition Assessment

- Electrical
  - 2400 volt Plant SWGR – acceptable
  - Power Center 1 – good
  - Power Center 2 – good to Acceptable
  - Power Center 3 – good
  - Power Center 4 – good

30

Condition Assessment

- Electrical
  - Power Center A – good
  - Power Center B – good
  - Power Center C – acceptable

31

Condition Assessment

- Electrical
  - Motor Control Centers (most) – good to excellent
  - Motor Control Center MCC CA – poor

32

Condition Assessment

- Electrical
  - Engine Generators – acceptable to good
  - Generator Main Breakers – good
  - New GDC – excellent

33

Condition Assessment

- Electrical
  - Generator Paralleling Controls – acceptable

34

Condition Assessment

- Instrumentation and Controls
  - Metering Flumes – good
  - Metering Weirs – good to acceptable

35

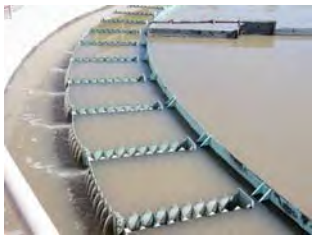
Condition Assessment

- Instrumentation and Controls
  - Magnetic Flow Meters (Sludge) – good
  - Orifice Plates (Process Air) – acceptable to poor

36

Condition Assessment

- Instrumentation and Controls
  - No flow metering to individual PST's
  - No flow metering to individual Bio Towers



37

Condition Assessment

- Instrumentation and Controls
  - Remote monitoring of equipment operating status and valve status mostly not available
  - Remote operation of equipment mostly not available
  - Automatic operation of equipment mostly not available

38

Condition Assessment

- Instrumentation and Controls
  - Fiber optic system installed
  - PLC's and other SCADA devices to permit remote monitoring/operation not fully utilized

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Roger Road WWTP

Fiber Optic Network

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Condition Assessment

- Summary of condition assessment
  - Most major structures appear in generally good condition
  - Most major equipment appear in generally good condition
  - Most major electrical components appear in generally good condition
  - Significant lack of I&C

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Condition Assessment

- Summary of condition assessment
  - Potential reuse of Roger Road Facilities depends largely upon whether facilities are appropriate for conversion to BNR
  - Planned improvements for several areas of the plant are necessary to maintain treatment effectiveness regardless of the final decision on the long-term continued use of Roger Road WWTP

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Stakeholder Interview Summary

Anne Smith

Planning

- *Need long-term plan that integrates all wastewater aspects for the benefit of the whole community*
- *Need a short-term plan that addresses critical issues and decisions so "on-hold" improvements can proceed*
- Lack of consistency in how planning is done by member and regulatory agencies

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Stakeholder Buy-in

- *Satisfying all interests related to the Roger Road plant operation and associated wetland and riparian habitat impacts will be challenging*
- *Need to build trust between the Pima County Board and PCWMD. Recent PCWMD management change seen as positive for culture*
- *Need to address odor issues quickly to gain community trust*

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Stakeholder Buy-In

- *Need buy-in at all levels, staff, the Board, local agencies, and regulatory agencies*
- The stakeholder workshop approach is good
- Public doesn't understand the difference and impacts of managed recharge vs. constructed recharge on water rights

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Decision Making

- *Final recommendations need to allow maximum flexibility in balancing funding with regulatory requirements and needs*
- *Wastewater/Reuse/Water planning decisions need to be coordinated and made holistically*

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Decision Making

- *There is confidence that the best technical solution can be identified but that the regulatory deadlines will be missed due to procurement decisions/procedures*
- Have procedures to prevent backsliding of decisions after workshops
- There are differing perspectives at all levels as to the drivers for decisions

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Technical Challenges

- *Sizing of the Interconnect pipeline between Ina and Roger Road plants*
- *Alternative methods for biosolids disposal due to shrinking land availability*
- Site and setback issues at Ina Road plant
- Increase in influent wastewater concentrations due to conservation and gray water use

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Initial Screening of Processes

Joe Popeck

Initial Screening of Processes

- Overview presentation and discussion of processes for N&P removal
  - Bioselection
  - MLE (Phoenix NdeN processes)
  - Four/Five Stage (A2O2) Bardenpho (UCT Process)
  - AS/NTF – DeN filters w/MeOH
  - BT/NAS – DeN Filters w/MeOH
  - Step-feed NdeN
  - IFS Biostyr and Biofor
  - IFS Kaldnes (KMT)
  - MBR (membranes)

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Initial Screening of Processes

- Today's objective
  - Reduce number of alternatives – three or four most promising
  - Eliminate alternatives for cause, by experienced based examination:
    - Alternative not proven on large scale or number of installations
    - Alternative not proven on duration of operation
    - Alternative overly complex or costly to install or operate
    - Alternative not able to effectively utilize existing process tankage
    - Other experienced based cause from Workshop Participant's input

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Development of 2030 Flow and Loadings

Orrie Albertson

Development of Y2030 Flow and Loadings

- Existing conditions (Y2004-2006)
  - Reduction of most recent 30 months of data
    - Define trends
    - Establish monthly average, maximum, minimum standard deviations
    - Determine data needs
- Future conditions (Y2030)
  - Hydraulic capacity – December 2030 projections
  - Domestic loading – population projections
  - Industrial allocation – Pima County
  - Lower flow/capita effects

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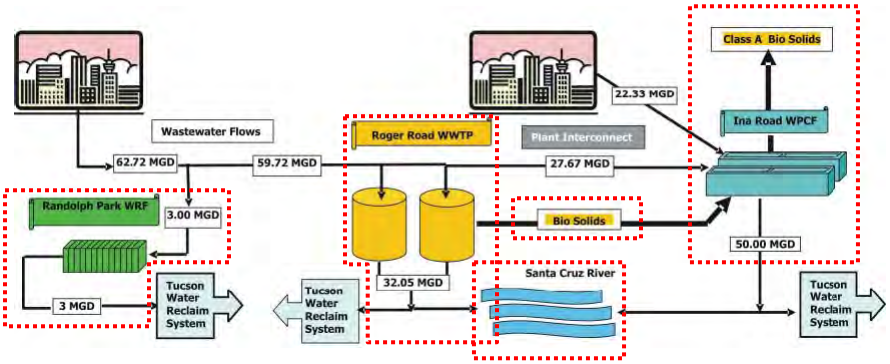
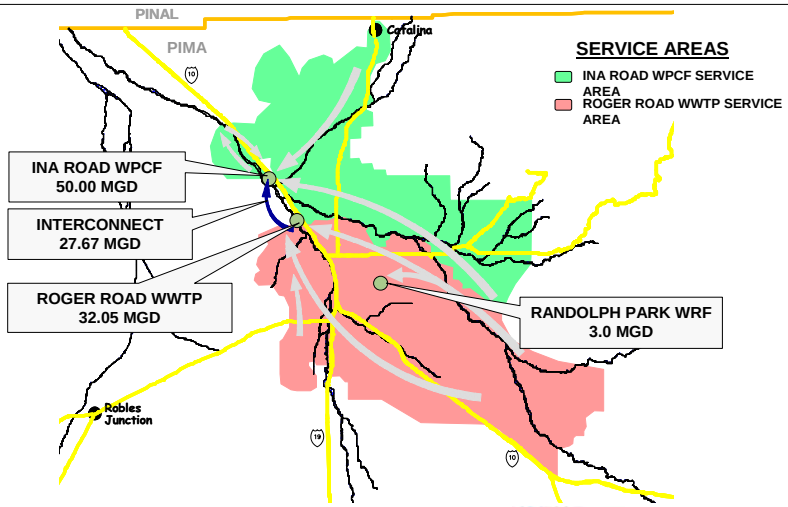
Existing Plan Schematic



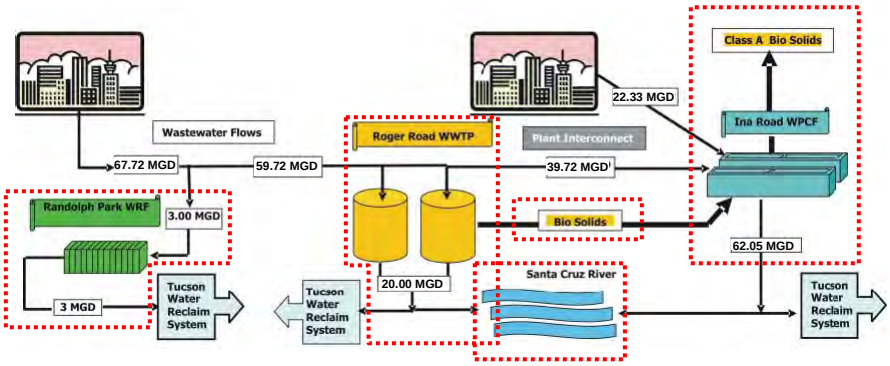
55

Existing Plan (2030)



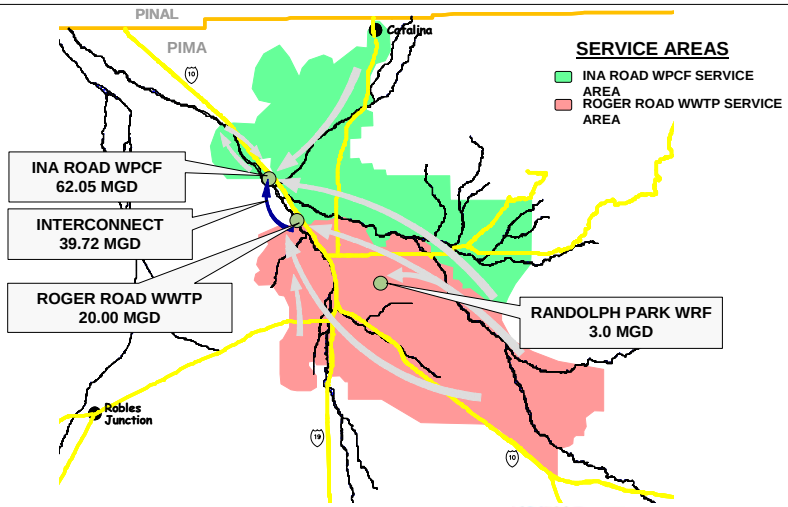
56

Transfer Some Schematic



57

Transfer Some (2030)



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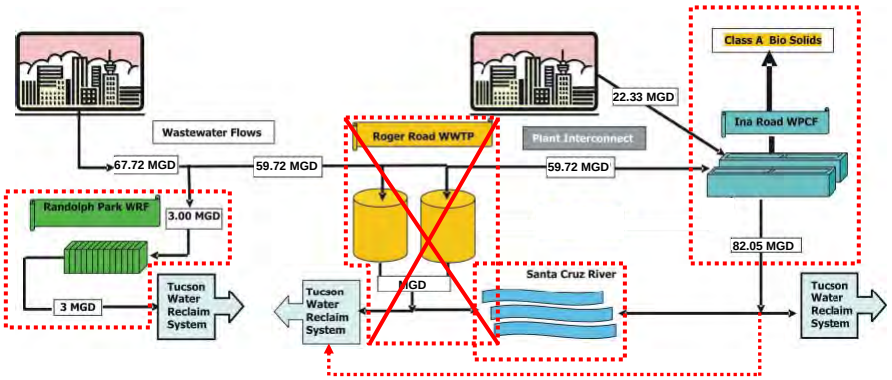
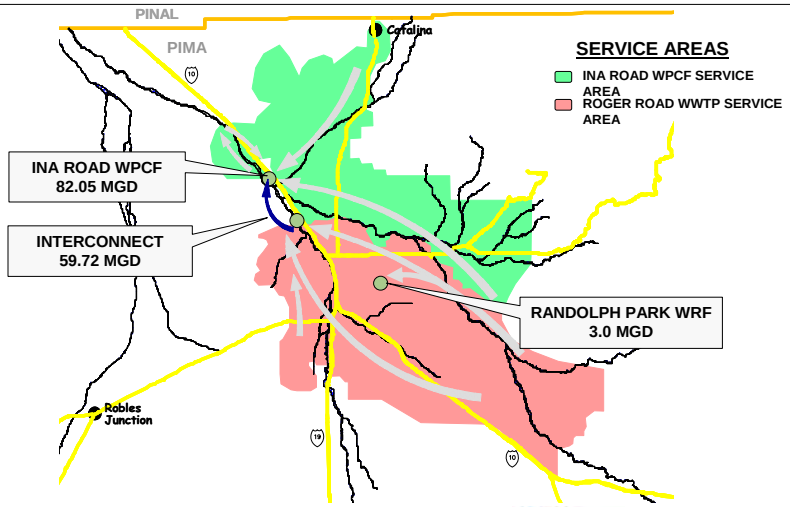
Transfer All Schematic



59

Transfer All (2030)



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Ina Road WPCF Wastewater Characteristics

		Raw Influent WW				Primary Effluent			
Date	Flow	COD	BOD_5	TSS	TKN	COD	BOD_5	TSS	TKN
2006	mgd	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1/1/2006	23.26		230	181			149	79	
1/2/2006	26.29		264	235			152	93	
1/3/2006	25.44	790	230	236			125	80	
1/4/2006	24.4		230	243			115	78	
1/5/2006	22.43		246	262			125	78	
1/6/2006	22.35		244	269			121	64	
1/7/2006	24.58		264	281				82	
1/8/2006	24.19		252	254			144	98	
1/9/2006	23.01		240	260			136	70	
1/10/2006	19.87		253	281					
1/11/2006	18.2	624	270	275			143	90	
1/12/2006	18.33		265	280	48.1		113	74	58.3
1/13/2006	17.36		233	277			114	73	
1/14/2006	17.65	581	276	294				84	
1/15/2006	17.22		218	289			133	76	
1/16/2006	17.59		246	254			151	135	
1/17/2006	17.17		281	340			113	64	
1/18/2006	15.69	630	296	296			129	59	
1/19/2006	16.31		276	290			122	61	
1/20/2006	17.14		268	345			122	58	
1/21/2006	17.96	362	254	300				67	
1/22/2006	19.22		277	274			139	79	
1/23/2006	17.77		264	282			125	80	
1/24/2006	18.62		246	248			122	60	
1/25/2006	18.4	631	254	266			128	73	
1/26/2006	17.44		292	308			129	51	
1/27/2006	18.52		248	242			121	72	
1/28/2006	19.17		258	272				77	
1/29/2006	19.38		232	266			150	84	
1/30/2006	19.16		250	264			140	70	
1/31/2006	18.99		253	286			138	71	
Average	19.78	603	255	273	49.1		131	77	58.3
Minimum	15.69	352	218	181	49.1		113	51	58.3
Maximum	26.29	790	298	345	49.1		152	135	58.3
Std. Dev.	2.96	138	19	31			12	15	

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Ina Road WPCF Wastewater Characteristics *(continued)*

	Raw Influent WW				Primary Effluent				Primary Removals	
Date	COD	BOD_5	TSS	TKN	COD	BOD_5	TSS	TKN	BOD_5	TSS
2006	lb/d	lb/d	lb/d	lb/d	lb/d	lb/d	lb/d	lb/d	%	%
1/1/2006		44617	35112			30349	16091		35.2	56.4
1/2/2006		57884	51526			34994	21411		42.4	60.4
1/3/2006		48799	50072			27847	17822		45.7	66.1
1/4/2006	160762	46804	49450			24572	18688		50	67.9
1/5/2006		46018	49011			24552	15321		49.2	70.2
1/6/2006		45481	50141			23682	12528		50.4	76.2
1/7/2006		54119	57504				17650			70.8
1/8/2006		50840	51243			30504	20760		42.9	61.4
1/9/2006		46057	49895			27404	14105		43.3	73.1
1/10/2006		41926	48566							
1/11/2006	94716	40983	41742			22791	14344		47	67.3
1/12/2006		40511	42804	7506		18138	11878	9358	5734	73.6
1/13/2006		33734	40105			17330	11098		51.1	73.6
1/14/2006	85524	40627	43277				12983			71.4
1/15/2006		31308	41505			20056	11460		39	73.7
1/16/2006		36088	37262			23259	20795		38.6	46.9
1/17/2006		40239	48687			16990	9623		59.8	81.2
1/18/2006	82438	38995	38733			17724	8106		56.7	80.1
1/19/2006		37543	39447			17425	8712		55.8	79
1/20/2006		38310	49317			18312	8706		54.5	83.2
1/21/2006	54223	38048	44938				10537			77.7
1/22/2006		44402	43921			23395	13298		49.8	71.2
1/23/2006		39125	41793			19451	12449		52.7	71.6
1/24/2006		38202	38512			19893	13044		50.4	67.7
1/25/2006	96831	38978	40819			20624	11782		49.6	72.6
1/26/2006		42471	44798			19701	7789		55.8	83.4
1/27/2006		38305	37379			19624	11677		51.2	70.2
1/28/2006		41248	43487				12926			71.7
1/29/2006		37498	42993			25457	14256		35.3	68.4
1/30/2006		39949	42186			23490	11745		44	73.5
1/31/2006		40069	45296			22949	11807		45.5	75.2
Average	95749	41909	44504	7506		22712	13378	9358	48.2	71.2
Minimum	54223	31308	35112	7506		16990	7789	9358	35.2	46.9
Maximum	160762	57884	57804	7506		34994	21411	9358	59.8	83.4
Std. Dev.	35313	5683	5181			4641	3643		8.7	7.8

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Data Needs

Orrie Albertson

Data Needs

- Additional data
  - Primary effluent COD, sCOD
  - Primary effluent TKN and TP
  - Composite samples – 20
    - COD, sCOD, BOD_5, TSS, VSS, TKN, NH_4-N and TP
- Agreements
  - Domestic growth at 85.05 (Y2030) gal/capita day
  - Typical COD, BOD_5, etc. contributions
  - Industrial allocation – flow and loads

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Preliminary Wastewater Characteristics

Parameter	*Units*	*Primary Influent*	*Primary Effluent*
COD	mg/L	649	420
BOD_5	mg/L	300	207
sBOD	mg/L	122	122
TSS	mg/L	281	112
VSS	mg/L	219	92
TKN	mg/L	54.4	51.5
TP	mg/L	9.8	9.2

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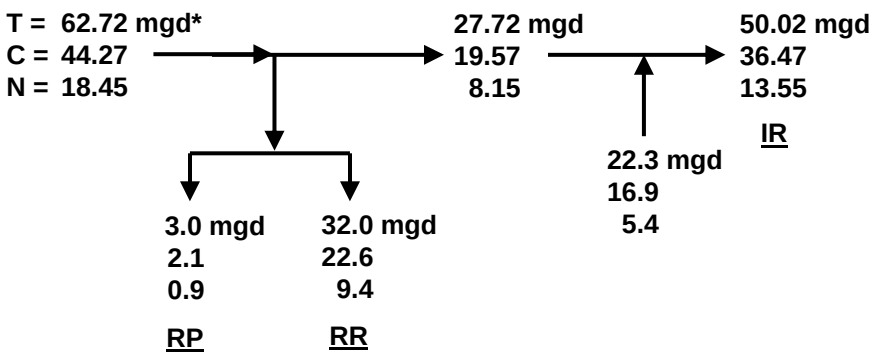
Pima County Wastewater Management Department

GREELEY AND HANSEN

Treatment Plant Design Options

Orrie Albertson

Pima County Treatment Plant Flows – Existing Plan (A)



*T = Total Flow; C = Current Flow; N = New Flow

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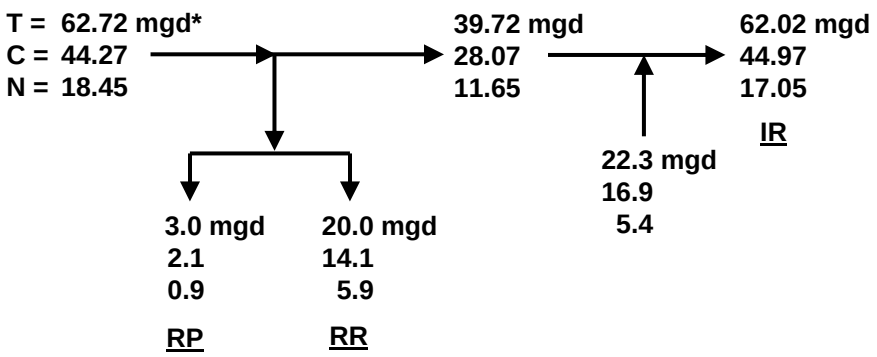
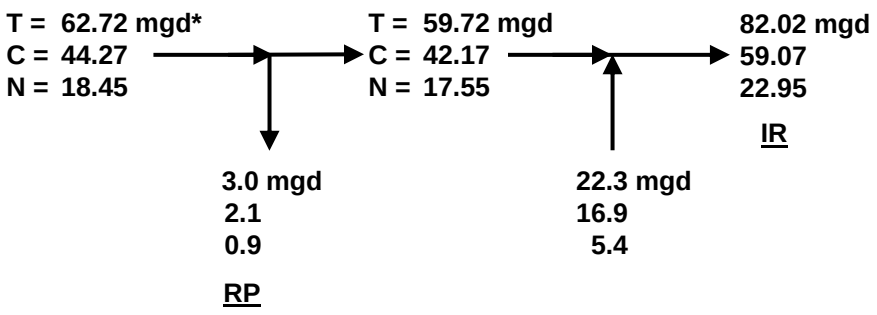
Pima County Treatment Plant Flows – Transfer Some (B)



*T = Total Flow; C = Current Flow; N = New Flow

68

Pima County Treatment Plant Flows – Transfer All (C)



*T = Total Flow; C = Current Flow; N = New Flow

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Treatment Plant Design Options

- Rogers Road WWTP
  - A. 32 mgd B. 20 mgd C. 0 mgd
- Ina Road WPCF
  - A. 50 mgd B. 62 mgd C. 82 mgd
- Randolph Park WRF
  - A. 3 mgd B. 3 mgd C. 3 mgd

70

General Considerations/Risks

- Existing facilities / components
  - Rehabilitation / reuse?
  - Retire?
- Process reliability
  - Accepted design methodology
  - No black box systems
  - Multiple successful plants

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General Considerations/Risks
(continued)

- Economical / practical / minimal complexity
- Common flowsheet?
  - Rogers Road WWTP
  - Ina Road WPCF
  - Satellite WRF

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Process Alternatives

Orrie Albertson

Process Alternatives

- Overview presentation and discussion of processes for N&P removal
  - Bioselection
  - MLE (Phoenix NdeN processes)
  - Four/Five stage (A_2O_2) Bardenpho (UCT Process)
  - AS/NTF – DeN filters w/MeOH
  - BT/NAS – DeN Filters w/MeOH
  - Step-feed NdeN
  - IFS Biostyr and Biofor
  - IFS Kaldnes (KMT)
  - MBR (membranes)

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Bioselection

- Bioselection: Natural control of those organisms which cause sludge bulking
- Benefits:
  - Eliminate need for chemical control
    - Lower turbidity in effluent
    - Stable process
    - Lower costs
  - Higher secondary overflow rates
    - Smaller units
  - Higher aeration MLSS
    - Smaller aeration volume
  - Higher RSS concentration
    - Lower RAS rate, less power

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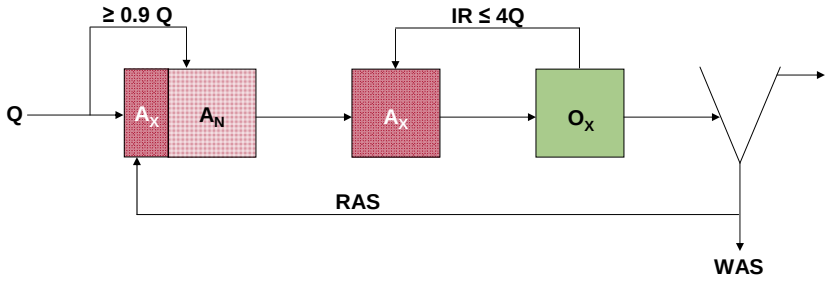
RAS DeN to Enhance Bio P Removal



Modified MLE 3-Stage Bio P_R and NdeN

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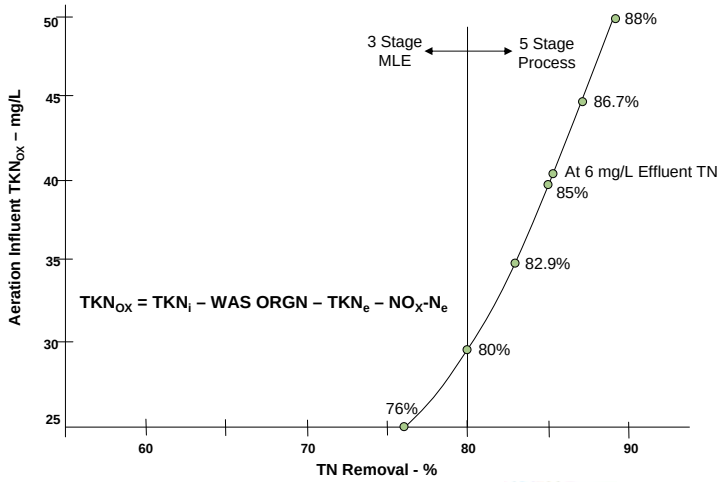
Process Alternatives vs. TKN_{OX} Concentration



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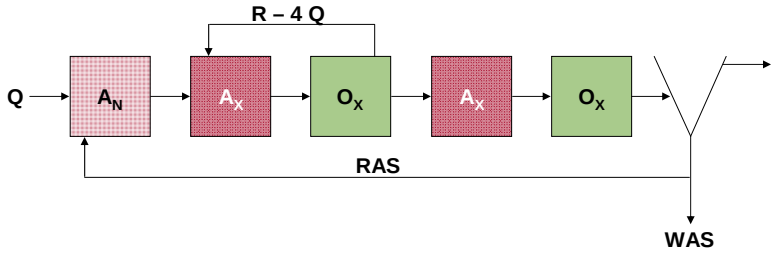
Process Design for ≤ 3 to 5 mg/L Effluent TN and Bio P_R



5-Stage Bardenpho Process

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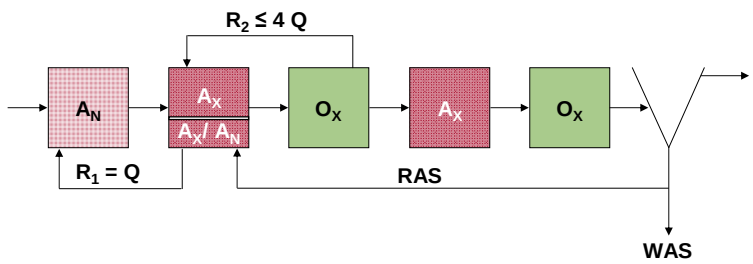
Process Design for ≤ 3 to 6 mg/L TN and Bio P_R



5-Stage UCT Process

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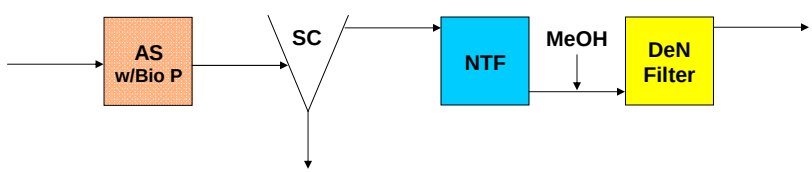
AS/NTF- DeN Filter w/MeOH Flowsheet



AS – Activated Sludge

NTF – Nitrifying Trickling Filter

SC – Secondary Clarification

MeOH – Methanol

AS / NTF – DeN Filter w/MeOH Flowsheet

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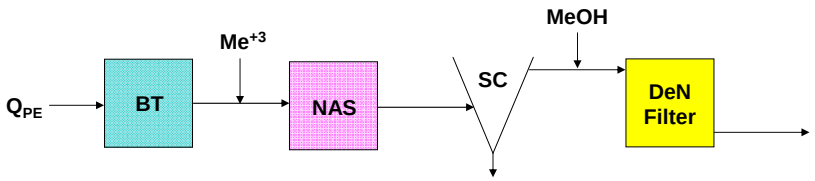
BT/NAS – DeN Filter w/Me^{+3} and Methanol Flowsheet



BT – Biotower

SC – Secondary Clarification

Me^{+3} – Metallic ion, Al or Fe

NAS – Nitrifying Activated Sludge

MeOH – Methanol

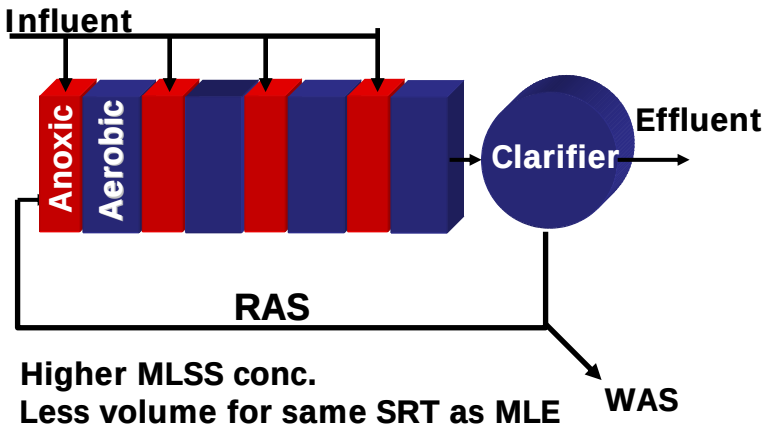
BT / NAS - DeN Filter w/Me^{+3} and Methanol Flowsheet

81

Process Alternatives

Dave Stensel

Step BNR Process



Higher MLSS conc.
Less volume for same SRT as MLE
No internal recycle piping and pumps required
NO_3-N < 5-8 mg/L

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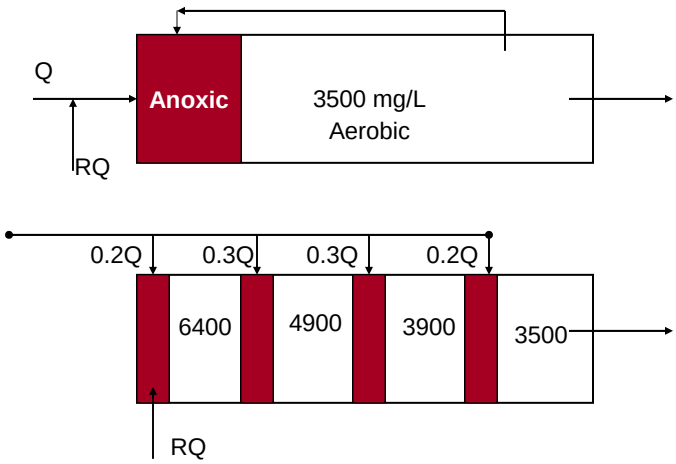
Higher Avg. MLSS Concentration in Step Feed May Reduce Total Volume Needed Compared to MLE



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Issues in Step NdeN Design

- Final tank influent flow split ratio affects effluent NO_3-N concentration
  - i.e., if split = 0.20Q and influent oxidized N = 25 mg/L, effluent NO_3-N will be ~5.0 mg/L
- Need to match influent feed and anoxic tank sizing with amount of nitrate fed from previous stage or RAS flow
- DO concentration in feed to downstream anoxic tank should be kept low
- How will flow split be controlled and measured?
- Can flow split match model flow split within reason and thus provide expected performance?

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Issues in Step NdeN Design

- More baffles and mixer needed
- Are specific nitrification rates at high MLSS comparable to that at conventional MLSS of 3500 mg/L?
- Simulation models extremely useful for design
- Can add internal recycle in last pass to obtain lower effluent N concentration

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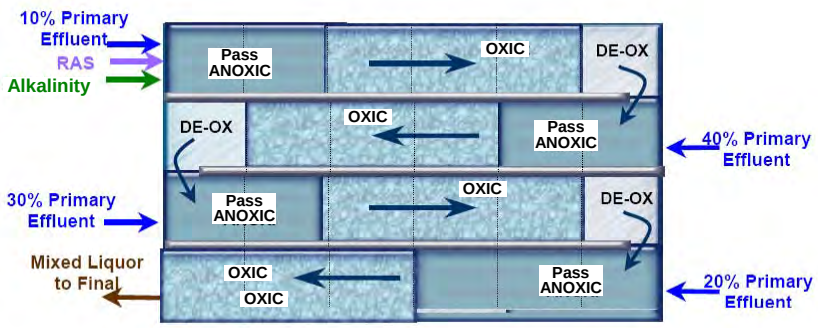
NYC Step Feed BNR



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Advantages of Step Feed NdeN

- Eliminates piping and pumping for internal recycle
- May increase treatment capacity for a given tank volume
- Compatible with retrofit of existing multiple pass basin or step feed systems
- Provides means to handle high wet weather flows and maintain solids inventory

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Disadvantages of Step Feed NdeN

- More mixers and treatment zones
- More foam handling locations
- DO control important for preanoxic zones for more locations
- Control of influent feed split and flow measurements

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Biological Aerated Filters Biostyr and Biofor

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Biological Aerated Filters are Useful Where Space is Limited

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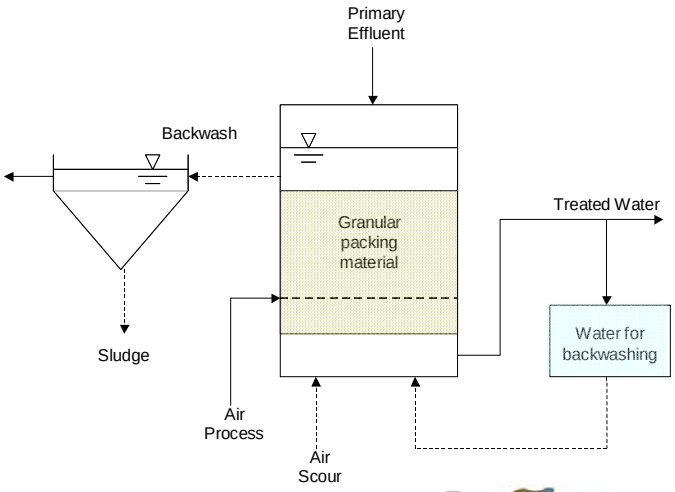
Biological Aerated Filter (BAF) Processes are Used in Land Limited Situations



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BAF Process Description

- Submerged fixed film process
  - Bacteria attached to media
- Media size 2 to 4 mm
- Biomass conc. 6000 – 8000 mg/L
- Diffused aeration provided
- Media provides solids filtration
  - No final clarifier needed
  - Requires backwash as in water treatment filters
- Depth 1.5 to 3.0 m
- Empty bed detention time 30 – 60 min

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BAF Process Description (cont)

- Air sparging needed to provide oxygen
- Upflow and downflow proprietary processes
- Area requirements less than half of that for activated sludge process
- Process technology has evolved since 1982

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BAF Cells – Easy to Cover System Due to Small Space

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Most Common BAF Processes

- Biofor
  - Degremont / Infilco
- Biostyr
  - OTV
- Biocarbone
  - First commercial BAF

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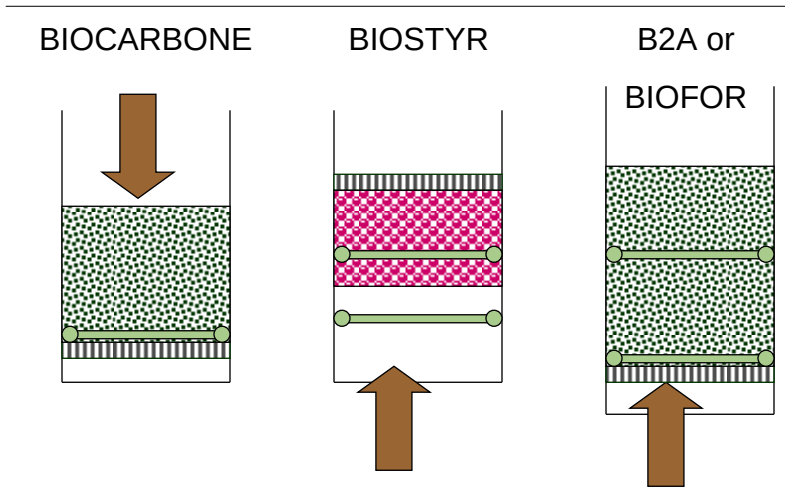

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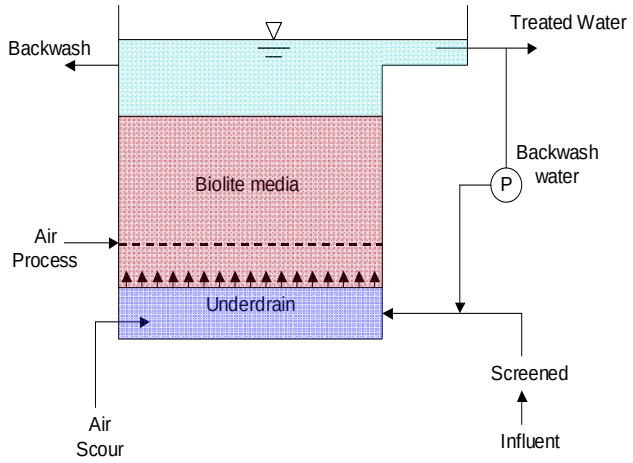
Schematic of Biofor



Flow is upflow and media is dense

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Typical Design Loadings Reported for the Biofor® Process

Application	*Loading**
BOD Removal	**3.5-4.5 kg BOD/m^3-d**
Tertiary Nitrification	**1.5-1.8 kg NH_4-N/m^3-d**

Hydraulic application rates range from 5.0-6.0 m^3/m^2-h

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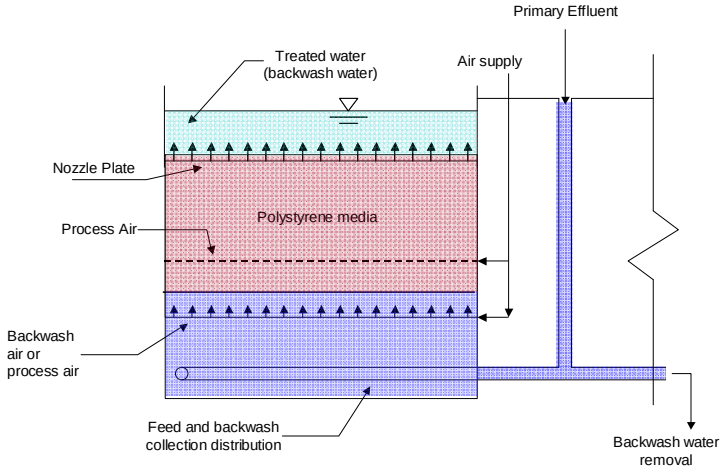
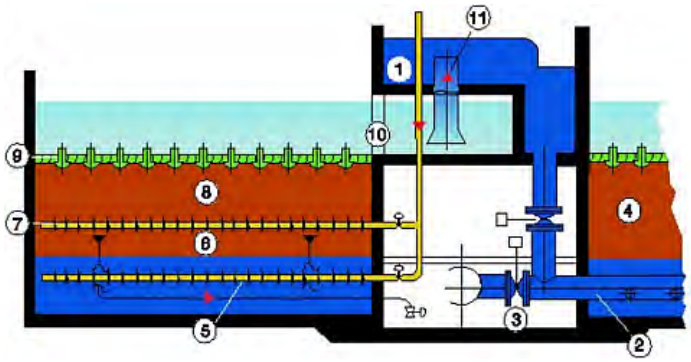
Schematic of Biostyr



Flow is upflow and media is buoyant

100

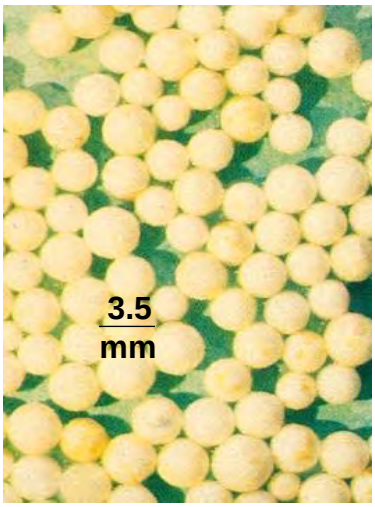
BIOSTYR



1. Feed Box
2. Feed / Drain Pipe
3. Drain Valve
4. Media
5. Scour Air Grid
6. Anoxic Zone
7. Process air Grid
8. Aerated Zone
9. Nozzle Deck
10. Storage Tank
11. Recirculation Pump

101

Polystyrene Beads used for Biostyr Media



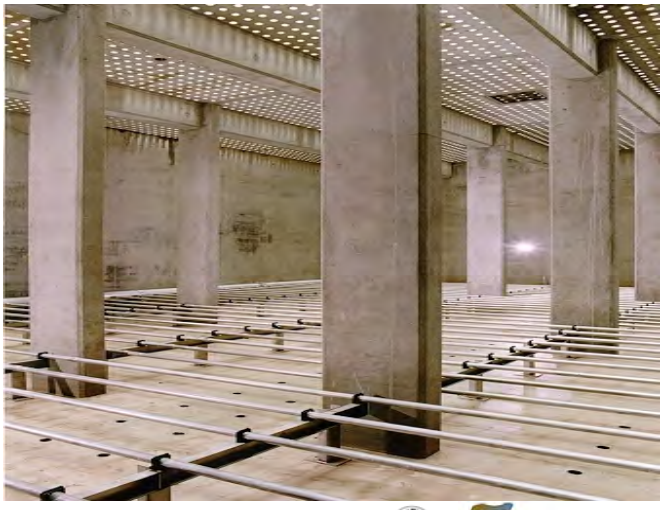
3.5 mm nominal diameter

bulk density - 40 kg/m3

Uniformity Coefficient - 1.2

102

Biostyr System Structure; Underdrain, Air Headers, and Upper Nozzle Plate



103

Typical Design Loadings Reported for the Biostyr® Process

Application	*Loading**
BOD Removal	**3.5-4.0 kg BOD/m^3-d**
BOD Removal and Nitrification	**1.8-2.2 kg BOD/m^3-d**
Tertiary Nitrification	**1.0-1.7 kg N/m^3-d**

*Based on empty bed volume

104

Comparison of BAF Processes

Parameter	*Biofor*	*Biostyr*
Media	**Expanded Clay**	**Polystyrene**
Size (mm)	**2 – 4**	**2 - 4**
Feed Flow	**Upflow**	**Upflow**
Air Flow	**Upflow**	**Upflow**
Flow Distribution	**Inlet Nozzles***	**Effluent Nozzles**

*3 mm screening required

105

Differences in BAFs

- Favoring Biostyr
  - 120 TO 150% autotrophic capacity
  - Less backwash power
  - Lighter media > less structure $$
  - Nozzles at the top of the filter
  - No loss of media
  - Better filtration into cycle (between washes)

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Favoring Dense Media

- Less expensive to build
- Handles high flows when dirty
- Higher solids loading capacity (TSS and heterotrophic growth)
- Better filtration on clean wastes

107

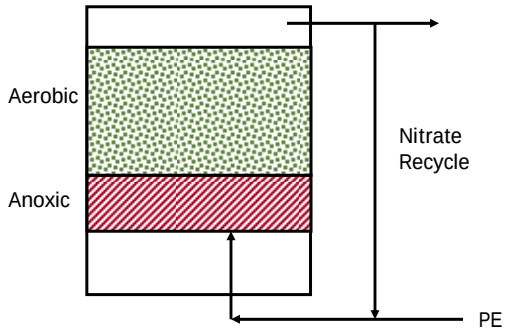
Nitrogen Removal

- I. Internal NdeN – Biostyr
- II. Pre-Anoxic BAF
- III. Post Anoxic BAF

108

Internal Anoxic Biostyr

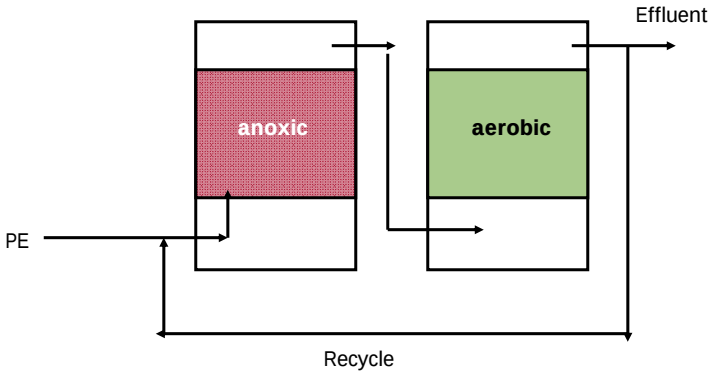
- Aerobic zone is above bottom of bed where anoxic conditions exist



109

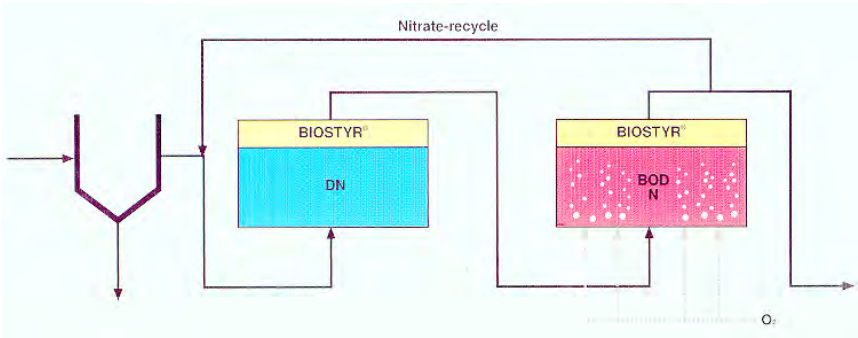
Pre-Anoxic BAF

- A separate anoxic tank is used before the aerobic BAF



110

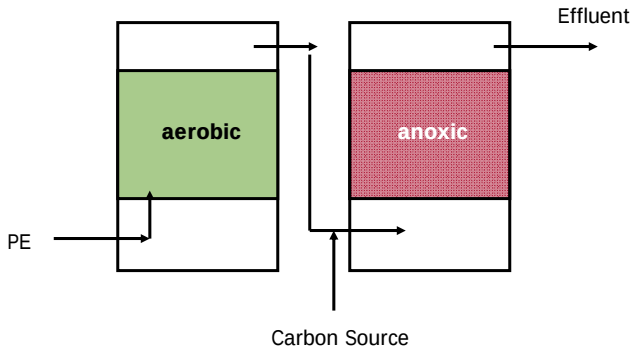
Recirculating Denitrification



111

Post Anoxic BAF

- An anoxic tank is used after the aerobic BAF and carbon must be added



112

Pre-Anoxic Loadings (Biofor)

Nitrogen kg NO_3-N/m^2-d	**1.0 – 1.5**
Hydraulic application (including recycle) m^3/m^2-hr	**24 – 31**

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Post Anoxic Loadings

Loading	*Biofor*	*Biostyr*
kg NO_3-N/m^3-d	**3.0 – 4.0**	**0.8 – 4.0**
Hydraulic Appl m^3/m^2-hr	**10 – 15**	**6 - 15**

Requires methanol or carbon source

114

Schematic of Design for Cergy – Pontoise, France

- Showing BAF Cells, backwash collection, thickeners and digesters

115

Example of Compact BAF System – Assens, Denmark

116

Full-Scale Results of NdeN with BAF Process

- Frederikshavn WWTP, Denmark
- 1998 results
- Biostyr process
- 15 other Biostyr installations since 1998

117

Biostyr Performance Frederikshavn WWTP

Parameter	*Influent, mg/L*	*Effluent Required, mg/L*	*Average Effluent, mg/L*
BOD	**200**	**15**	**2.7**
TSS	**92**	**20**	**4.9**
TN	**39**	**8**	**3.2**
NH_4-N	**22**		**1.0**
TP	**4**	**1.5**	**0.7**

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Frederikshavn Operating Conditions

- Loadings (kg/m^3-d)
  - BOD 1.5 kg/m^3-d
  - TKN 0.32 kg/m^3-d
- Reactor
  - Media polystyrene
  - Anoxic depth 0.9 m
  - Aerobic depth 2.1 m
  - HRT 2.2 hrs
  - % backwash 15% of treated flow

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Advantages / Disadvantages

- Advantages
  - Minimal space needed
  - Simple operation
  - No sludge settling, bulking issues
  - Attractive looking facility
- Disadvantages
  - More complex equipment
  - Requires good instrumentation and controls skills
  - Can be more costly
  - Limited economies of scale
  - Vulnerable to high influent solids loadings

120

Integrated Fixed-Film Activated Sludge Process (IF/AS)

121

What is IF/AS or "Hybrid" System?

- Combination of fixed-film and activated sludge
- Media provides surface area for microbial growth
- Higher equivalent MLSS concentration – 4000-6000 mg/L *without higher solids load on secondary clarifier*
- Higher SRT than that based on MLSS concentration and tank volume
- Many types of media available

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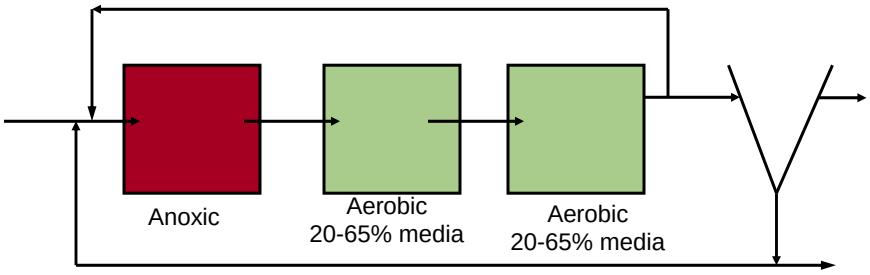
Schematic Example of IF/AS Nitrogen Removal System



123

Common Proprietary Media

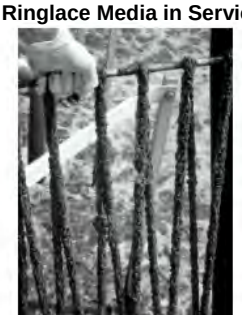
120 – 500 m^2 area/m^3

9-12 g biomas/m^2 media area

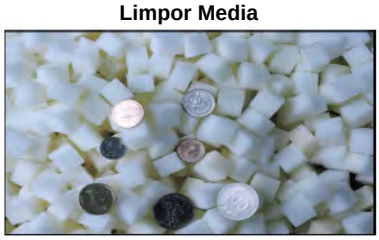
Name	*Material*
Kaldnes **US Filter AGAR** **Hydroxyl**	**Plastic**
Linpor **Captor**	**Polyurethane**

124

Ringlace Media in Service



Limpor Media



AnoxKaldnes K1 Media – New and Used (500 m^2/m^3)

125

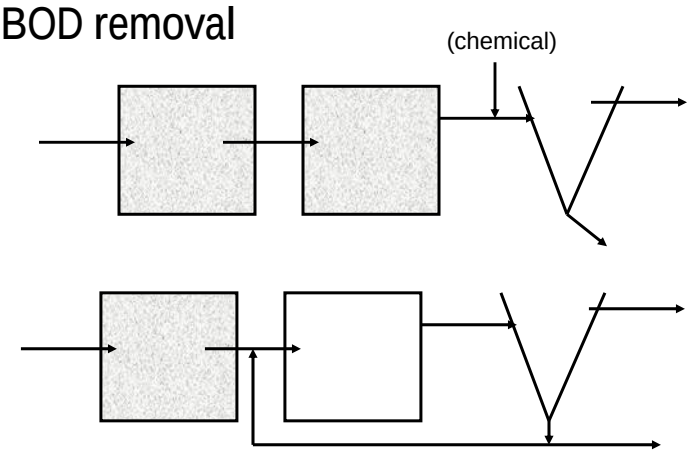
MBBR (Moving Bed Bioreactor) versus IF/AS

- Kaldnes polyethylene media – density 0.95 g/cm^3
- Filling fraction about 67% and media specific surface area is 465 m^2/m^3
  (effective area estimated at 335 m^2/m^3)
- Most biomass growth is on media
- Media kept in reactor by outlet screen
- Coarse bubble aeration provides oxygen and circulation
- No sludge return from secondary clarifier
- Over 300 systems in 22 countries

126

MMBR Applications (All with Primary Treatment)

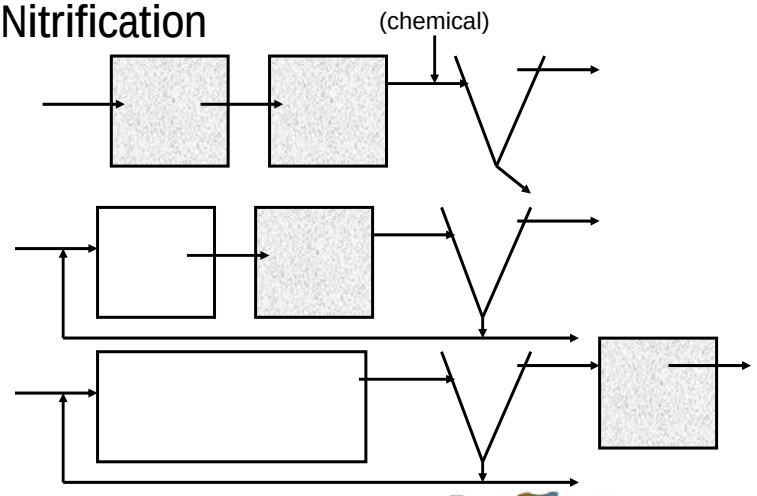
- BOD removal



127

MMBR Configuration for Nitrification

- Nitrification



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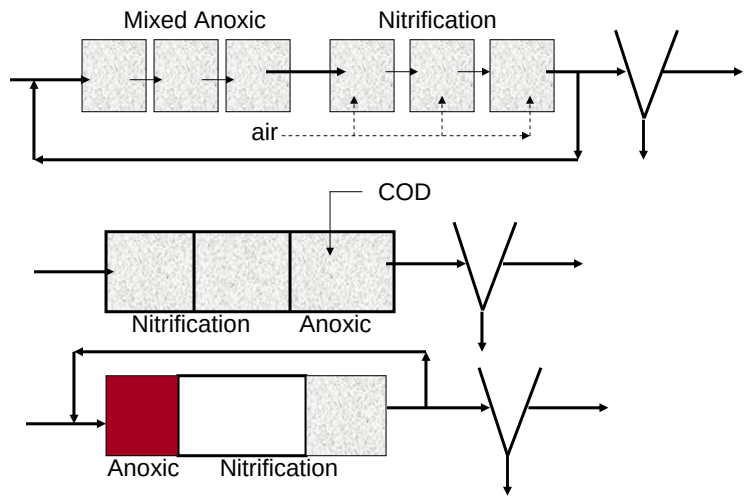
Example of MMBR for NdeN



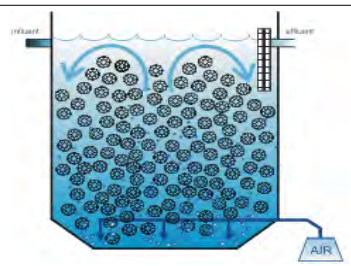
129

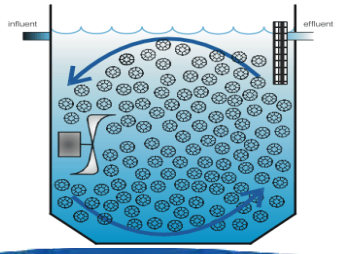
Facilities Needed for Kaldnes Systems

- Pre-treatment
  - Primary clarifier /fine screens (<6 mm)
- Baffle walls
- Reactor effluent screens
  - Automatic self-cleaning or via air knives
- Aeration and mixing system 0.03 scfm/ft^3
- DO concentration
- Media mixing in anoxic
- Media packing density

130

Aeration/Mixing of Hybrid Systems





- Aerobic Basin
  - Usually use coarse bubble diffusers
  - Higher transfer efficiency due to media (close to fine bubble system)
- Anaerobic/Anoxic
  - Submerged internal mixers

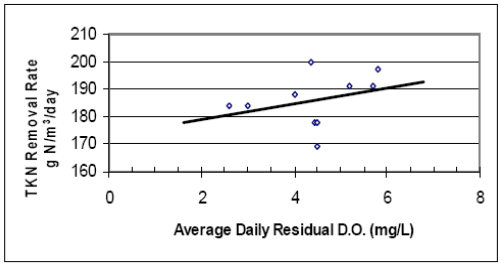
131

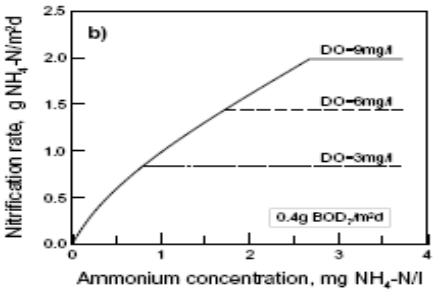
Media and Effluent Separation

Cylindrical Sieves

132

Impact of DO on Specific TKN Oxidation Rate





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Design Parameters and Criteria

Parameters	*IFAS*	*MBBR*
Media Fill (%)	20-50	20-70
MLSS (mg/L)	1500-3500	100-250
SRT of AS (d)	>3	0.15
HRT in Aerobic (hrs)	>3.5	3
DO (mg/L)	>2	>2

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Performance

Parameters	*IFAS*	*MBBR*
Nitrification Rate	($gN/m^2.d$)	($gN/m^2.d$)
	0.4 - 0.8	0.4 - 1.0
Denitrification Rate	(gN/gVSS.d)	($gN/m^2.d$)
Pre-Denitrification	0.03 - 0.12	0.25 - 0.8
Post-Methanol / Ethanol	0.1 - 0.32	3

* Rates at 10-12 ^oC

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Key Factors – Affect Performance

- sBOD
  - Affects bio-film thickness
  - Affects OUR in both bulk phase and inside biofilm
- NH_4-N
  - NH_4 concentration in bulk phase affects nitrification rate
- DO
  - Linear increase of nitrification rate for DO 2-5 mg/L
  - DO transfer rate through biofilm
- Mixed liquor SRT
  - Affect nitrification rate of the mixed liquor
- Mixing Pattern
  - Uniformity of contact between media and liquid

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Operating Concerns

- Wear Rate of Media
  - Normal Media Life expectancy: 10-30 years
- Media Clogging
  - Biofilm thickness affected by mixing pattern and BOD loads
  - Place media of different pore size in different zones
- Screen Plugging
  - Starvation of organics may leads to ciliates buildup
  - Plug flow push media towards screens
  - Effects system headloss and hydraulics

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Operating Concerns

- Maintenance of aeration system
  - System to pump and place media
- Predators – worms
  - Pore size
  - Organic loads fluctuation
- Peak flow conditions
  - Flow over baffle and screens
  - Media recycle pump capacity

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Municipal Installation in U.S.

A number of municipal WW hybrid systems in U.S.

Location	*Flow, mgd*	*Process*	*Status*
Cheyenne, WY	12	NdeN	construction
Cheyenne, WY	7.5	N	in operation
Broomfield, CO	8.0	BNR	in operation
South Adams, CO	5.5	NdeN	in operation

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BNR Performance Examples – Norway

Parameter	*Lillehammer*	*Nordre Follo*	*Gadermoen*
Flow, Mgal/d	7.6	4.8	5.8
BOD_L, kg/d	2900	2660	2680
TKN_L, kg/d	755	460	700
HRT, hrs	3.2	4.9	6.3
TN in, mg/L	35	30	51
TN out, mg/L	4.5	8.0	10.0
% N removal	85	73	81

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Pros and Cons – IF/AS and MBBR

- Pros
  - Smaller footprint
  - Increase capacity of existing facilities
  - Good biomass control
  - High solids inventory
- Cons
  - Cost of media
  - Less operational experience in U.S.

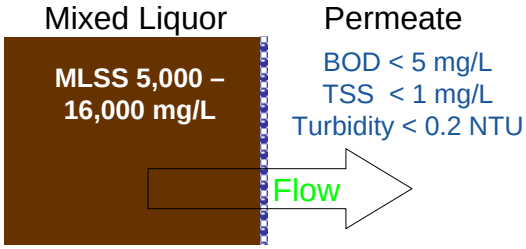
141

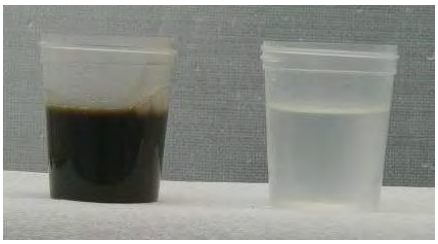
Membrane Separation for Biological Wastewater Treatment

- Used for liquid-solids separation
- Microfiltration –0.04 to 0.40 um
- Can replace clarifier and filter in terms of performance
- Used in biological nutrient removal processes

142

Low-Pressure Polymeric Membrane Provides Solids Separation





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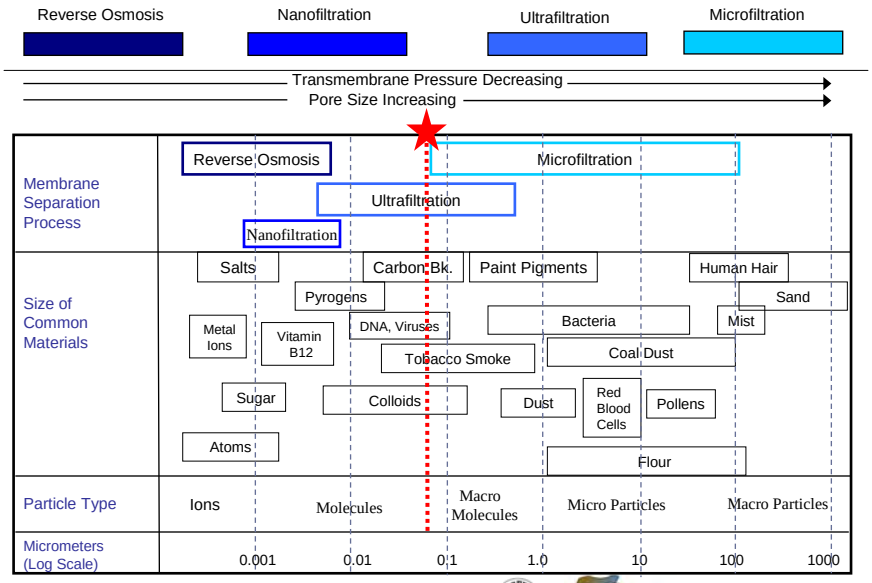
Membrane Filtration Spectrum



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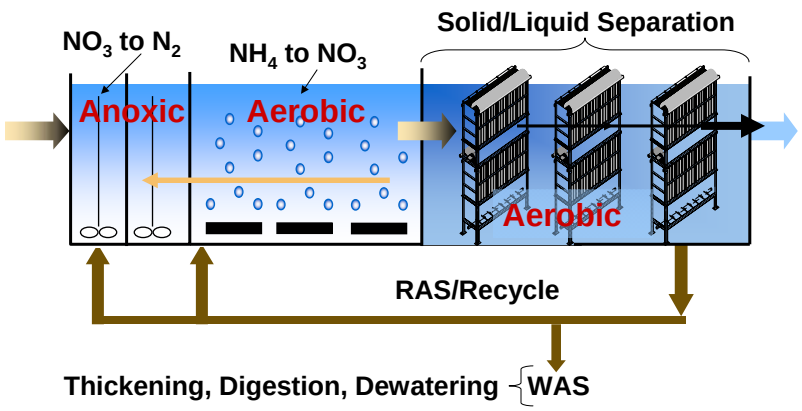
MBRs Use Membrane Equipment within a Biological Process Design Commonly Applied for N Removal



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Membrane Suppliers (U.S.) - Membranes, Process Configurations, Aeration, and Fouling Control Equipment

- Zenon – Hollow fiber membrane (UF)
- Kubota – Flat plate membrane (MF)
- U.S. Filter - Hollow fiber membrane (UF)
- Mitsubishi – Hollow fiber membrane (UF)
- Huber – Plate –Rotating disc (UF)

146

Kubota 515 Type Cartridge

Polyethylene

148

Zenon

Polyolefin

149

GREELEY AND HANSEN

Immersed Membrane Product: U.S. Filter

150

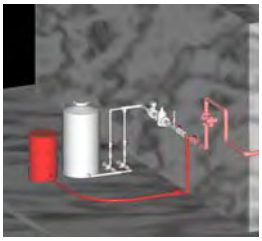
GREELEY AND HANSEN

Huber Plate

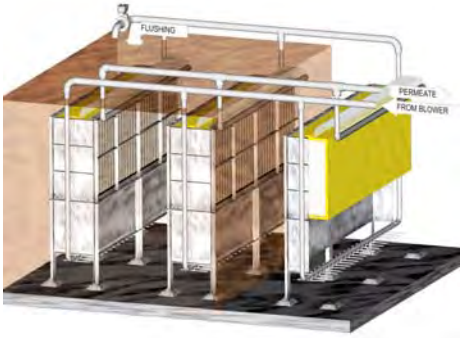
151

Membrane Manufacturers Provide Membrane Equipment Systems

Cleaning System



Membrane Equipment



Blowers

152

Process Considerations for MBRs

- Pretreatment – fine screening (2-3 µm)
- Flow equalization – control peak/Avg flow
- Effluent (permeate) pumping and headloss
- Membrane flux
- Membrane fouling control
  - Air agitation
  - Backwash systems
  - Cleaning method

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MBR Characteristics

Manufacturer	*Zenon*	*Kubota*	*US Filter*
Pore Size, µm	**0.04**	**0.40**	**0.04**
Avg Flux gpd/ft^2	**10-15**	**10-15**	**10-15**
Peak (<6 hr) gpd/ft^2	**<23**	**<36**	**<30**
TMP, psi	**4-10 psi**	**0.7-3 psi**	**2-8 psi**
Membrane life, yrs	**8**	**>10**	**5-10**
SRT, days	**10-15**	**10-15**	**10-15**
MLSS, mg/L	**≤ 10,000**	**≤ 10,000**	**≤ 10,000**
HRT, hrs	**4-8**	**4-8**	**4-8**

154

Oxygen Transfer Efficiency Inversely Related to Alpha

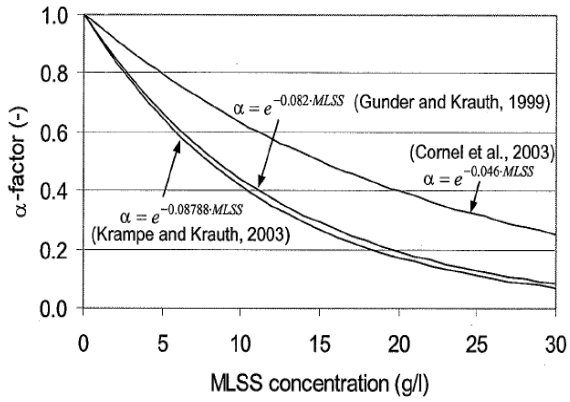
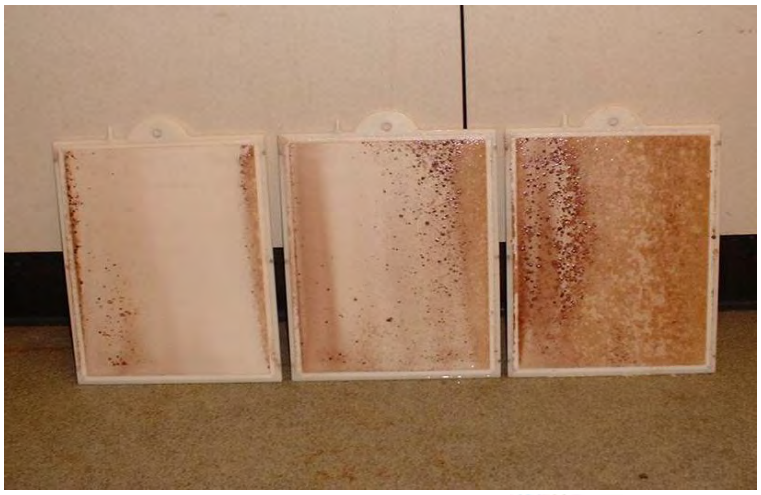


FIGURE 7
α-MLSS CONCENTRATION RELATIONSHIPS FOR FINE-BUBBLE SYSTEMS[6]

155

Lab Membrane Plates Showing Effect of Air Scour



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Membrane Fouling Control

- Agitate membrane with aeration to control solid cake formation on membrane
  - Adds 40 to 80% to A.S. aeration energy
- Use special operating conditions
  - Backpulse, relaxation period
- Cleaning in Place (CIP)
  - Daily or weekly flush with hypochlorite –hollow fiber
  - 1/6 months for flat plate
- Maintenance Cleaning
  - Soak with citric acid
- Fine screening pretreatment
  - 1.0 to 3.0 µm
- Minimize oil and grease in influent

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MBRs Commonly used with BNR Processes

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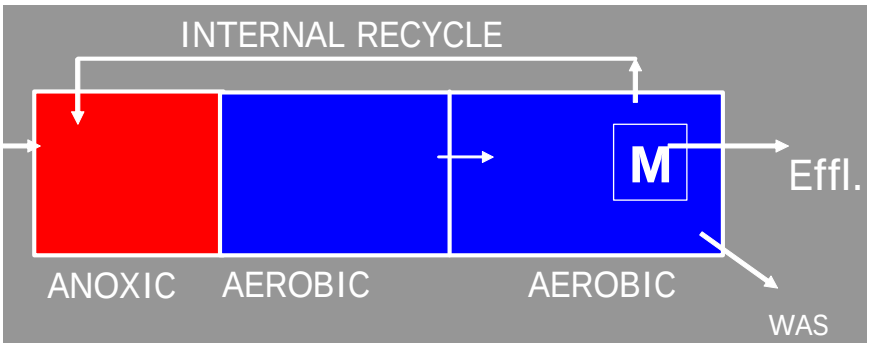
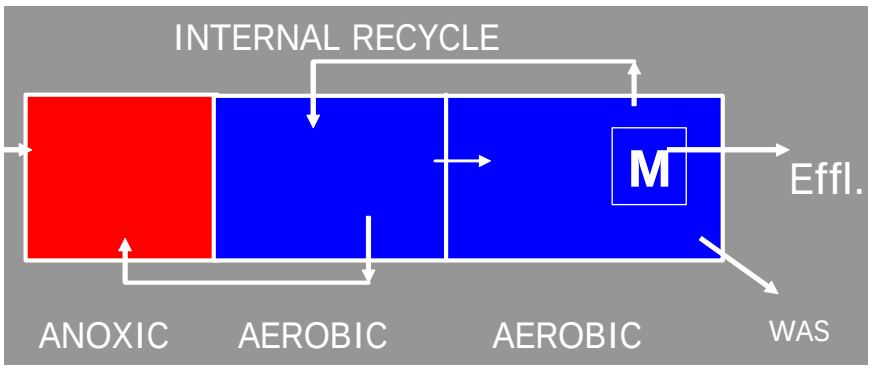
Anoxic-Aerobic Process is Applied in Membrane Bioreactors



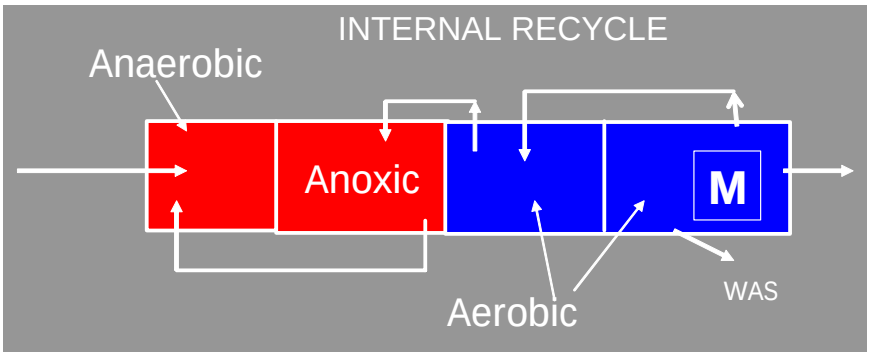
159

Anoxic-Aerobic Process Uses Additional Recycle Due to High DO



160

EBPR Process is Used in MBRs



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Features of Membrane Technology

Parameter	*Membrane*	*A.S. Clarif.*
Footprint	Less	
Aesthetics	Better	
Effl. Turbidity	<0.50 NTU	<2.0 NTU with Filter
Disinfection Cost	Less	
N Removal	Similar	Similar
Virus Removal	Better	

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Features of Membrane Technology

Parameter	*Membrane*	*A.S. Clarif.*
Energy Demand	Higher	
Capital Cost	Higher	
Effect of Filaments	May be Good	Bad
Operating Reliability	High	Medium
Removal of Micropollutants	May be Better	

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Advantages of MBRs

- Saves Space
  - Eliminates secondary clarifiers/smaller aeration tanks/no filters
- Increase capacity for existing aeration tanks
  - Much higher MLSS conc. Possible/shorter HRT
  - Size may be limited by oxygen transfer capacity per unit volume
- Longer SRTs
- Bulking/filamentous sludge not an issue
- Easy to retrofit
- High quality effluent – common for water reuse
- Automated operation

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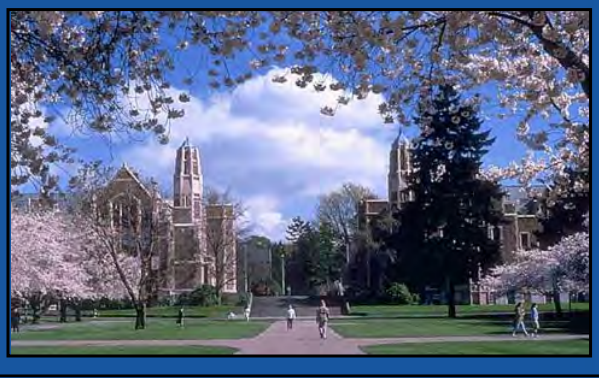
Side-Stream Treatment

Dave Stensel



Outline

- Impact of nitrogen in sidestream
- Process goals for sidestream treatment
- Getting much attention
  - BABE
  - SHARON
  - MAUREEN
  - ANA – (MMOX)
  - And others

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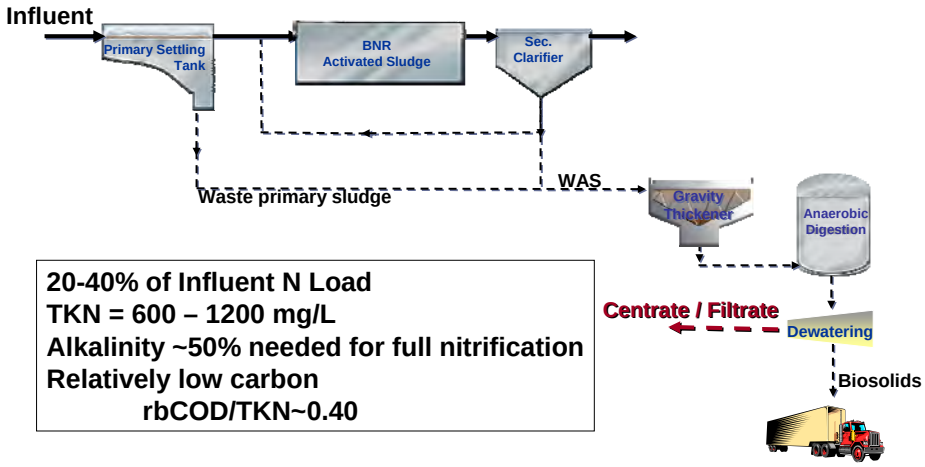
Dewatering Centrate/Filtrate Rich in Ammonia Nitrogen



20-40% of Influent N Load
TKN = 600 – 1200 mg/L
Alkalinity ~50% needed for full nitrification
Relatively low carbon
rbCOD/TKN~0.40

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Why Consider Treatment of Centrate Recycle?

- Impact of high NH_4-N loads on nitrification and denitrification process performance
  - Load equalization
- Minimal nitrification capacity of liquid treatment process
  - Bioaugmentation of nitrification from recycle stream
- Insufficient influent BOD for necessary denitrification for nitrogen removal goals – carbon limited
  - Decrease carbon needed for nitrogen removal

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Alternatives to Side Stream Treatment

- More treatment capacity volume
- Equalization basin

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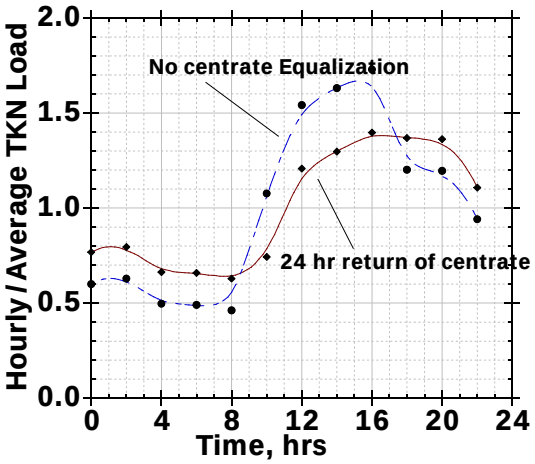
Possible Impacts of Centrate Return

- High peak ammonia loads on nitrification system



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Centrate Recycle Equalization Improves Performance

BioWin Simulations

SRT=15 days, Temperature = 10˚C, Avg. TKN = 41 mg/L

NH4-N Concentration, mg/L (weighted composite)

System	*Constant Load*	*Diurnal with Centrate Fed 8 hr/day*	*Diurnal with Centrate Equalization*
CMAS	0.7	2.1	1.1
3 tanks in series			
Stage 1	6.3	8.9	7.7
Stage 2	0.7	3.5	2.3
Stage 3	0.1	0.8	0.4

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Bioaugmentation with Recycle Treatment

- Nitrification of centrate recycle in side stream reactor
- Mixed liquor added to liquid treatment nitrification process
- Nitrifier seed enhances nitrification rate and thus complete nitrification occurs at lower SRT
- Useful for systems with limited tank volume and SRT and thus limited nitrification capacity
- Processes
  - BABE, InNITRI, AT#3

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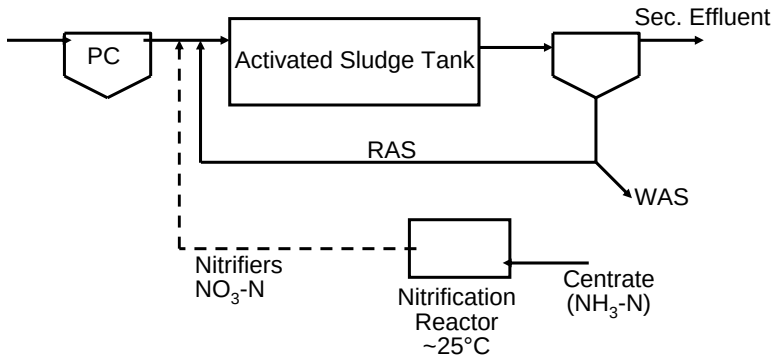
InNitri Process was the First Bioaugmentation Scheme



Expected benefit may not have been fully realized
- Temperature change
- Poor capture of recycle stream nitrifiers
- Predation
- Change in total dissolved solids content – osmotic pressure

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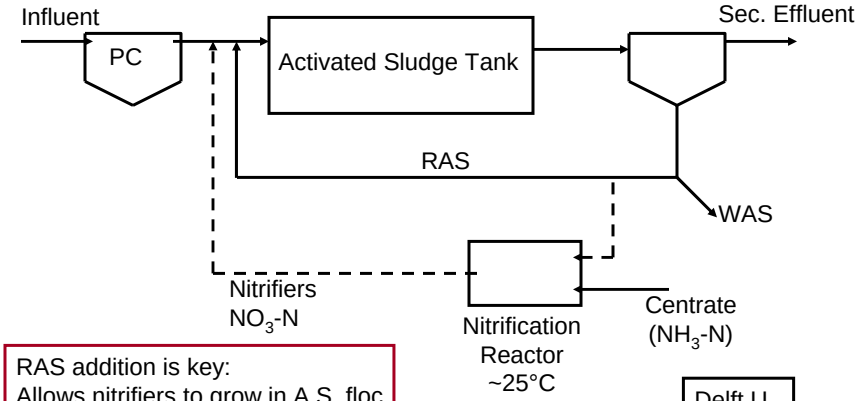
BABE Process
Bio-Augmentation Batch Enhanced



RAS addition is key:
Allows nitrifiers to grow in A.S. floc
Acclimated to both environments

Delft U.
DHV
STOWA

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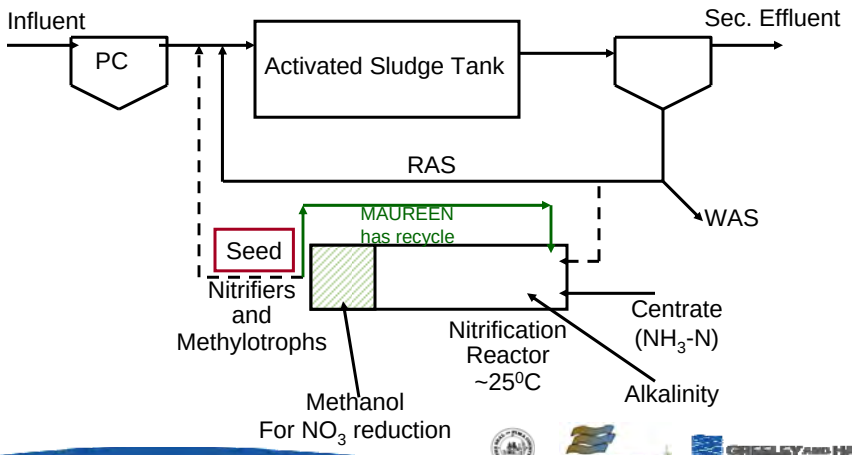
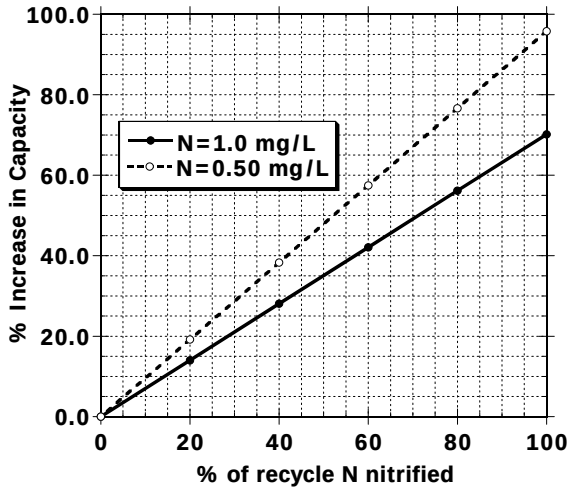
New York City AT-3 Process

MAUREEN IS A MODIFIED VERSION
(Mainstream Autotrophic Recycle Enabling Enhanced N-removal)



175

Percent Increase in Nitrification Tank Capacity as a Function of % of Recycle N Nitrified and Effluent NH_4-N Concentration (Theoretical Maximum)



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Insufficient Carbon for Nitrate Reduction

- Purchase additional carbon (methanol, acetate)
- On-site fermentation of primary sludge
- Use Nitritation process in recycle stream
  - SHARON
- Use De-Ammonification process in recycle stream
  - ANAMMOX
- Fixed film nitritation and de-ammonification processes
  - OLAND
  - CANON

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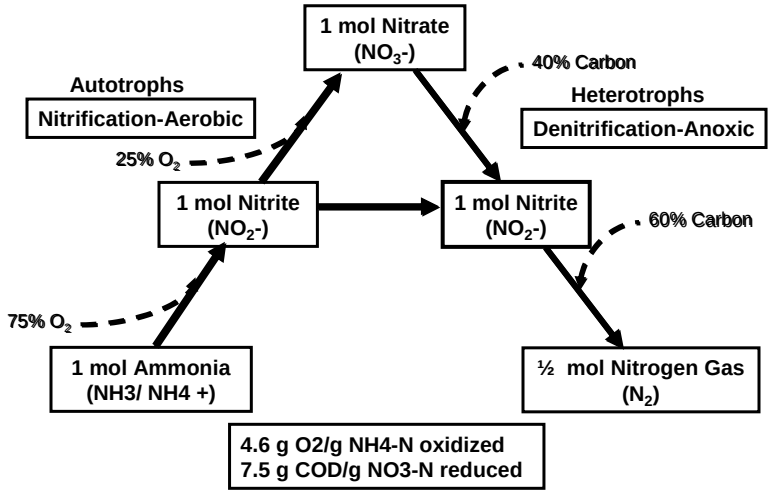
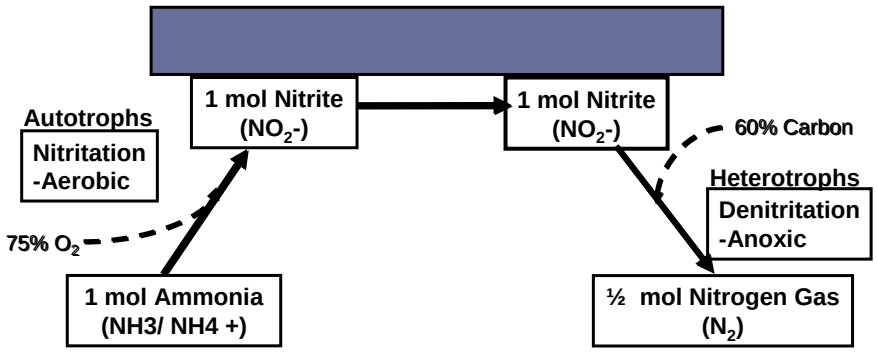
Nitrification – Denitrification



178

Nitritation – Denitritation



Advantages;
25% Reduction in Oxygen Demand
40% Reduction in Carbon (e- donor) Demand
40% Reduced Biomass Production

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SHARON Process
(Single reactor High activity Ammonia Removal Over Nitrite)

Developed at Delft University – Netherlands

Location	Nitrogen Load lbs N/day	Commissioning Date	Status
Utrecht	1980	1997	O
Rotterdam	1830	1999	O
Zwolle	1190	2003	O
Beverwijk	2650	2003	O
Groningen	6200	2004	O
Haag – Houtrust	2900	2005	

New York City 2007 (Bowery Bay WWTP) 14,500 lbs N/day

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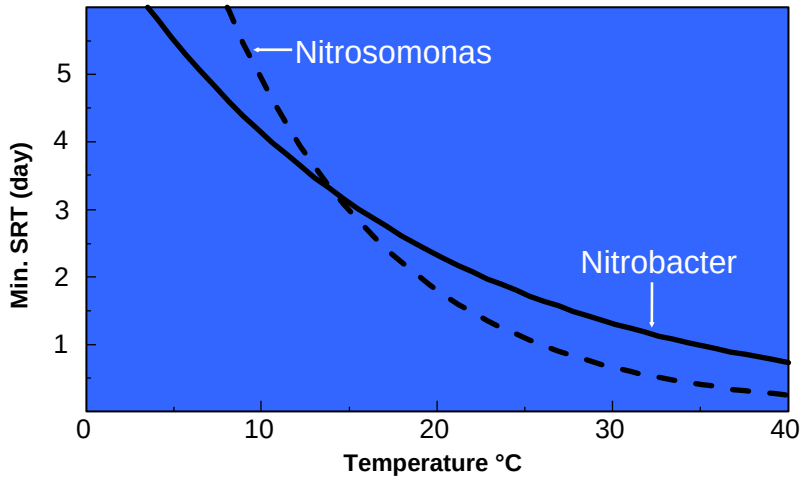
NH_4 Oxidizers grow faster than NO_2 oxidizers at temperatures above 25°C



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Sharon Process Features

- SRT=HRT (~2.0 days)
- Temperature = 30°-35°C
- Temperature control (heat exchangers)
- Higher temperature favors NH_4 oxidizers over NO_2 oxidizers at low SRT
- Alkalinity must be added or produced to promote maximum NH_4+ oxidation to NO_2-
  - Provide methanol for denitrification, which produces alkalinity
    - Add alkalinity
- Time is about 2/3 nitritation and 1/3 denitritation

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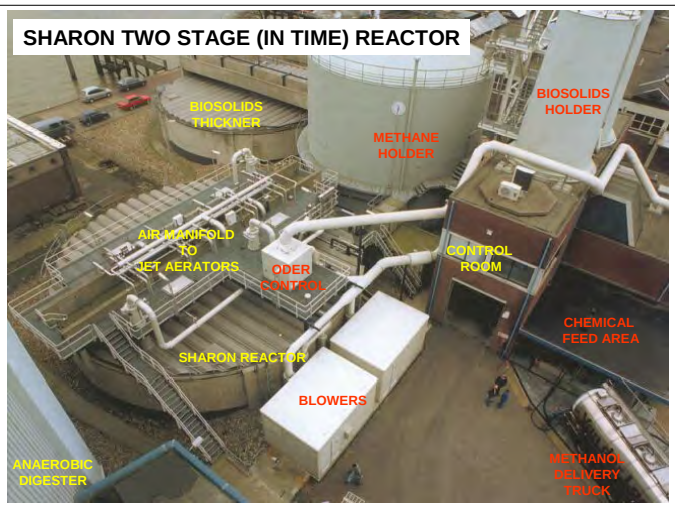
Rotterdam



Mixing and Mass Transfer Technologies INC LOTEPRO Environmental Systems and Services

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Design Parameters Rotterdam, the Netherlands

Parameter	Units
Flow $_{design}$	199,735 gal/day
Flow $_{maximum}$	317,040 gal/day
NH_4 $_{influent}$	1000-1500 ppm
Nitrogen Load $_{design}$	1190 lbs/day
Nitrogen Load $_{maximum}$	1830 lbs/day
Reactor Size	
oxic/anoxic	475,560 gallons
Oxic Retention Time	1.0 day
Anoxic Retention Time	0.5 day

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De-Ammonification Ammonia and Nitrite Removal with no Carbon Requirement

- Nitrosomonas Bacteria – microaerophilic
  - NH_3 oxidized to hydroxylamine (NH_2OH) by ammonia monooxygenase enzyme
  - $NH_2OH + HNO_2 \longrightarrow N_2O + 2H_2O$
- Nitrosomonas Bacteria – anoxic
  - $NH_3 + 5HNO_2 \longrightarrow 6NO + 4H_2O$
- ANAMMOX Bacteria – anaerobic
  - $NH_4^+ + 1.32NO_2^- + 0.066HCO_3^- + 0.13H^+ \; 0.26NO_3^- + \longrightarrow 1.02N_2 + 0.066C(H_2O)_{0.5}N_{0.15} + 2.03H_2O$

Biomass

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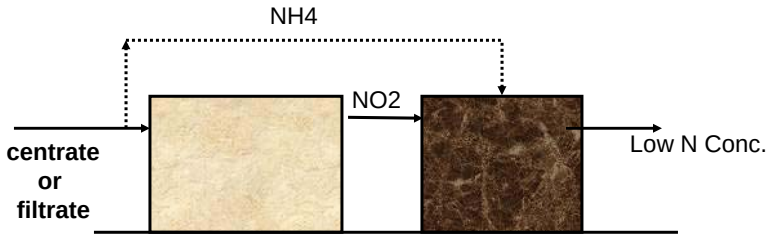
ANAMMOX Process
ANerobic AMMonia OXidation

- ANAMMOX process developed at Delft University
- Testing at Rotterdam – slow start up
- Bacteria
  - Autrophic
  - In order Planctomycetales
- Growth Conditions
  - Anaerobic-sensitive to oxygen
  - Temperature @ 30-35°C
  - Very slow growers –
    - μ_m = 0.069 g/g-d (consider nitrification μ_m = 0.85 g/g-d)
    - Doubling time = 10 days
    - SRT (30-50+ days)
  - $NH_4^+ : NO_2^-$ ratio ≈ 1 : 1.32
    - pH (neutral range)
    - Nitrite (maintain at <40 mg/L)
    - Free Ammonia (maintain at <10 mg/L)

186

Where to get NO_2- for ANAMMOX Process?

- SHARON Process



Underway at Rotterdam Dokhaven WWTP (The Netherlands)

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Summary

- Recycle sidestream treatment can provide more stable and effective nitrification
  - Equalization
- Recycle sidestream treatment can increase nitrification capacity of existing system
  - BABE, InNITRI, AT-3, MAUREEN
- Recycle sidestream treatment can help reduce carbon demand for nitrogen removal
  - SHARON, ANAMMOX

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Evaluation Criteria

Gordon Culp

Cost Matrix

System Element	*Existing Plan*	*Transfer Some*	*Transfer All*
Treatment-Capital Cost			
Conveyance-Capital Cost			
Treatment-Annual O&M			
Conveyance-Annual O&M			
Total, Present Worth Cost			

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Evaluation Matrix

Criteria		Ranking			Weighted Ranking		
	Criteria Weight	Existing Plan	Transfer Some	Transfer All	Existing Plan	Transfer Some	Transfer All
Cost							
Schedule							
Constructability							
Flexibility							
Env. Impacts							
Water Reuse							
Public Acceptability							
Employee Safety							
Cost Sharing Potential							
Effects on Financing							
System Reliability							
TOTAL							

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Evaluation Criteria

- Feasibility
- Cost
- Schedule
- Constructability
- Flexibility
- Environmental impacts
- Water reuse potential
- Public acceptability
- Public acceptability
- Employee safety
- Cost sharing potential
- Effects on ability to optimize financing
- System reliability

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Evaluation Criteria

- Feasibility (treatment alternatives)
  - Can existing facilities be converted to BNR?
  - Will the conversion result in a user-friendly treatment facility that is readily and reliably operable as a BNR plant?
  - Are there any other aspects of the alternative that are fatal flaws?
  - Only alternatives that pass this initial screening will be ranked against other criteria

193

Evaluation Criteria

- Cost (treatment plant, water reclamation system and wastewater conveyance system)
  - Capital
  - O&M
  - Life cycle (includes consideration of probable life of rehabilitated vs. new facilities)
  - Potential for cost saving from alternative delivery method

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Evaluation Criteria

- Schedule, consideration of time requirements for:
  - Permitting
  - Financing
  - Land or easement acquisition
  - Construction
  - Potential for time saving from alternative delivery method
  - New multi-party agreements
  - Addressing other legal issues

195

Evaluation Criteria

- Constructability
  - Maintaining treatment capacity while constructing new facilities
  - Transition of operation from old system to new system
  - Construction staging
  - Compatibility with land available at and near existing sites

196

Evaluation Criteria

- Flexibility, includes consideration of ability to cope with:
  - Changing development pace and patterns
  - Changing discharge and reuse requirements
  - NdeN requirements
  - Changing biosolids demands and regulations
  - Future expansion
  - Advances in available technology

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Evaluation Criteria

- Environmental impacts, includes consideration of:
  - Nature of land uses impacted
  - Odor
  - Noise
  - Construction activities
  - Riparian habitat/wetlands
  - Archeological impacts
  - Surface water quality
  - Use of alternative, sustainable energy sources

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Evaluation Criteria

- Water reuse potential, includes consideration of:
  - Location of reclaimed water
  - Location of potential demand for reclaimed water
  - Quantity of reclaimed water
  - Quality of reclaimed water
  - Groundwater recharge – effects on quality and quantity
  - Community-wide impact of reuse potential

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Evaluation Criteria

- System reliability
  - Conveyance system
  - Treatment technology reliability-wastewater
  - Treatment technology reliability-biosolids
  - Treatment redundancy-wastewater
  - Treatment redundancy-biosolids
  - Compatibility with system-wide standardization

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Evaluation Criteria

- Public acceptability
- Employee safety
- Cost sharing potential
- Effects on ability to optimize financing

201

Comments at Workshop 1

- Technology reliability
- Value of reuse to entire community
- Recharge potential
- What extent using proven technology
- How measure risk
- User friendly, consider labor impacts
- Employee safety

202

Comments at Workshop 1

- Odor generation potential
- Transition from old to new system
- Flexibility to expand over time
- Archeological impacts
- Compatibility with system-wide standardization
- Alternative energy sources

203

Comments at Workshop 1

- Cost impacts on reclaimed water system
- SCADA, impact on O&M
- Space issues, e.g. new laboratory
- Risks of not looking at new technology
- How to make the technology work vs. experience at other locales
- Business case of using existing facilities if O&M costs are driven up

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Comments at Workshop 1

- Ease of operation related to uniformity throughout the system
- "Bleeding edge" vs. proven technology

205

Cost Matrix

System Element	*Existing Plan*	*Transfer Some*	*Transfer All*
Treatment-Capital Cost			
Conveyance-Capital Cost			
Treatment-Annual O&M			
Conveyance-Annual O&M			
Total, Present Worth Cost			

206

Evaluation Matrix

Criteria		Ranking			Weighted Ranking		
	Criteria Weight	Existing Plan	Transfer Some	Transfer All	Existing Plan	Transfer Some	Transfer All
Cost							
Schedule							
Constructability							
Flexibility							
Env. Impacts							
Water Reuse							
Public Acceptability							
Employee Safety							
Cost Sharing Potential							
Effects on Financing							
System Reliability							
TOTAL							

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Evaluation Matrix

Criteria		Ranking			Weighted Ranking		
	Criteria Weight	Existing Plan	Transfer Some	Transfer All	Existing Plan	Transfer Some	Transfer All
Cost	5						
Schedule	5						
Constructability	3						
Flexibility	4						
Env. Impacts	4						
Water Reuse	5						
Public Acceptability	5						
Employee Safety	4						
Cost Sharing Potential	3						
Effects on Financing	3						
System Reliability	5						
TOTAL							

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Summary

Andy Richardson

Workshops #5 and #6 Meeting Notes
NdeN Process Selection

1. The NdeN Process Selection Workshop for Pima County Regional Optimization Master Plan was held on July 12, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Jackson Jenkins
Mike Bunch
PCWMD Staff
David Bartos
James Doyle
Frank Gall
David Garrett
Michael Kostrzewski
Jing Luo
Pete Magaddino
Byron McMillan
John Munden
Steve Munsell
Jeff Prevatt
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
John Sherlock
Jack Van Riper
Legal
Harlan Agnew
Chuck Wesselhoft

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Dennis Rule
Tim Thomure

BUREAU OF RECLAMATION
Deborah Tosline

PEER GROUP
Joe Husband, MPI
Gary Newman, B&C
Denny Parker, B&C
Cindy Wallis-Lage, B&V

GREELEY AND HANSEN PROJECT TEAM
Orrie Albertson
Jerry Bish
Gordon Culp
Carl Koch
Jong Lee
Joe Popeck
Anne Smith

2. Major topics of the workshop were:
   - Workshops #5 and #6: NdeN Process Selection
     - Condition Assessment of Ina Road
     - Wastewater Treatment Design Options Short List
     - Short Listed Options for Roger Road WWTP
     - Short Listed Options for Ina Road WPCF

- Process Selection to Evaluate Plan Options:
  - Existing Plan
  - Transfer Some
  - Transfer All

Handouts were provided to each attendee. Handouts included presentation slides of the Ina Road WPCF Condition Assessment and review of the short listing of wastewater treatment alternatives used during the workshop. Other slides numbered 78 through 189 were used during the workshop presentations, but not handed out to attendees, were sent electronically to attendees following the workshop. The other slides were identified as Workshops #5 & #6 NdeN Process Selection, July 12, 2006 "amended pages – July 14, 2006."

Throughout the workshop, notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and considerations to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, opened the workshop by inviting all to actively participate, especially the peer group who were attending their first project workshop. He stated the theme of the workshop was to narrow the wastewater treatment process alternatives down to the most cost effective system(s) for the County. Process selection is the most important decision to be made for the study.

4. Anne Smith defined her role as facilitator to move the group through the agenda and to encourage participation from all. The purpose of the workshop was to review the condition assessment report of Ina Road WPCF and spend most of the time to narrow down the wastewater process alternatives for further study in the system alternatives evaluation for Roger Road WWTP and Ina Road WPCF. The framework for the treatment process selection was outlined.

   Agenda, groundrules, objectives of the workshop and treatment process evaluation framework were presented and covered on pages 1 through 4 of the handout.

5. Gordon Culp previewed the alternative evaluation matrix to be used later in the workshop to narrow the treatment process selection. The evaluation criteria include life cycle costs and resource consumption considerations among others. Comments from the attendees ranged from what varies among the processes, to usability of the effluent, whether Class A+ water was the basis of process performance, how recycle streams were addressed, would power generation continue at the facilities and whether Bio P (biological phosphorus) removal was considered.

Responses included that Class A+ Water was used as the basis for the process development, that recycle loads were taken into account for the Ina Road WPCF plant loadings (assumes Roger Road WWTP solids are thickened/dewatered at Ina Road WPCF) and that Bio P removal was a basis for the process criteria. There were differing opinions amongst the attendees on whether Bio P removal should be used as a basis for the process design.

It was agreed that the Bio P removal issue would be revisited by the project team, especially after the upcoming Biosolids workshop. In response to the power generation comment, it was stated that power generation was under evaluation since the condition assessment of those facilities had been completed.

The evaluation preview was covered on pages 5 through 7 of the handout.

6. Joe Popeck provided a quick condition summary review of Ina Road WPCF. Since this facility is much newer than Roger Road WPCF and a portion had just been newly constructed, this facility was generally rated in good condition. Concrete and mechanical equipment appeared to be in good condition throughout. The existing instrumentation and control system was rated as good, but appeared to be under utilized for a facility this size. There were some notes made on an electrical motor control center that require some attention. It was noted that any wastewater facility must continually renew and replace components and systems to remain a viable operation.

   The Ina Road WPCF condition assessment was covered on pages 8 through 23 of the handout.

7. Orrie Albertson reviewed the results of Workshop #4 to screen or narrow down eight possible wastewater treatment processes to a fewer number through a qualitative process. There were 10 questions applied to each potential process. The use of Bio P removal affected the decision as to whether a process should continue for consideration. It was previously concluded, although not required by current or near future regulations, that provisions for Bio P removal could have beneficial operational cost impacts, if it were required, versus the approach of adding chemical to address phosphorous removal. It was suggested by the peer group that the decision to include Bio P removal in the initial facilities be reconsidered.

   Denny Parker offered that utilities elsewhere are experiencing “sticker shock” at the cost of facilities and it may not be a good idea to include Bio P removal capability that might not be needed in the near future with the initial projects based on cost considerations. To keep costs down, there should be emphasis on reusing tankage wherever reasonable. (As stated in item 5 above, Bio P removal is to be revisited by the project team.) Five processes were selected from

Workshop #4 for continued evaluation. These processes were the basis for the more detailed analysis to be addressed in the items below.

There were many questions related to the basic assumptions used in the evaluation criteria for narrowing the alternatives. Among other comments, the peer group questioned whether on a "first cut" basis that the wastewater characteristics between the facilities should be considered similar, and whether denitrification and Bio P removal were viable based on the available carbon in the wastewater. It was agreed that available carbon should be allocated to nitrogen removal first and removal P second.

Recent construction costs information indicates that new treatment facilities are expensive and that existing structures and systems, if worthy, need to be considered in future plans. It was stated that the two metro plants need to be looked at separately to effectively address the utility of the existing structures and facilities. Further, it was suggested that the evaluation criteria be weighted to provide a higher value to reuse of existing tankage.

Dennis Froehlich noted that the MBBR process was ruled out on Bio P removal criteria, but is may be a very cost effective way forward.

It was agreed that the process evaluation team including the peer group would re-examine the screening criteria apply it to each plant. It was further stated that processes of merit would be noted for future consideration in the study, but it was needed to narrow the processes to one for the evaluation of overall system options between the metro plants. After complete regional systems (with a process) are developed for the options, the processes of merit will be tested against the process used for the comparative studies to decide on the most cost effective approach for the County. It is possible, and maybe likely, that the process used in the comparative analysis will not be the final selected process at each plant. Therefore, no process is ruled out at this time, but to be efficient in moving the study forward a process for comparative analysis needs to be identified.

The screening of alternatives review was covered on pages 24 and 25 in the handout.

8. Joe Popeck proceeded through the presentation of the five wastewater processes that were shortlisted in Workshop #4. The bases of the additional analysis of treatment plant processes included treatment plant flows at Roger Road WWTP and Ina Road WPCF under the three study options, raw wastewater characteristics and effluent criteria. In addition to describing the treatment components of each system, site layouts at Roger Road WWTP and Ina Road WPCF

and preliminary costs for comparative purposes were provided. Treatment processes were developed in two modes: 1) nitrification, and 2) nitrification-denitrification. Processes included MLE, Bardenpho, Step-Feed, IFAS and MBR.

Comments included why flows higher than 32 mgd at Roger Road WWTP were not considered and how much flow remains in the Santa Cruz River after reuse water should be considered. Higher flows at Roger Road WWTP will be addressed in future workshops. Higher flow is to be determined in part by the Tucson Water reuse water needs and Ina Road WPCF existing systems capacity. The flow in the Santa Cruz River to sustain riparian habitat has been reported to be 7 mgd. This river flow was attributed to Frank Postillon, who was not present at the workshop.

In the site layouts, tankage and facilities are shown to illustrate the space they would require not necessarily where they would finally reside after more engineering analysis. It was noted by PCMWD Staff that at Roger Road WWTP the distribution pipes in the ground will significantly impact future construction implementation and costs within and near the existing facilities.

On costs issues it was stated that the present worth analysis was based on 20 years with an approximate 8 percent interest and a 3 percent escalation. It was further noted that the costs did not account for demolition, if required. There was a Peer Group comment that the aeration costs looked low and asked if it included mechanical equipment. The answer was that the aeration costs did include mechanical equipment costs.

Mike Gritzuk asked if all the existing tanks would be required at Roger Road WWTP for the processes considered. The response was no, that there was excess primary and secondary clarification capacity. It was further stated that primary tanks 1 though 4 are not useful as constructed.

Setback requirements used for new facilities on the site layouts were based on 350 feet. There still appears to be an open issue on set backs. Paul Bennett has some map information that addresses setbacks at each plant.

Frank Gall asked if the process designs included a peaking factor. The answer was yes based on a historical factor of 1.4 for maximum day and 2.0 for maximum hour.

Jing Luo asked why the MLE process was still being considered as it was discarded in Workshop #4. The response was that the MLE process was added back into the mix at the end of Workshop because with denitrifying filters the process meets the effluent criteria.

Questions arose from the peer group on specific values and assumptions used in the various analyses, such as depth of new aeration tanks (16 feet), MLSS used, SRT (days), power consumption and dissolved oxygen concentration by process stage . Each was answered by the project team.

There was discussion of the step feed process and it was eliminated from further consideration based on the complexity of achieving Bio P removal. The comment was made that step feed would be expected to provide superior performance for nitrogen removal.

Gary Newman asked if the biotowers were removed at Roger Road WWTP whether wastewater could flow by gravity from the primary tanks to the aeration tanks. The answer is yes, but there is very limited hydraulic head available.

IFAS requires fine screens in front of the system to prevent fouling. The metro plants have 6 mm clear screen openings in the headworks which are sufficient for the process media.

For the IFAS system there was a question on the density (500 square meters per cubic meter) considered and how the media is handled during maintenance. After some discussion it was concluded that the density utilized in the analysis was appropriate. Cindy Wallis-Lage indicated that the media of a higher density may have oxygen transfer difficulties in this service. For maintenance of the system the media would be pumped to another operating tank while the maintenance proceeds and pumped back after it is returned to service. A question was raised by the peer group about the approach to sizing of the IFAS basins and some disagreement with the approach was voiced. Cindy Wallis-Lage indicated that within the system analysis the DO assumed in some zones may be unnecessarily high.

There remains an issue of warm weather performance with IFAS. While there may be a facility approved in a warm weather area, there is no operating experience.

With the membrane technology it has proven very difficult to place membrane bundles into existing tankage. Usually after structural analysis the existing tanks are abandoned and new tanks constructed for the membranes.

9. Once the alternatives for each process at each plant were presented, a present worth summary table for all the alternatives was provided. The summary information did not show much

difference between Bardenpho and IFAS, but indicated that those two were significantly lower than MLE and MBR.

Mike Gritzuk asked if the cost of Bardenpho and IFAS are equal, then what are the advantages and disadvantages of each. Advantages and disadvantages of Bardenpho and IFAS include: Bardenpho is one of the oldest BNR technologies in the US and has been proven. There are many in warm climates (20 in Florida).

IFAS is a newer technology and it is harder to understand the science within its operation. IFAS has proven to be successful at achieving an effluent N of 10 mg/L, but not at 6 mg/L as required for Pima County. IFAS can be operated with a lower MLSS than Bardenpho which makes the final clarifiers more tolerant of higher flows. The IFAS does not have a track record in warm weather areas. Also, if the IFAS needs to carry a DO of 2 mg/L, it will lose in a comparative analysis on energy. It is cautioned that the IFAS should not be used unless piloted tested in Pima County.

10. Denny Parker offered an alternative at Roger Road WWTP to reuse of the biotowers in a nitrification mode with the existing aeration tanks. It is possible to concurrently achieve some denitrification in the biotowers. The process is being used at Littleton-Englewood, Colorado. This would maximize the use of the existing facilities, but would require chemical addition for P removal. This alternative remains a potential for further consideration, particularly if flows are 20 mgd or less.

11. For the Ina Road WPCF the NdeN processes analyses, HPO tanks were converted to an anoxic zone. There was a question on how the model handled the recycle of nitrogen. There is a concern that the system could be “poisoned” with a large recycle load from the sludge treatment process. It was noted that sludge treatment is to be addressed in the next workshop.

Joe Husband indicated that the new BNRAS system at Ina Road WPCF is designed to add a fourth stage. It may accommodate a fifth stage, if necessary.

The rapid sand filters were based on a 4 gpm loading rate at average flows. If the peaking factor is 2.0, the bases may need to change to 3 gpm to allow for a peak of 6 gpm trough the filters.

Items 8, 9 and 11 were covered in pages 25 and 26 of the handout and slides numbered 78 through 182 at the workshop. Slides were provided electronically to attendees after the workshop.

12. Gordon Culp introduced the evaluation matrix with two items for the group to discuss and rate operability and proven process. Operability includes items, such as, higher I&C skills, mixed liquor control and SRT control. For proven process the MBR has had difficulty in nutrient removal applications while IFAS has had very limited experience (one plant) with nutrient removal. Ron Riska expressed concerns for the complexity that membrane systems require. Franks Gall indicated that Bardenpho appears to be the safest process based on experience. IFAS is more difficult to deal with because of the media in the water.

The matrix evaluation table was completed by the group for operability and proven process and then the table was reviewed and revised in the other evaluation categories, which were completed ahead of the workshop by the project team as they required quantitative values, such as costs.

It was agreed by the group that processes with nitrification only would be removed from further consideration. It was further agreed to prepare a separate evaluation matrix for Roger Road WWTP and Ina Road WPCF in the workshop. With the remaining processes each evaluation category by each process was reviewed and some adjustments made. The completed matrix for Roger Road WWTP and Ina Road WPCF are provided below.

Roger Road	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability		o		o		o		-
Proven Process		+		+		o		-
Present Worth Cost, Capital + O&M		-		+		-		-
Site Compatibility		o		o		o		o
Resource Consumption		-		+		+		-
Ease of Maintaining Treatment Capacity during Construction		-		-		-		-
Recommended Process								

Ina Road	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability		o		o		o		-
Proven Process		+		+		o		-
Present Worth Cost, Capital + O&M		-		+		-		-
Site Compatibility		-		+		+		+
Resource Consumption		-		+		-		-
Ease of Maintaining Treatment Capacity during Construction		+		+		+		+
Recommended Process								

From the matrix evaluation analysis it was decided, but not as a final process decision at each plant, that Bardenpho would be taken forward to evaluate the three system options -- existing plan, transfer some, and transfer all. There were no objections from the group that Bardenpho would be used in the system alternative evaluations.

With the completed tables additional comments were made on the results and included: when are the other costs, such as sludge process and conveyance added *(other costs will be considered in comparing complete system configurations)*, the decision to provide Bio P removal needs to be revisited (*NdeN plants typically remove 65 to 80 percent of P in addition to nitrogen)*, look at how flows will increase to each plant over time, and need to consider the detail on how to maximize the use of existing structures.

The evaluation matrix was covered in the slides numbered 183 through 189 at the workshop, but provided electronically to the attendees after the workshop.

13. Joe Popeck indicated that in working with existing facilities and structures that contractor risk needs to be factored into the evaluation. This is particularly true at Roger Road WWTP due to age and the existing facility arrangements.

14. Mike Gritzuk summarized the areas for additional clarification.

    - What are the capacity needs of Tucson Water and at what location? More discussion required with Tucson Water.
    - What is the minimum flow to the Santa Cruz River to maintain a green riparian habitat?
    - What is the future regulatory requirement for phosphorus?
    - What is the best way to plan for phosphorus removal?
    - Reconciliation needed on the pass/fail screening chart amongst the process team, County and peer group.
    - What are the costs of contractor's risk related to rehabilitation and adding on to existing facilities construction, especially at Roger Road WTTP?

15. Anne Smith reviewed the day's activities and listed the action items.

    - Provide Dennis Froehlich with the GPS-X layouts for the processes and costs
    - Paul Bennett to forward the setback maps to the project team.
    - Project team to provide information on how influent characteristic were developed.
    - Peer group to provide notes of additional issues and concerns form the workshop and request any additional information to Ron Riska.
    - Reconciliation of the pass/fail screening matrix is required between the project team, peer group and County staff.
    - Additional cost considerations for rehabilitation at Roger Road WWTP need to be developed.

16. Anne Smith indicated that the next workshops on Biosolids and conveyance were scheduled for July 19, 2006.

Agenda
Workshops #5 & #6 – NdeN Process Selection
July 12, 2006

Time	Topic	Presenter
7:30 am	*Continental Breakfast – Rio Nuevo Upstairs Conference Room, 52 W. Congress*	
8:00 am	Opening Session	
	• Welcoming Remarks	Mike Gritzuk
	• Overview of Agenda	Anne Smith
	• Purpose and Objectives	
8:20 am	Background/Condition Assessments – Ina Road WPCF	Joe Popeck
8:55 am	Wastewater Treatment Process Review	Orrie Albertson
9:15 am	Wastewater Treatment Process Short List Review	Joe Popeck
9:30 am	Peer Group Discussion of WWT Processes	Anne Smith
9:45 am	Break	
10:00 am	Roger Road Evaluations	Joe Popeck/Jong Lee
	• Process Evaluations	
	• Site Layouts	
	• Preliminary Costs	
11:40 am	Peer Group Discussion	Anne Smith
12:00 pm	Lunch	
12:45 pm	Ina Road Evaluations	Joe Popeck/Jong Lee
	• Process Evaluations	
	• Site Layouts	
	• Preliminary Costs	
2:25 pm	Peer Group Discussion	Anne Smith
2:45 pm	Break	
3:00 pm	Matrix Evaluation of WWT Processes	Gordon Culp
	• Roger Road WWTP	
	• Ina Road WWTP	
4:15 pm	Summary Wrap-Up	Anne Smith
	• Comment by Group	
	• Closing Remarks	Mike Gritzuk
4:30 pm	Adjourn	

Flip Chart Notes – July 12, 2006

Process Criteria Comments

- Disposal – options – Class A+ needs to be confirmed
- Regulatory position on P removal needs to be confirmed
- Sidestream treatment not included in cost estimates

Questions for Pass / Fail Matrix

- Ina/Roger Questions – similar influent characteristics
  - Need real numbers for influent (to be done soon); could skew processes (solids/liquid)
  - Impact of sidestream on N (County has some influent data on Roger Road)
  - P removal – should it be driver?
  - P & N removal may not both be possible without sufficient carbon source
  - Trickling filters should not eliminated because of P & N removal
  - Bio P removal should not be on the pass/fail criteria; favors certain processes
  - BT/NAS P failed on methanol need
  - ASNTF/BTNAS/Step/Biostyr – failed on P removal
  - Different evaluation if just look at Roger Road/Ina Road separately vs. all together
  - Consider comparing processes at 10 mgd increments.
  - Consider a range of flow values

<u>ROGER ROAD WWTP</u>

Process Options

- Questions
  - Why not 50 mgd at Roger Road?
  - 32 mgd not locked in fro Roger Road
  - Do larger flows affect process selection?
  - Tucson Water not married to 20 mgd at Roger Road;
  - Maybe get rid of river discharge at Roger Road – operate as scalping plant for reuse
  - 20 & 32 mgd at Roger Road are included in study options
  - 7 mgd in river – Roger Road to Ina Road needed for habitat

MLE(N) Process

- Cost of demolition not included
- 6.5 days aerobic SRT used
- Present worth: 20 yr 8% Interest 3% Inflation Net approximately 5%
- deN filters – cost based on current plant (Greeley and Hansen) cost/SF
- Focusing on major capital and O&M costs
- Flow distribution not included as it applies to all processes
- Grandfathering (assumed) for setbacks – maybe a problem with odors
- Open question: power requirements may be different for each (MLEN/MLENdeN)

5-Stage Bardenpho

- Total SRT 9.8 to 9.9 days total; aerobic SRT 6 to 6.5 days
- Could demolish #1 – 4 clarifiers at Roger Road , if space needed

Step Feed (with Alum/Methanol)

- General – piping costs excluded; will be addressed later in detail
- AN/anoxic process can be used to make step feed work for Bio P removal, but complex
- Surprised that step feed higher than MLE for methanol and chemical costs

IFAS N

- Assumed 4 mg/L DO in tanks
- Fine screens not included – not needed, already have 6 mm screens

MBR

- Cost evaluation of membrane includes initial plus two replacements over 20 years
- New tanks (membrane) have been more economical in past than using aerating existing tanks
- Mixed liquor concentration seems low – 8,000 to 10,000
- 10 mgd – $0.80 - $1m/m membrane tank (experienced elsewhere)– SRT 12 days MLSS – 8,000 aeration, 10,000 membrane
- Need equalization of flows
- Wastewater peak – 2 times average flow (Q)
- Experience indicates flux rates used are conservatively lower
- Experience with new facilities has MBR lower capital costs than conventional plus filters – present worth is higher
- More cost with retrofit

Cost Comparisons

- Need to consider piping/routing
- Power costs need refinement
- Cost basis – different; mixing actual plant costs and water cost model
- Need sensitivity analysis on processes present worth – O&M/cap
- May not be differentiated by cost
- The four processes considered - 3500 mixed liquor at 20 mgd; higher Q/conc. may be problem
- Option to consider – trickling filters with acetate addition and polishing – retrofit flocculator center wells and fine bubble aeration/anoxic zones (16 mgd)

IFAS

Con	Pro
High DO	Ease of O&M

Bardenpho

Con	Pro
Clarifier limits process	More plants in more climates
	Bio P and N removal good

Bio P removal can skew options
Need to capitalize on carbon source

INA ROAD WPCF

- MLE-N
  - Rated capacity needs to be checked seems low
  - Limiting factor – nitrogen
- MLE NdeN
  - Check volume of tanks at 82 mgd
- 5-Stage Bardenpho N
  - Check capability for process: removal of P and N
  - Need to control P on the return stream
- Bardenpho NdeN
  - New BNR planned for expansion to 25 mgd
  - May move final clarifier to accommodate digesters
  - How will peak flows be handled in rapid sand filters?
- MBR NdeN: May have opportunity to do MBR at Ina when considering new tankage
- Comparison
  - Need to consider other facilities (sludge) expansion at Ina when the largest flows are considered not just NdeN processes
  - Less problem increasing Roger Road capacity than Ina Road, or make Ina Road tanks deeper
  - Details may change evaluation
- Look at Other Configurations of IFAS

Matrix Evaluation Criteria Comments

- Proven Process
  - Is process proven in BNR setting?
  - Concern that a process works in hot/cold weather
  - IFAS may be required to be piloted by ADEQ
- Operability
  - MBR – size of units – many hard to operate when not as designed properly
- IFAS economics may change if DO changes
- Site: Constructability issue with MBR; issue also with MLE

Ina Road Evaluation

- No difference on operability/proven process between Roger Road and Ina Road
- Have plants been proven for influent N of 55 mg/L → effluent 6 mg/L

Comments

- If 20 mgd at Roger Road, then trickling filters should be looked at
- Make sure decision is not totally driven by Bio P
- Leave real estate for Bio P removal; consider flow projections in system alternative evaluation,
- Evaluate processes to a higher level detail now, not later, to avoid skewing of the evaluation
- Risk element to using existing tankage
- Need to look at existing tanks – taking out of operation to assess condition/maintain
- What capacity does Tucson Water need?
- Minimum Q needed for river 7 or 12 mgd?
- Regulatory requirement for P removal?

Action Items

- GPS-X layouts to Dennis
- PC (Paul) provide IGA maps for setbacks
- Peer Group, Greeley and Hansen, and Pima County to reconcile process evaluation criteria (Ron R.). Comments to Jerry/Ron prior to next meeting
- Peer group to submit additional comments after workshop, request for additional information and provide comments on pass/fail matrix changes within 2 weeks
- Comments on last set of meeting notes to Ron Riska
- Use Bardenpho for system alternative evaluation
- Peer group
  - Any additional input
  - What do you want to see?
  - Comment on matrix (within two weeks, conference call)
- Use August 9th meeting for brainstorming meeting vs. technical processes. Ron Riska/Jerry Bish to organize early August meeting with Peer Group, which will include reconciling the pass/fail chart
- How good are costs at Roger Road for rehabilitation? Will start to address these in the August workshop.

Pima County
Regional Optimization
Master Plan

Workshop #5 and #6
NdeN Process Selection

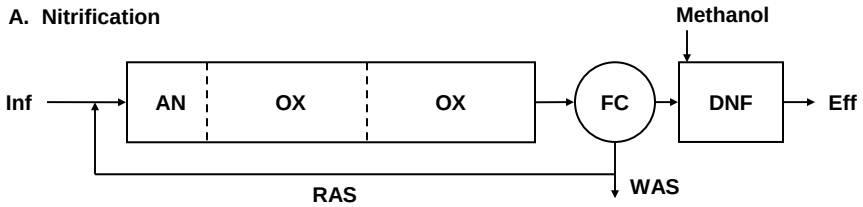
July 12, 2006
(Amended Pages–July 14, 2006)

Roger Road WWTP

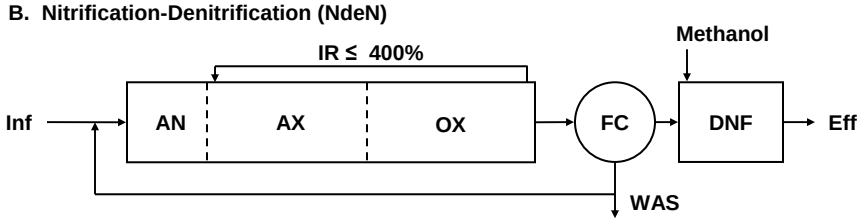
MLE

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

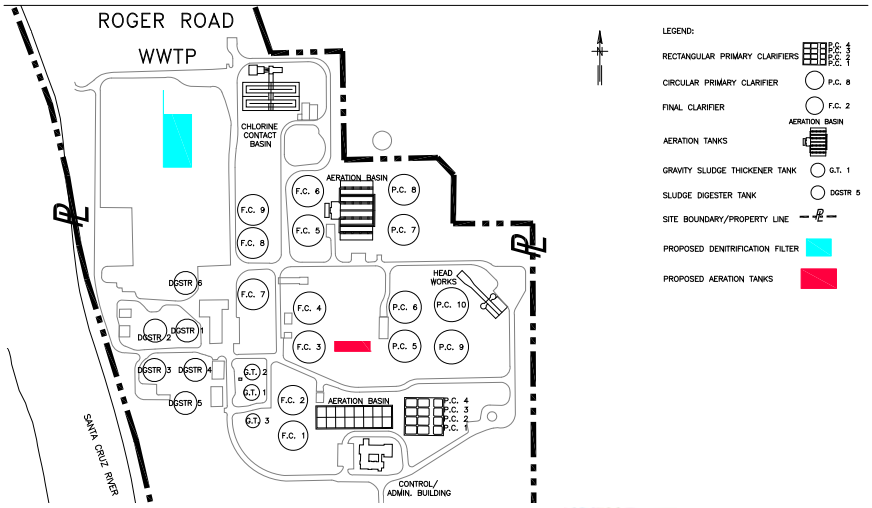
A. Nitrification



B. Nitrification-Denitrification (NdeN)



Process Type: MLE Nitrification
Plant Capacity: 20 MGD

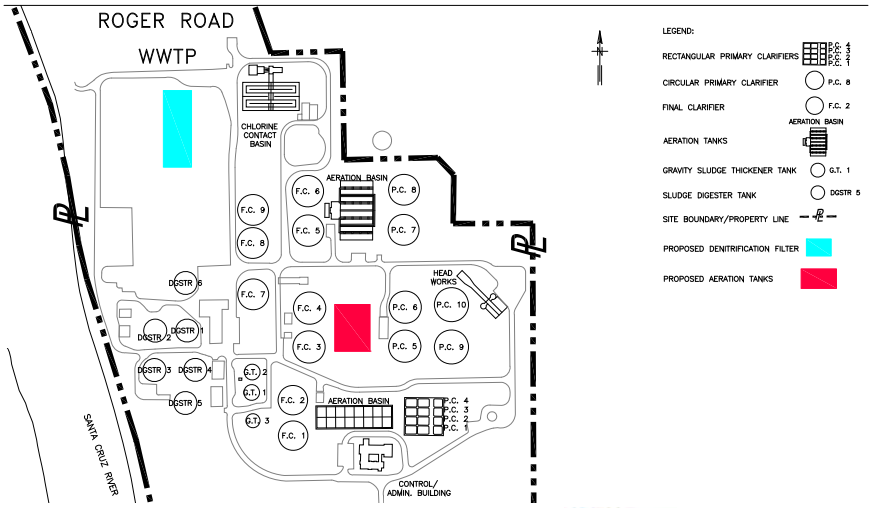


Process Type: MLE Nitrification
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$1,400
Denitrification Filters	$21,000
Estimated Annual Power Cost	$900
Estimated Annual Methanol Cost	$700
Present Worth	$38,100

82

Process Type: MLE Nitrification
Plant Capacity: 32 MGD



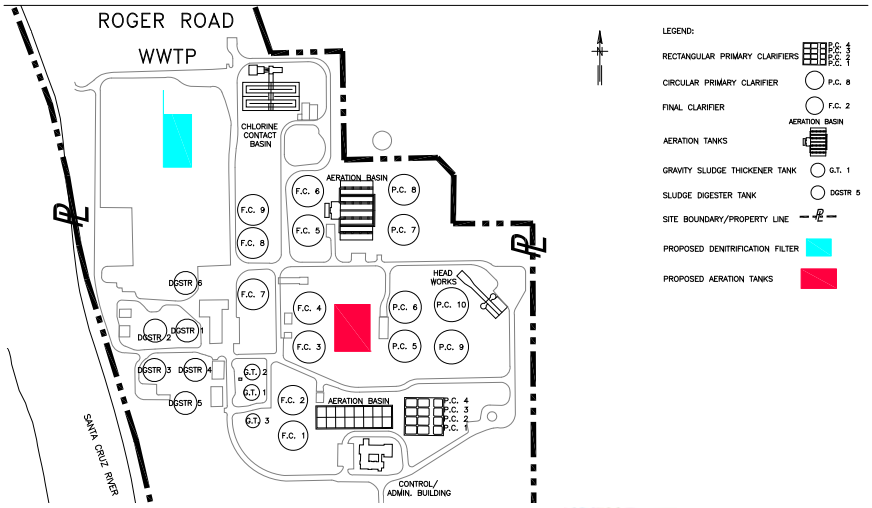
83

Process Type: MLE Nitrification
Plant Capacity: 32 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$7,700
Denitrification Filters	$33,600
Estimated Annual Power Cost	$1,400
Estimated Annual Methanol Cost	$1,100
Present Worth	$65,800

84

Process Type: MLE NdeN
Plant Capacity: 20 MGD



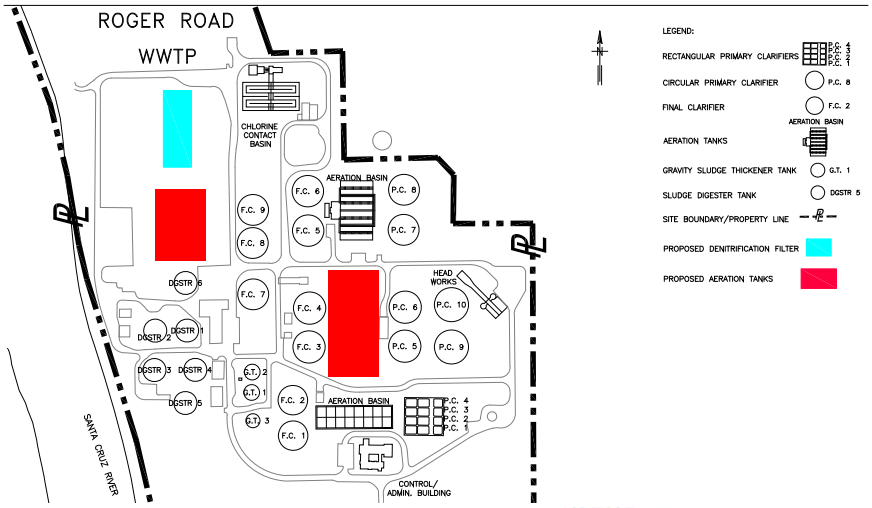
85

Process Type: MLE NdeN
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$7,700
Denitrification Filters	$21,000
Estimated Annual Power Cost	$900
Estimated Annual Methanol Cost	$100
Present Worth	$37,800

86

Process Type: MLE NdeN
Plant Capacity: 32 MGD



87

Process Type: MLE NdeN
Plant Capacity: 32 MGD

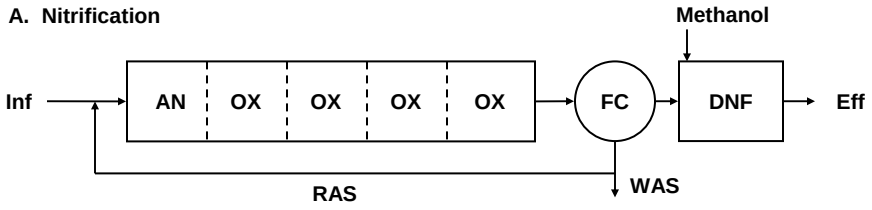
Item	*Cost ($1000's)*
Aeration Tanks	$17,900
Denitrification Filters	$33,600
Estimated Annual Power Cost	$1,500
Estimated Annual Methanol Cost	$160
Present Worth	$67,800

88

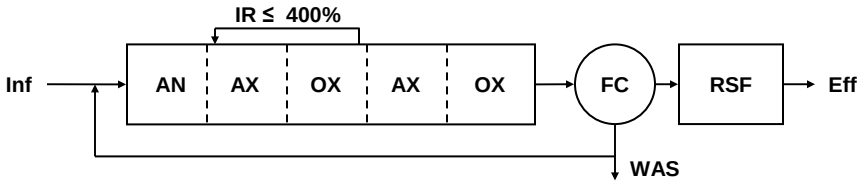
5-Stage Bardenpho

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

A. Nitrification

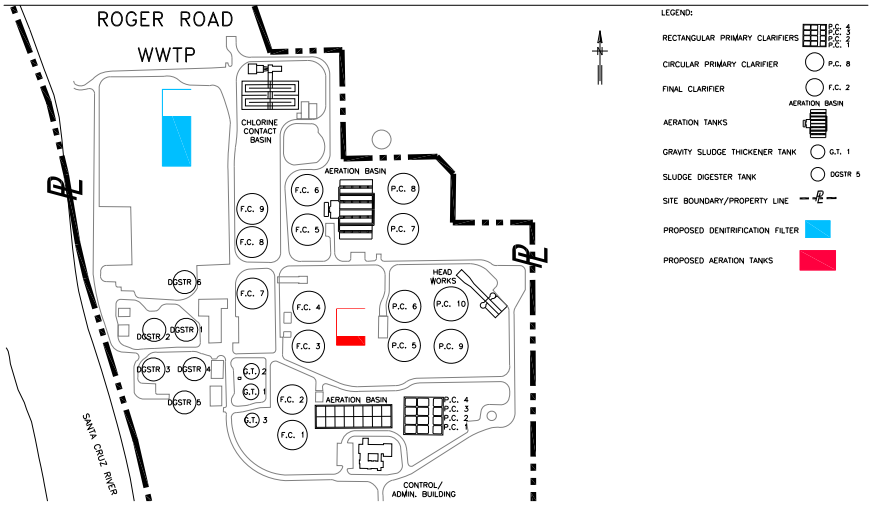


B. Nitrification-Denitrification (NdeN)



89

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 20 MGD



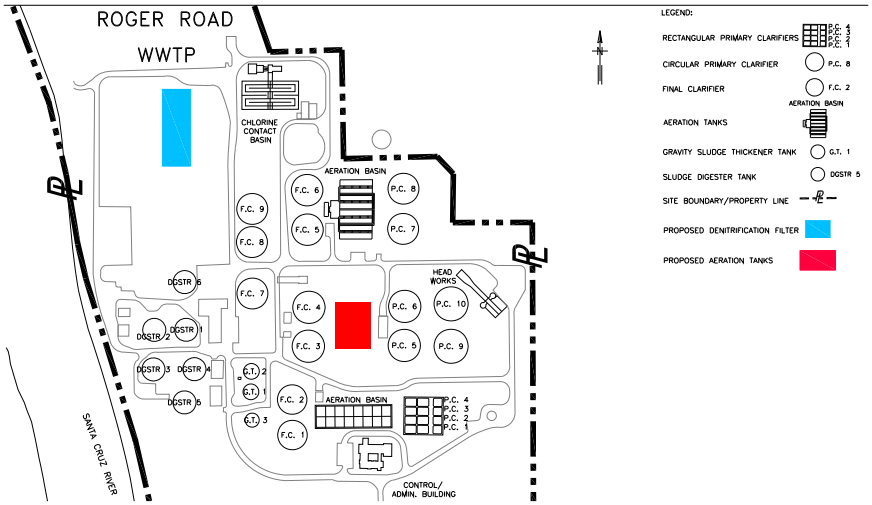
90

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$1,400
Denitrification Filters	$21,000
Estimated Annual Power Cost	$1,000
Estimated Annual Methanol Cost	$700
Present Worth	$39,100

91

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 32 MGD



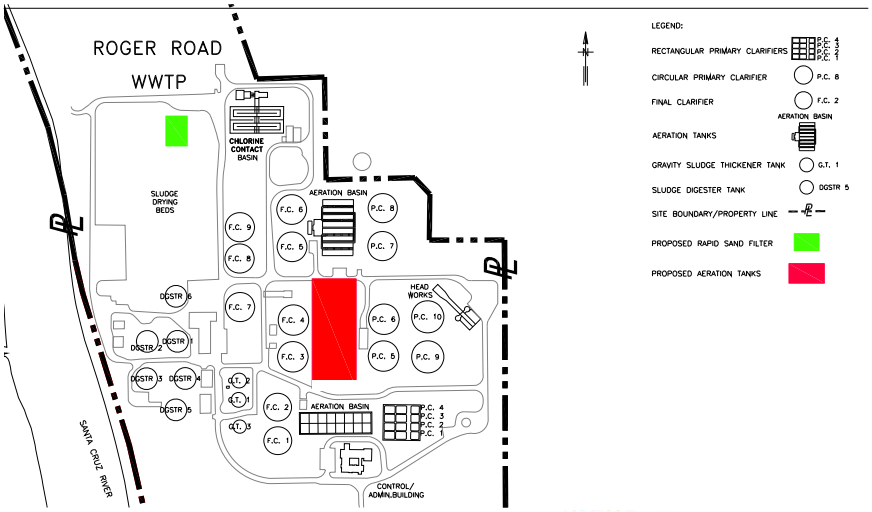
92

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 32 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$7,700
Denitrification Filters	$33,600
Estimated Annual Power Cost	$1,600
Estimated Annual Methanol Cost	$1,100
Present Worth	$67,800

93

Process Type: 5-Stage Bardenpho NdeN Plant Capacity: 20 MGD



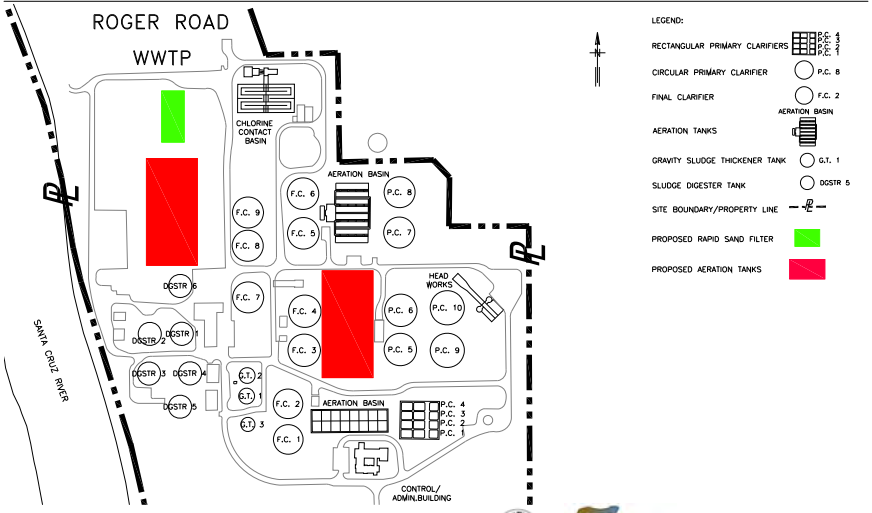
94

Process Type: 5-Stage Bardenpho NdeN Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$10,400
Rapid Sand Filters	$8,100
Estimated Annual Power Cost	$1,000
Estimated Annual Methanol Cost	$0
Present Worth	$28,300

95

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 32 MGD



96

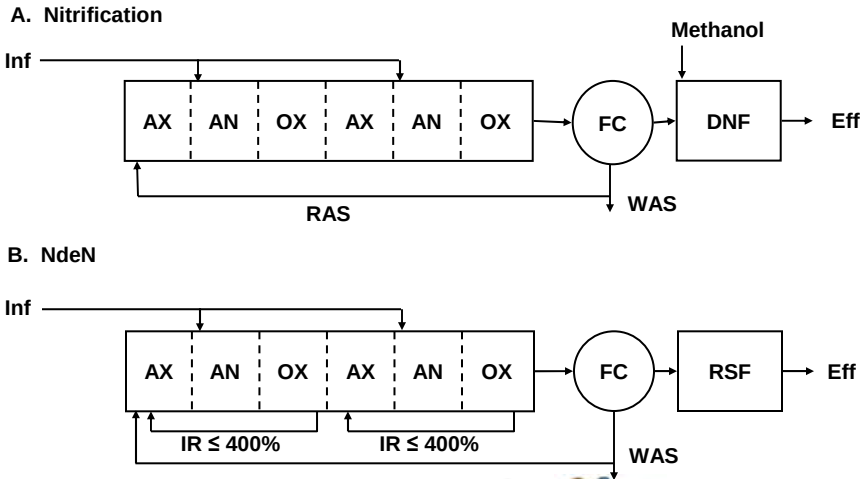
Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 32 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$22,300
Rapid Sand Filters	$12,900
Estimated Annual Power Cost	$1,600
Estimated Annual Methanol Cost	$0
Present Worth	$50,900

97

Step Feed

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter



98

Step Feed

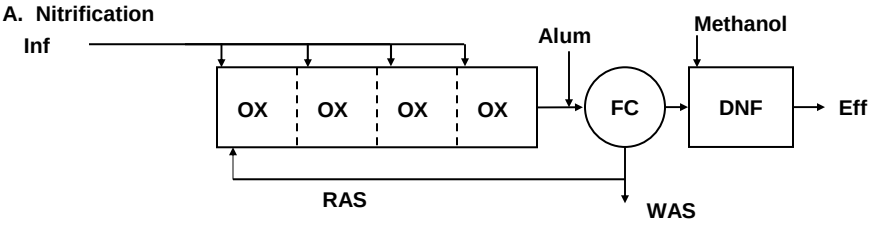
- Step Feed dropped for further consideration:
  - Does not utilize tankage efficiently for complete Nitrification
  - Does not utilize tankage efficiently for Bio P
  - Requires two sets of Recycle Pumps

99

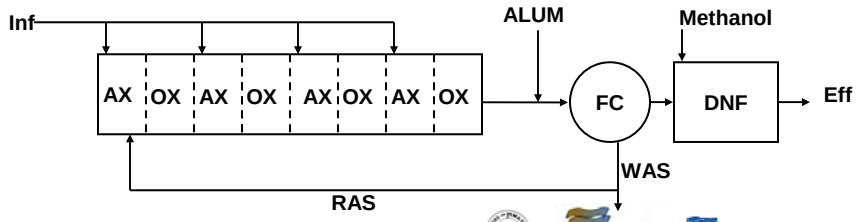
Step Feed – With Alum and Methanol

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

A. Nitrification

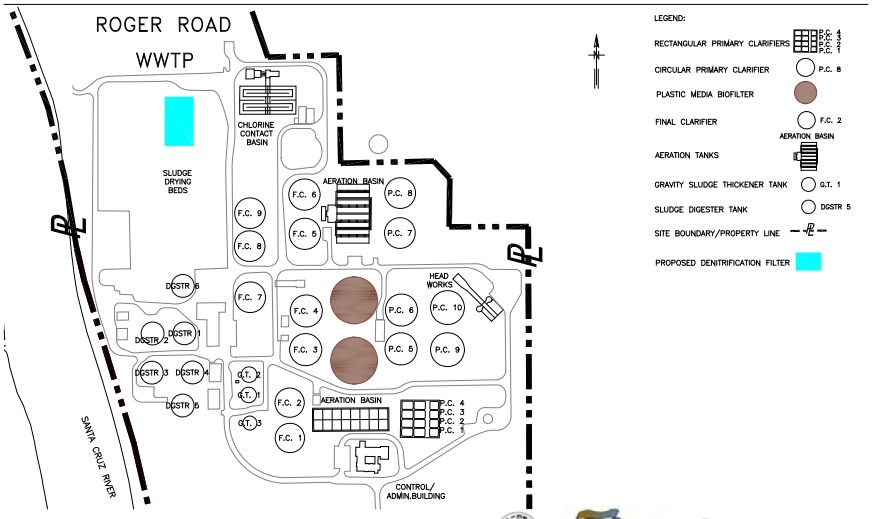


B. NdeN



100

Process Type: Step Feed Nitrification – With Alum and Methanol: Plant Capacity: 20 MGD



101

Process Type: Step Feed Nitrification – With Alum and Methanol: Plant Capacity: 20 MGD

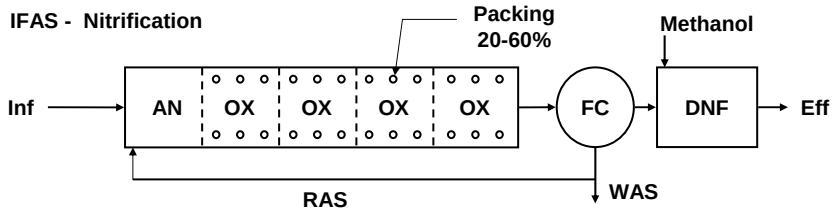
Item	*Cost ($1000's)*
Aeration Tanks	$0
Denitrification Filters	$21,000
Estimated Annual Methanol Cost	$900
Estimated Annual Alum Cost	$1,600
Estimated Annual Power Cost	$900
Estimated Annual Add'l Sludge Cost	$400
Present Worth	$58,400

102

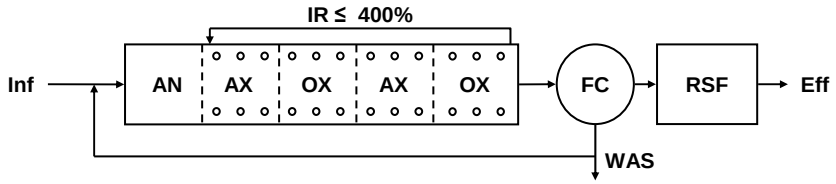
IFAS

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

IFAS - Nitrification

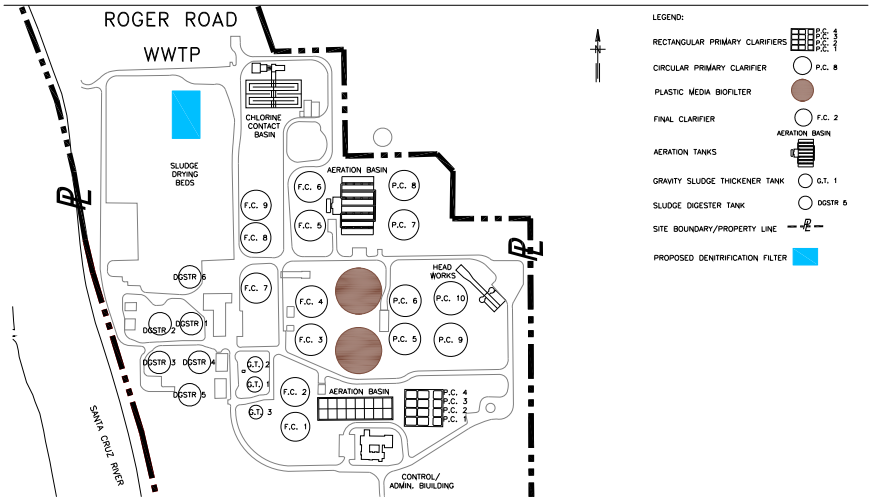


IFAS - NdeN



103

Process Type: IFAS Nitrification
Plant Capacity: 20 MGD



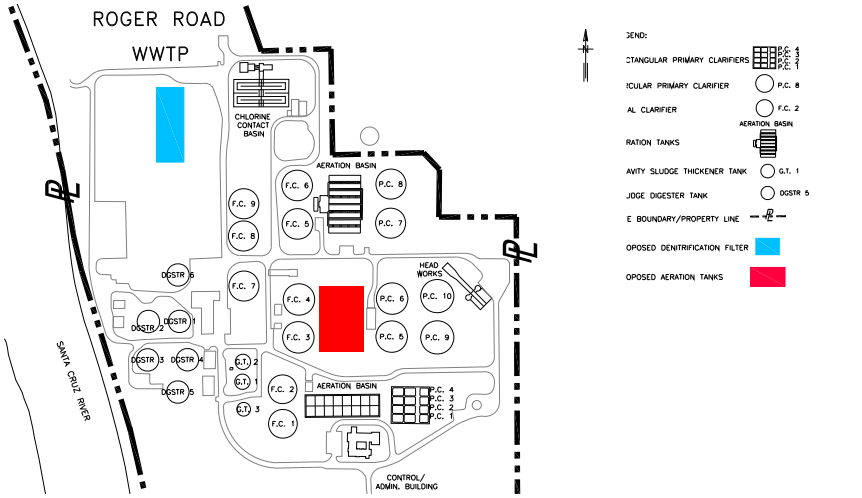
104

Process Type: IFAS Nitrification
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks (Addition of IFAS Media)	$5,700
Denitrification Filters	$21,000
Estimated Annual Power Cost	$1,500
Estimated Annual Methanol Cost	$600
Present Worth	$41,600

105

Process Type: IFAS Nitrification
Plant Capacity: 32 MGD



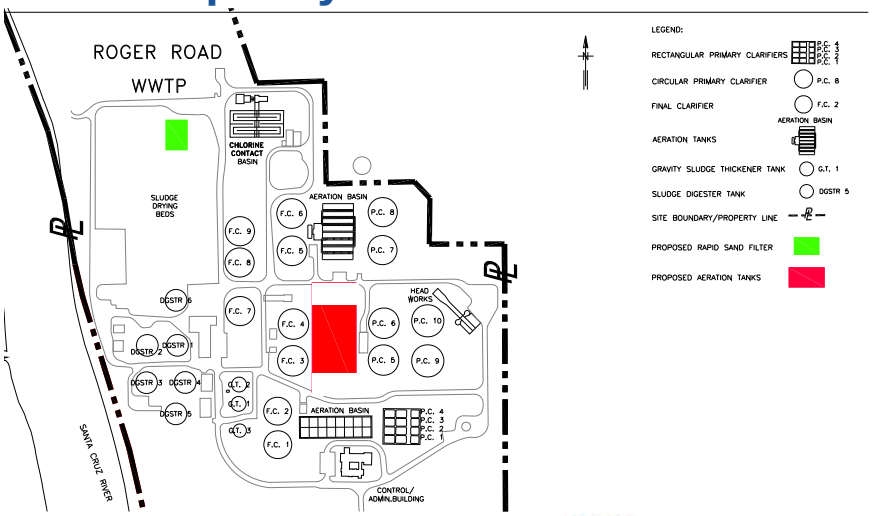
106

Process Type: IFAS Nitrification
Plant Capacity: 32 MGD

Item	Cost ($1000's)
Aeration Tanks	$10,500
Denitrification Filters	$33,600
Estimated Annual Power Cost	$2,400
Estimated Annual Methanol Cost	$1000
Present Worth	$76,800

107

Process Type: IFAS NdeN
Plant Capacity: 20 MGD



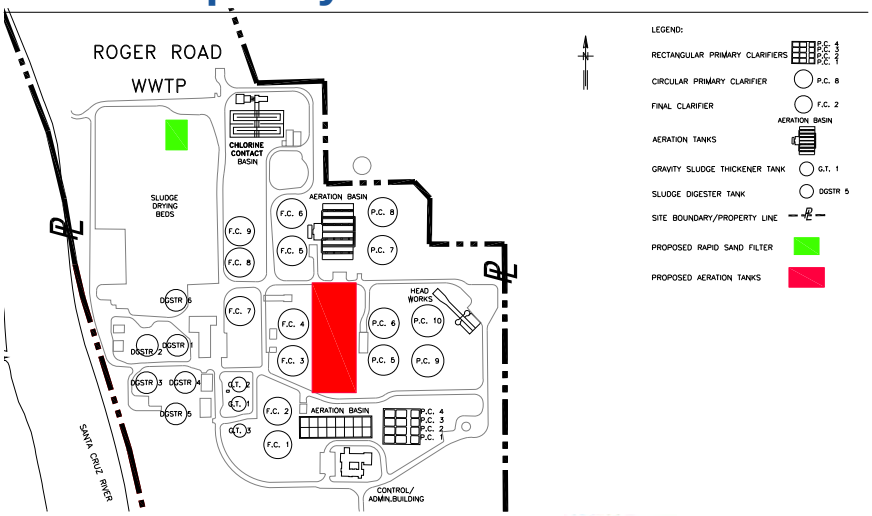
108

Process Type: IFAS NdeN
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$10,200
Rapid Sand Filters	$8,100
Estimated Annual Power Cost	$1,500
Estimated Annual Methanol Cost	$0
Present Worth	$33,000

109

Process Type: IFAS NdeN
Plant Capacity: 32 MGD



110

Process Type: IFAS NdeN
Plant Capacity: 32 MGD

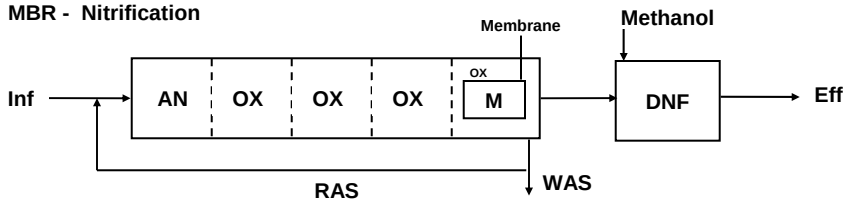
Item	*Cost ($1000's)*
Aeration Tanks	$21,900
Rapid Sand Filters	$12,900
Estimated Annual Power Cost	$2,400
Estimated Annual Methanol Cost	$0
Present Worth	$58,400

111

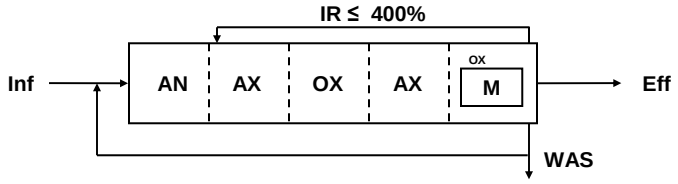
MBR

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

MBR - Nitrification

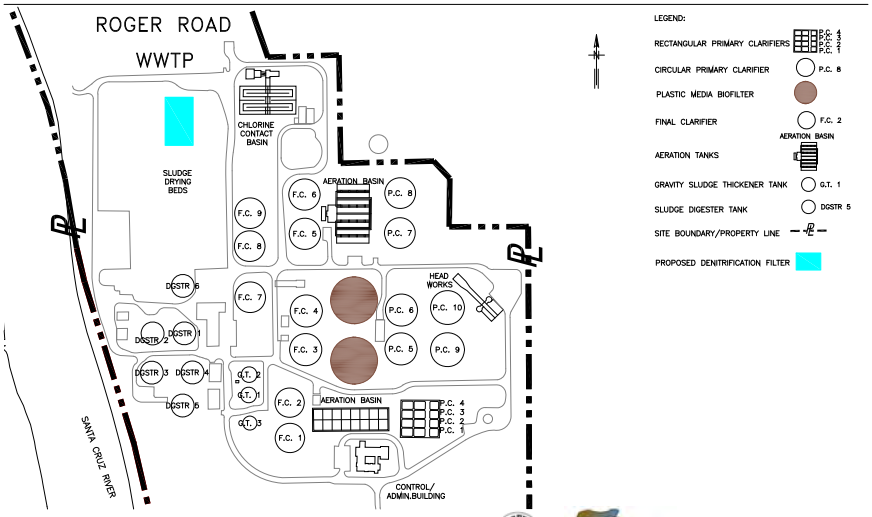


MBR - NdeN



112

Process Type: MBR Nitrification
Plant Capacity: 20 MGD



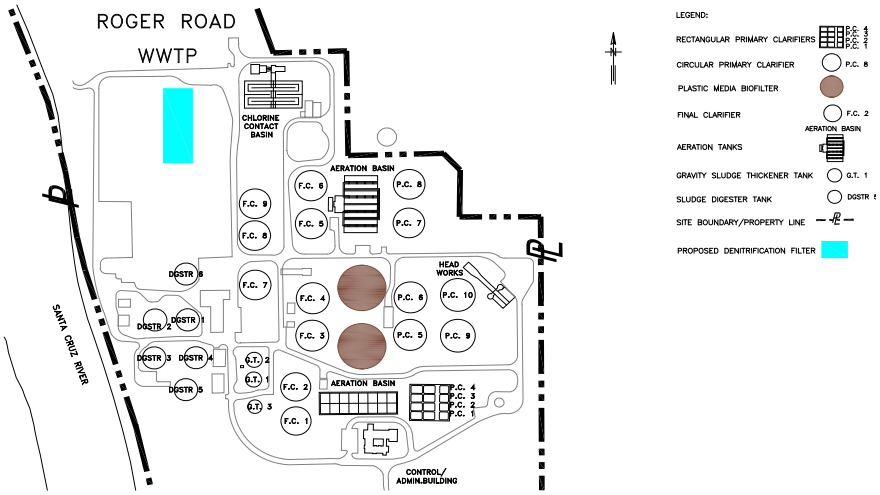
113

Process Type: MBR Nitrification
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks (Add Membrane System to Existing AT's)	$71,500
Denitrification Filters	$21,000
Estimated Annual Power Cost	$2,900
Estimated Annual Methanol Cost	$500
Present Worth	$125,900

114

Process Type: MBR Nitrification.
Plant Capacity: 32 MGD



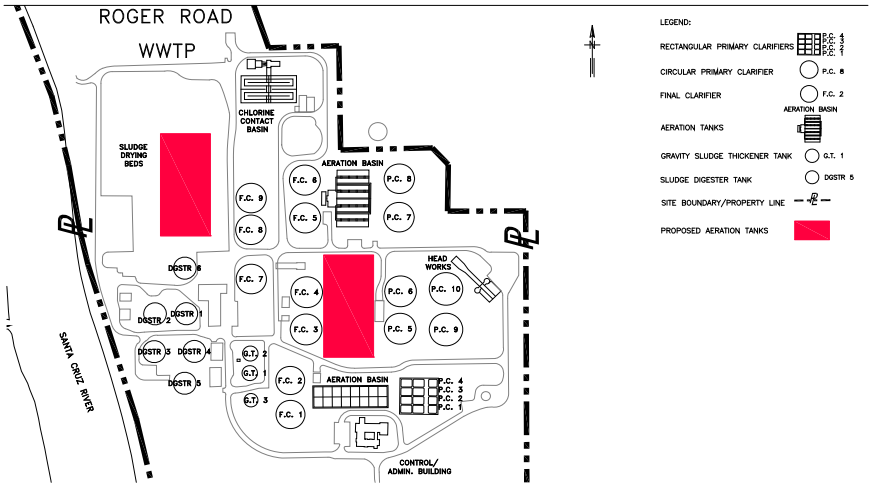
115

Process Type: MBR Nitrification
Plant Capacity: 32 MGD

Item	*Cost ($1000's)*
Aeration Tanks (Add Membrane System to Existing AT's)	$114,400
Denitrification Filters	$33,600
Estimated Annual Power Cost	$4,700
Estimated Annual Methanol Cost	$800
Present Worth	$201,900

116

Process Type: MBR NdeN
Plant Capacity: 20 MGD



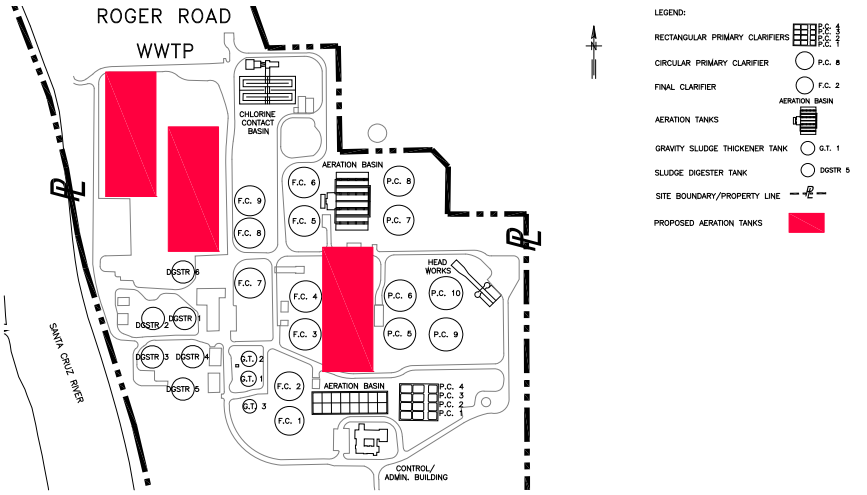
117

Process Type: MBR NdeN
Plant Capacity: 20 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$78,900
Rapid Sand Filters	$0
Estimated Annual Power Cost	$2,900
Estimated Annual Methanol Cost	$0
Present Worth	$107,400

118

Process Type: MBR NdeN
Plant Capacity: 32 MGD



119

Process Type: MBR NdeN
Plant Capacity: 32 MGD

Item	*Cost ($1000's)*
Aeration Tanks	$148,000
Rapid Sand Filters	$0
Estimated Annual Power Cost	$4,600
Estimated Annual Methanol Cost	$0
Present Worth	$193,200

120

20-mgd Capacity – Nitrification vs. NdeN

Process	*Nitrification* *Present Worth ($1000's)*	*NdeN* *Present Worth ($1000's)*
MLE	$38,100	$37,800
5-Stage Bardenpho	$39,100	$28,300
IFAS	$41,600	$33,000
MBR	$125,900	$107,400

121

32-mgd Capacity – Nitrification vs. NdeN

Process	*Nitrification* *Present Worth ($1000's)*	*NdeN* *Present Worth ($1000's)*
MLE	$65,800	$67,800
5-Stage Bardenpho	$67,800	$50,900
IFAS	$76,800	$58,400
MBR	$201,900	$193,200

122

Pima County Wastewater Management Department

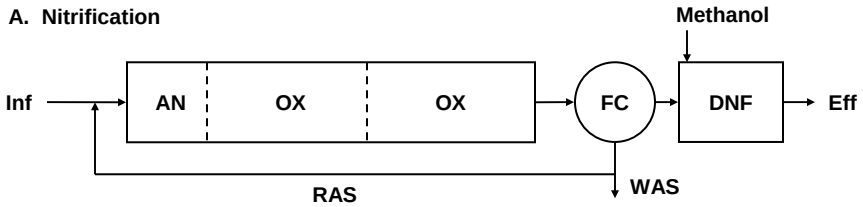
GREELEY AND HANSEN

Ina Road WPCF

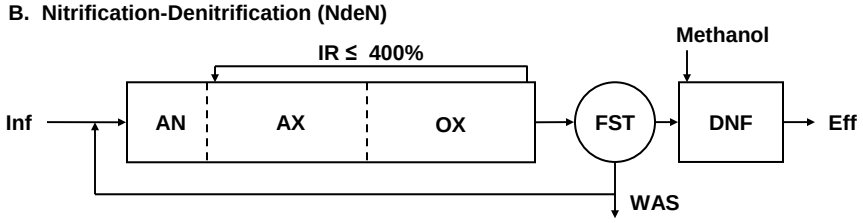
MLE

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

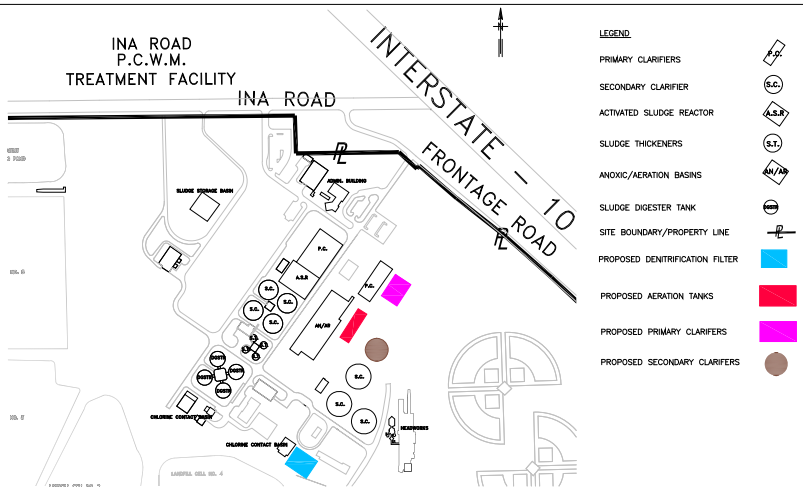
A. Nitrification



B. Nitrification-Denitrification (NdeN)



Process Type: MLE Nitrification
Plant Capacity: 50 MGD

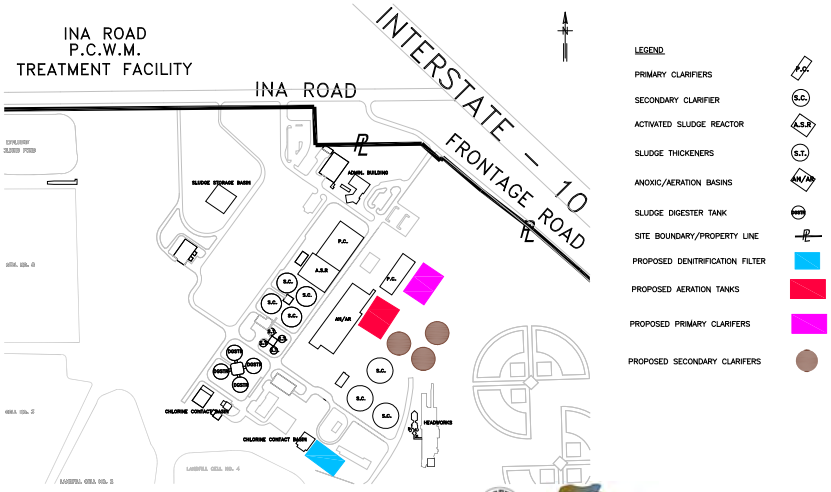


Process Type: MLE Nitrification
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$22,800
Denitrification Filters	$52,500
Estimated Annual Power Cost	$2,500
Estimated Annual Methanol Cost	$1,700
Present Worth	$116,000

126

Process Type: MLE Nitrification
Plant Capacity: 62 MGD



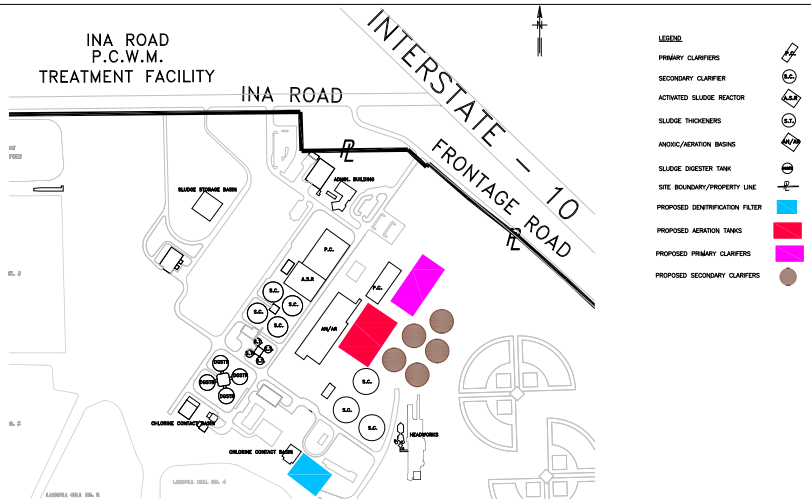
127

Process Type: MLE Nitrification
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$59,900
Denitrification Filters	$65,100
Estimated Annual Power Cost	$2,900
Estimated Annual Methanol Cost	$2000
Present Worth	$156,000

128

Process Type: MLE Nitrification
Plant Capacity: 82 MGD



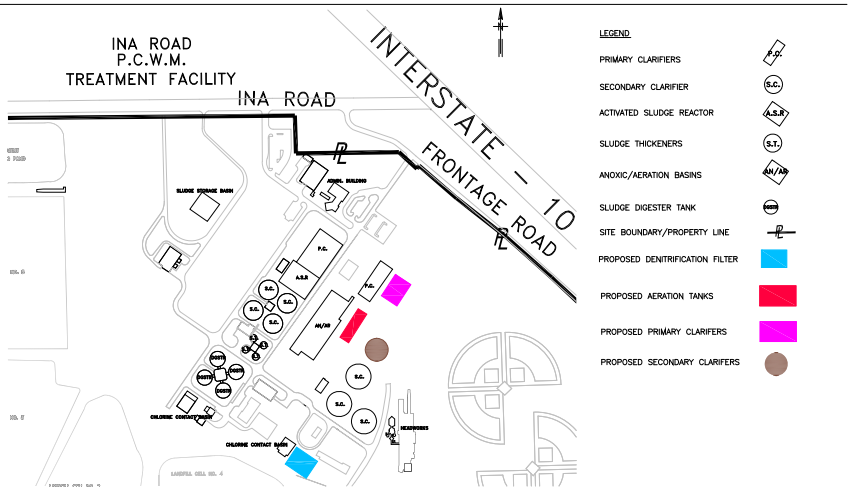
129

Process Type: MLE Nitrification
Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$69,700
Denitrification Filters	$86,100
Estimated Annual Power Cost	$4,100
Estimated Annual Methanol Cost	$2,700
Present Worth	$222,700

130

Process Type: MLE NdeN
Plant Capacity: 50 MGD



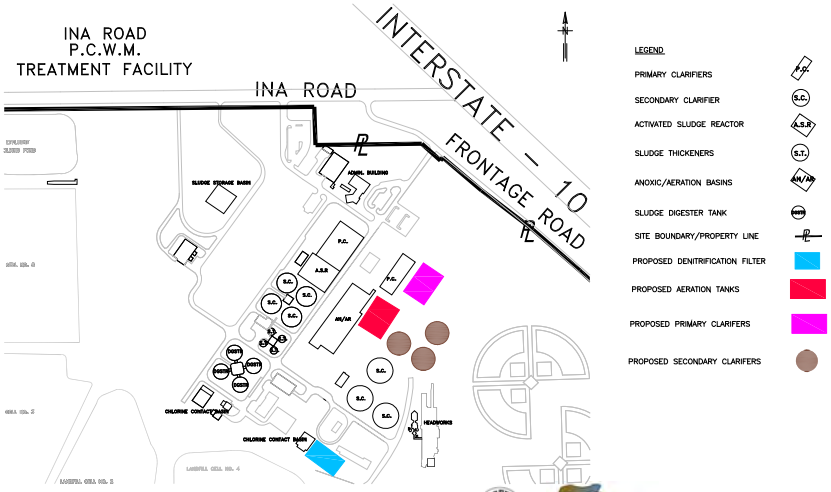
131

Process Type: MLE NdeN
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$38,500
Denitrification Filters	$52,500
Estimated Annual Power Cost	$2,300
Estimated Annual Methanol Cost	$200
Present Worth	$115,500

132

Process Type: MLE NdeN
Plant Capacity: 62 MGD



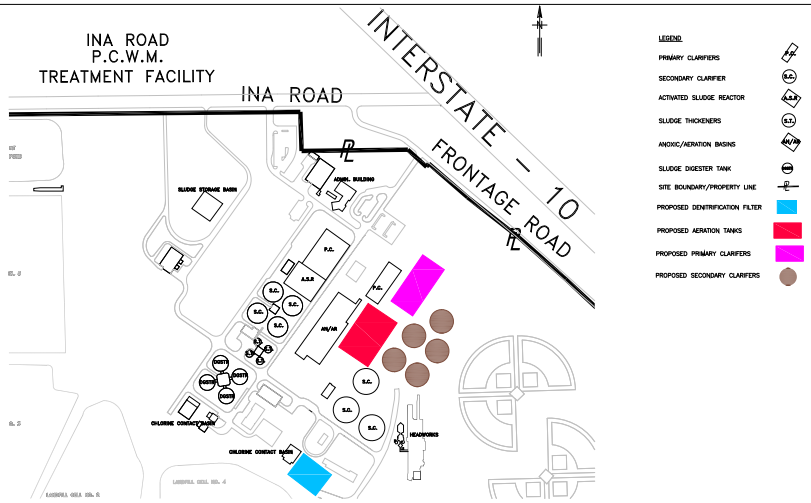
133

Process Type: MLE NdeN
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$59,900
Denitrification Filters	65,100
Estimated Annual Power Cost	$2,900
Estimated Annual Methanol Cost	$200
Present Worth	$155,400

134

Process Type: MLE NdeN
Plant Capacity: 82 MGD



135

Process Type: MLE NdeN
Plant Capacity: 82 MGD

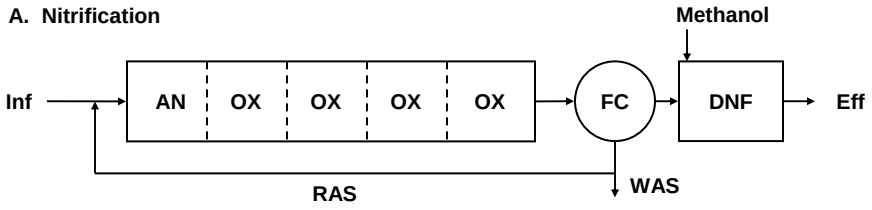
Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$95,600
Denitrification Filters	$86,100
Estimated Annual Power Cost	$3,800
Estimated Annual Methanol Cost	$300
Present Worth	$222,000

136

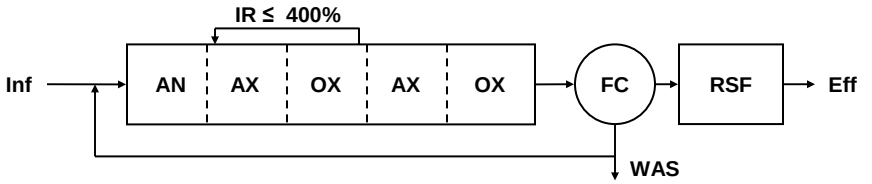
5-Stage Bardenpho

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

A. Nitrification

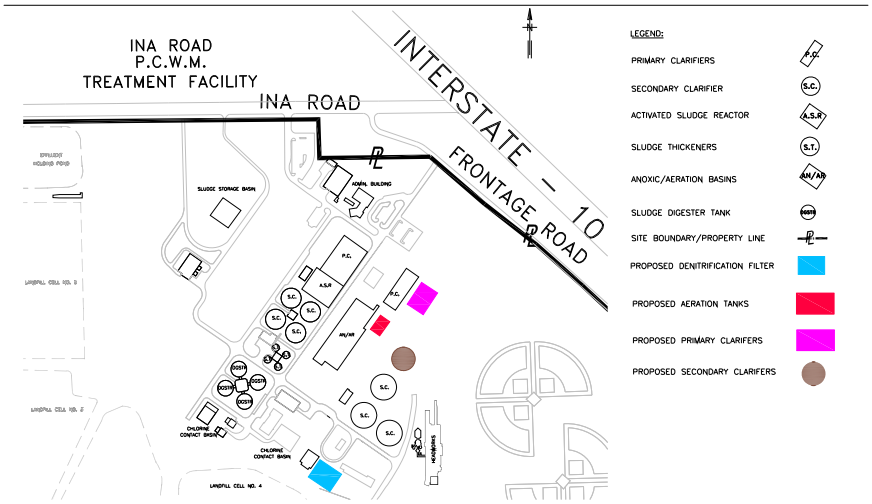


B. Nitrification-Denitrification (NdeN)



137

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 50 MGD



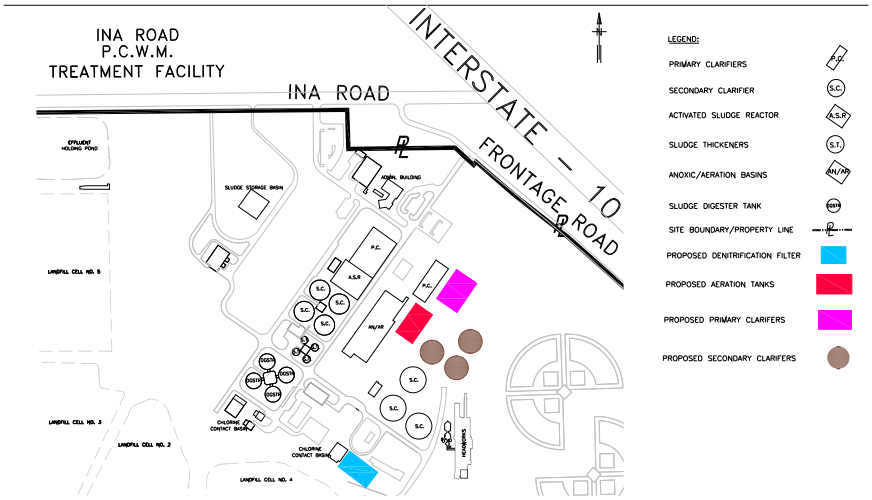
138

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$11,500
Denitrification Filters	$52,500
Estimated Annual Power Cost	$2,500
Estimated Annual Methanol Cost	$1,700
Present Worth	$104,700

139

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 62 MGD



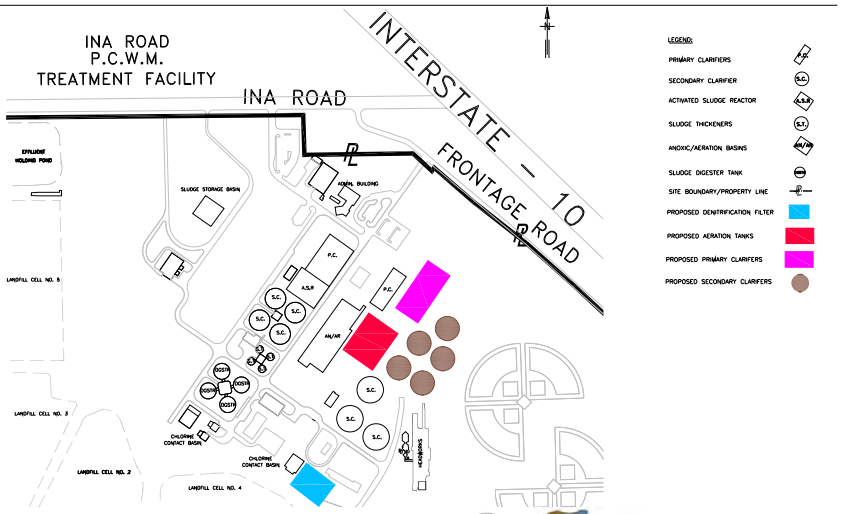
140

Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$27,200
Denitrification Filters	$65,100
Estimated Annual Power Cost	$3,100
Estimated Annual Methanol Cost	$2,000
Present Worth	$142,900

141

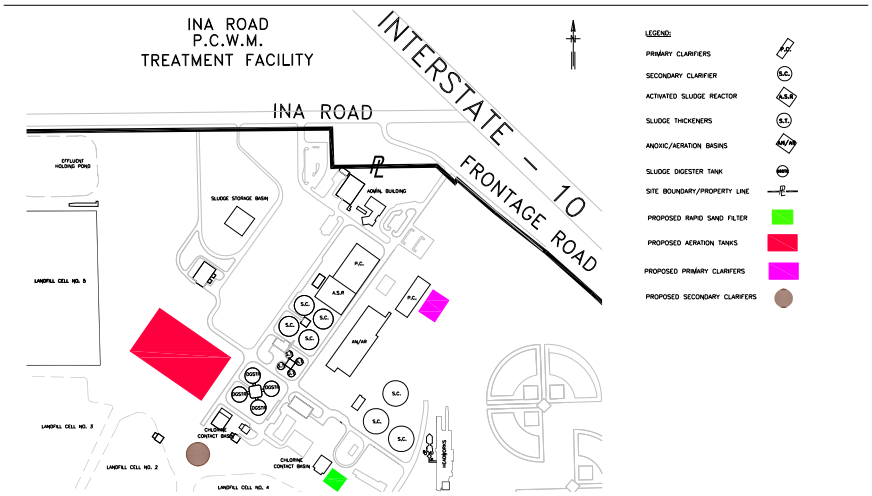
Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 82 MGD



Process Type: 5-Stage Bardenpho Nitrification – Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$69,700
Denitrification Filters	$86,100
Estimated Annual Power Cost	$4,100
Estimated Annual Methanol Cost	$2,700
Present Worth	$222,700

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 50 MGD



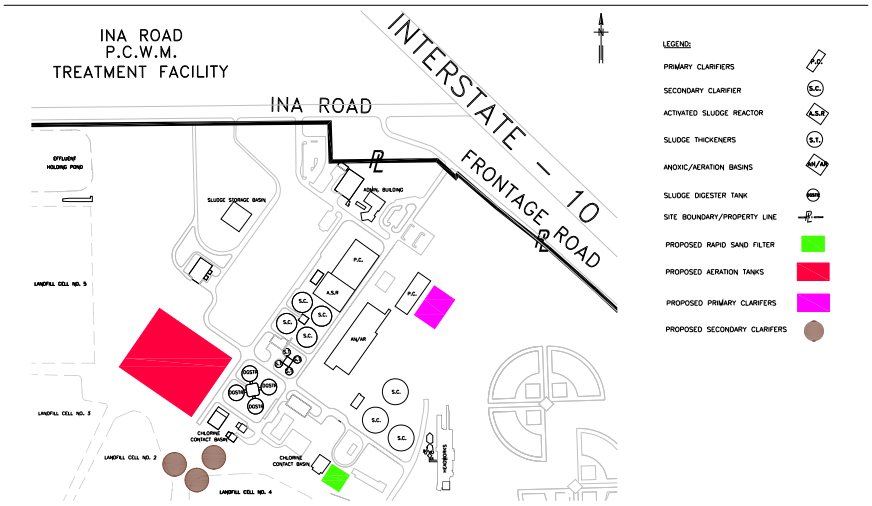
144

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$45,400
Rapid Sand Filters	$20,100
Estimated Annual Power Cost	$2,300
Estimated Annual Methanol Cost	$0
Present Worth	$88,100

145

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 62 MGD



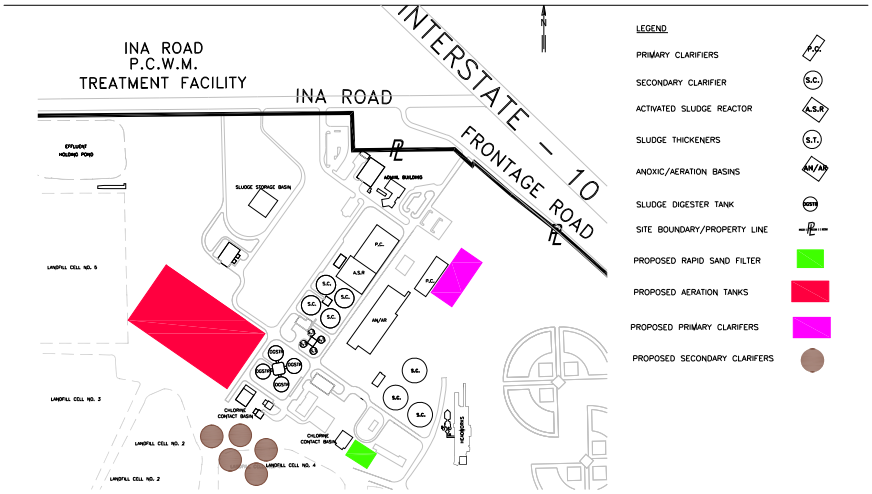
146

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$68,400
Rapid Sand Filters	$25,000
Estimated Annual Power Cost	$2,900
Estimated Annual Methanol Cost	$0
Present Worth	$121,900

147

Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 82 MGD



148

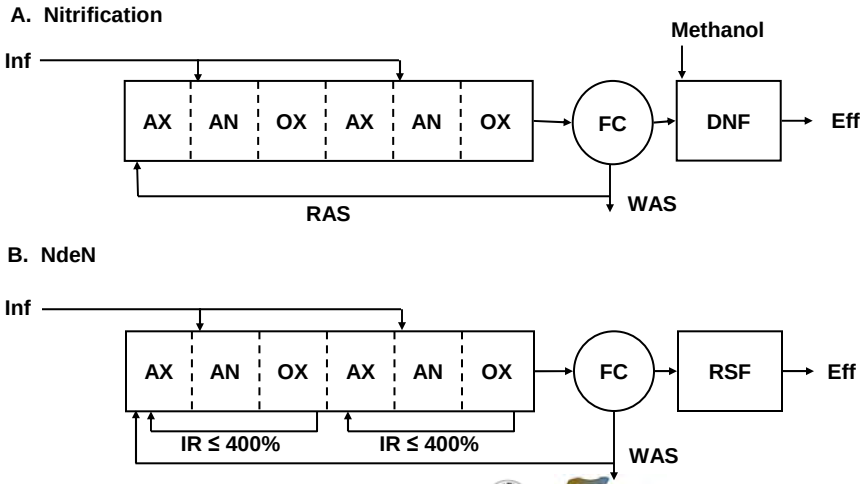
Process Type: 5-Stage Bardenpho NdeN
Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$106,900
Rapid Sand Filters	$33,000
Estimated Annual Power Cost	$3,800
Estimated Annual Methanol Cost	$0
Present Worth	$177,200

149

Step Feed

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter



150

Step Feed

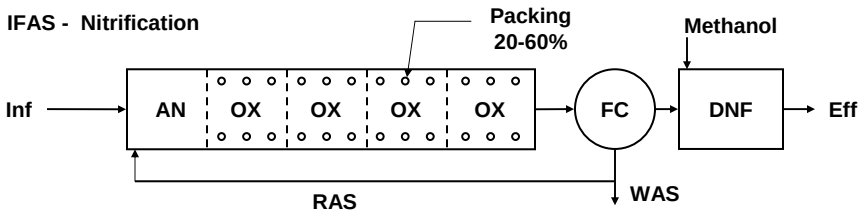
- Step Feed dropped for further consideration:
  - Same reasons as stated for Roger Road WWTP

151

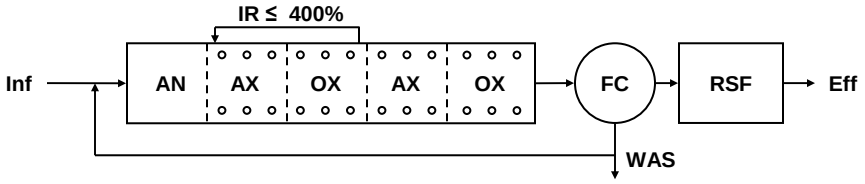
IFAS

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

IFAS - Nitrification

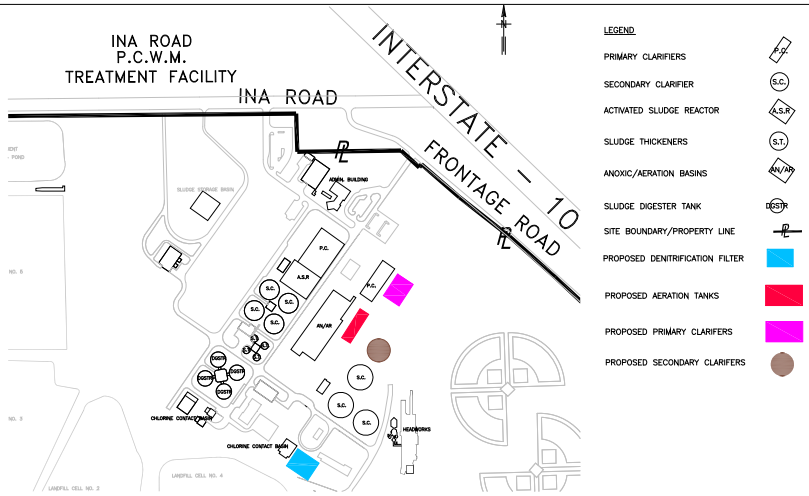


IFAS - NdeN



152

Process Type: IFAS Nitrification
Plant Capacity: 50 MGD



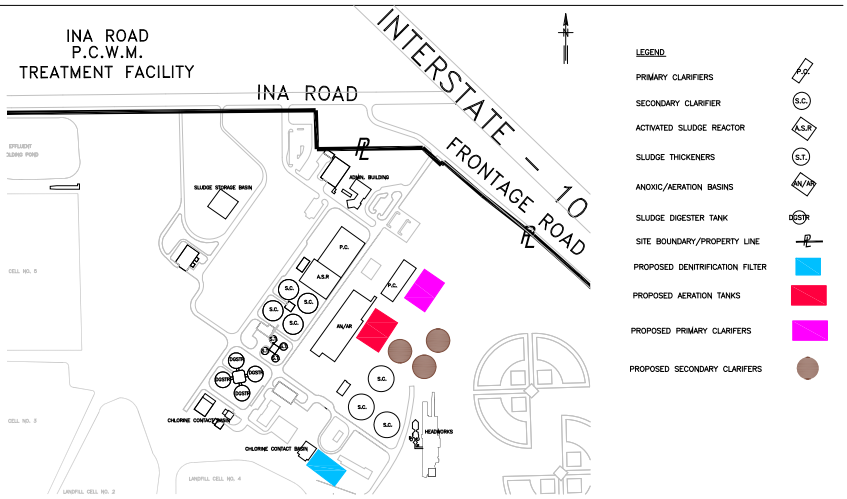
153

Process Type: IFAS Nitrification
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$39,700
Denitrification Filters	$52,500
Estimated Annual Power Cost	$3,900
Estimated Annual Methanol Cost	$1,500
Present Worth	$134,100

154

Process Type: IFAS Nitrification
Plant Capacity: 62 MGD



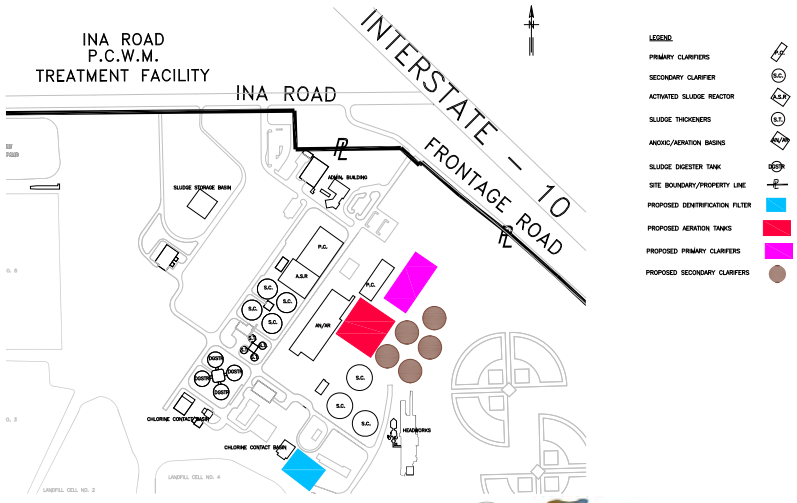
155

Process Type: IFAS Nitrification
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$50,300
Denitrification Filters	$65,100
Estimated Annual Power Cost	$4,800
Estimated Annual Methanol Cost	$1,800
Present Worth	$180,200

156

Process Type: IFAS Nitrification
Plant Capacity: 82 MGD



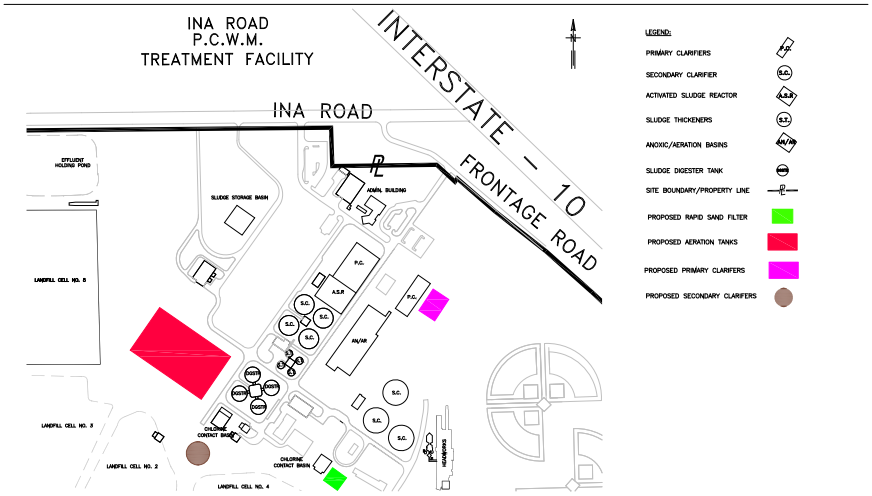
157

Process Type: IFAS Nitrification
Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$91,100
Denitrification Filters	$86,100
Estimated Annual Power Cost	$6,400
Estimated Annual Methanol Cost	$2,400
Present Worth	$263,300

158

Process Type: IFAS NdeN
Plant Capacity: 50 MGD



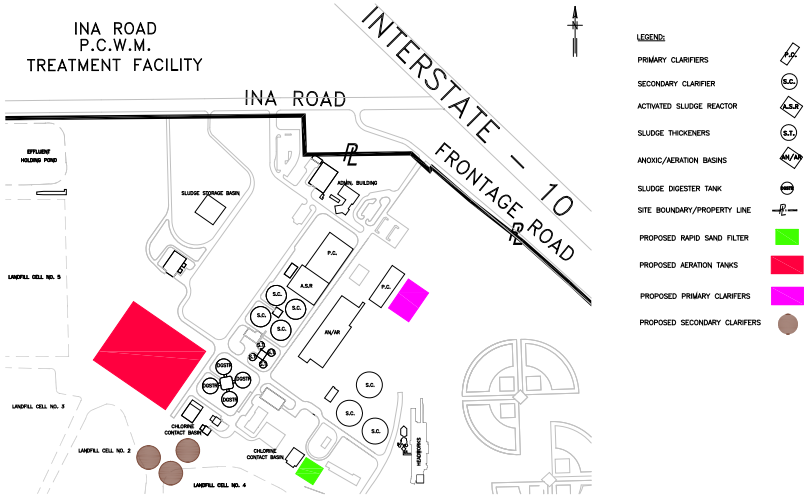
159

Process Type: IFAS NdeN
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$67,400
Rapid Sand Filters	$20,100
Estimated Annual Power Cost	$3,900
Estimated Annual Methanol Cost	$0
Present Worth	$125,800

160

Process Type: IFAS NdeN
Plant Capacity: 62 MGD



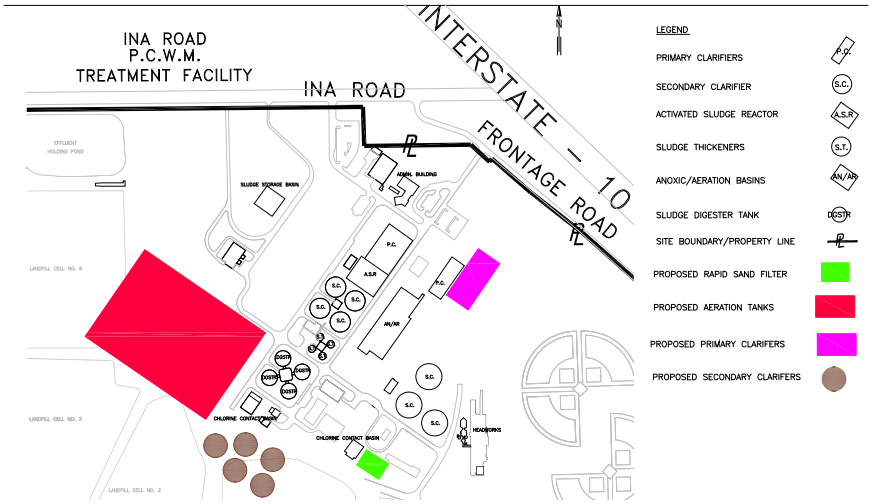
161

Process Type: IFAS NdeN
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$86,800
Rapid Sand Filters	$25,000
Estimated Annual Power Cost	$4,800
Estimated Annual Methanol Cost	$0
Present Worth	$159,900

162

Process Type: IFAS NdeN
Plant Capacity: 82 MGD



163

Process Type: IFAS NdeN
Plant Capacity: 82 MGD

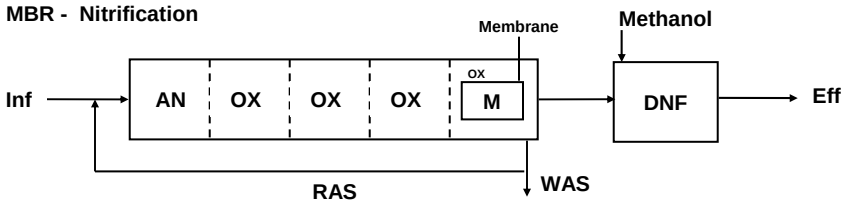
Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$123,300
Rapid Sand Filters	$33,000
Estimated Annual Power Cost	$6,400
Estimated Annual Methanol Cost	$0
Present Worth	$219,100

164

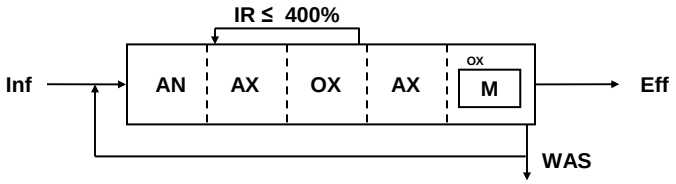
MBR

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

MBR - Nitrification

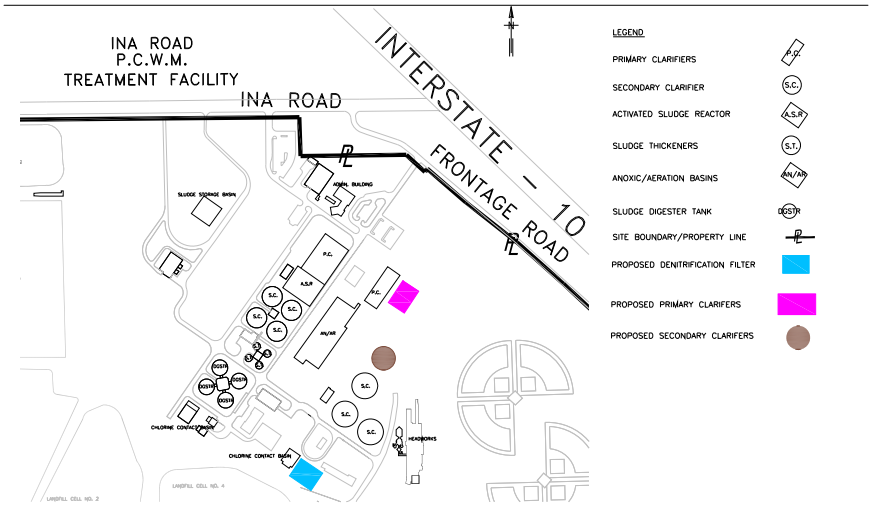


MBR - NdeN



165

Process Type: MBR Nitrification
Plant Capacity: 50 MGD



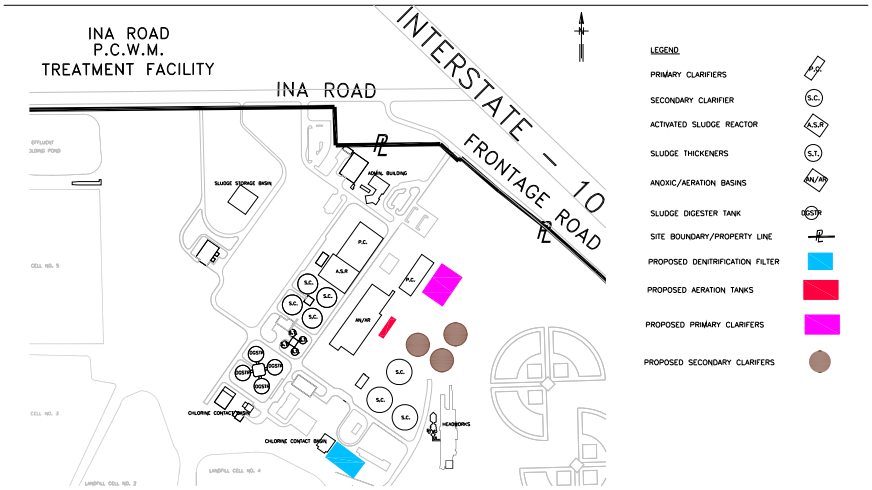
166

Process Type: MBR Nitrification
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks (Addition of Membranes to Existing Aeration Tanks) and Secondary Clarifiers	$188,800
Denitrification Filters	$52,500
Estimated Annual Power Cost	$6,500
Estimated Annual Methanol Cost	$1,200
Present Worth	$317,300

167

Process Type: MBR Nitrification. Plant Capacity: 62 MGD



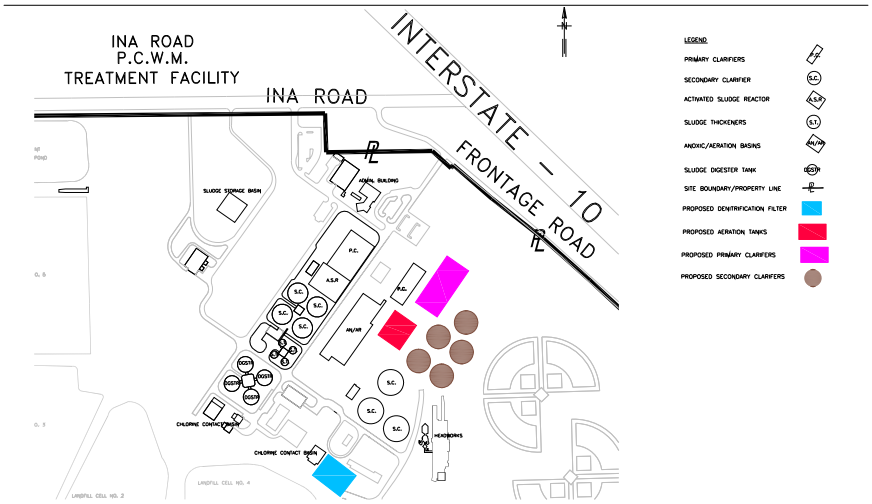
168

Process Type: MBR Nitrification. Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$243,800
Denitrification Filters	$65,100
Estimated Annual Power Cost	$8,000
Estimated Annual Methanol Cost	$1,500
Present Worth	$402,500

169

Process Type: MBR Nitrification. Plant Capacity: 82 MGD



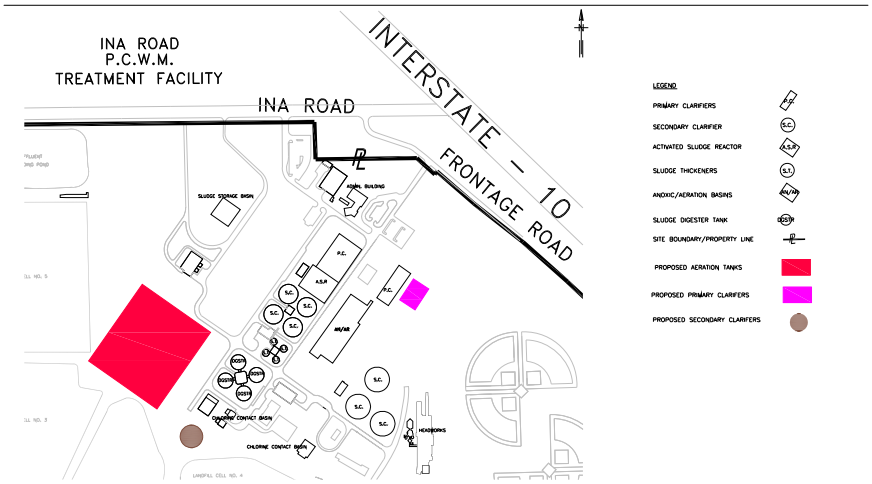
170

Process Type: MBR Nitrification. Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$339,900
Denitrification Filters	$86,100
Estimated Annual Power Cost	$10,600
Estimated Annual Methanol Cost	$2,000
Present Worth	$550,000

171

Process Type: MBR NdeN
Plant Capacity: 50 MGD



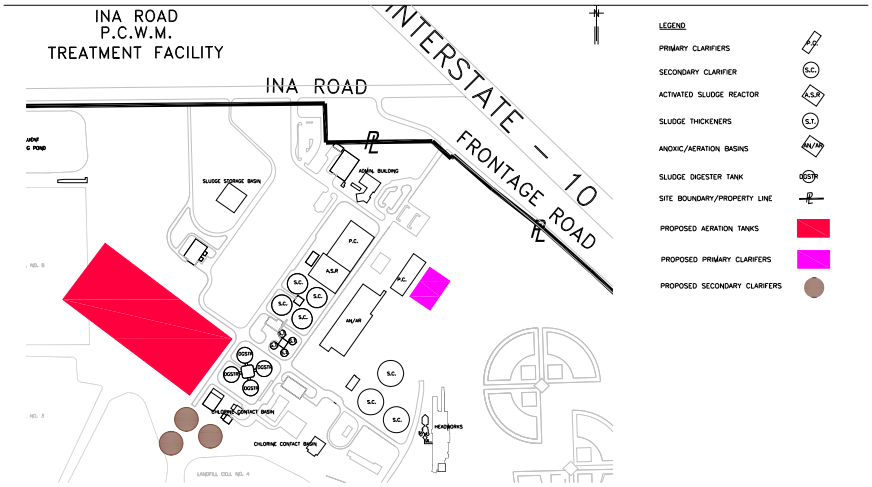
172

Process Type: MBR NdeN
Plant Capacity: 50 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$231,600
Rapid Sand Filters	$0
Estimated Annual Power Cost	$6,500
Estimated Annual Methanol Cost	$0
Present Worth	$305,400

173

Process Type: MBR NdeN
Plant Capacity: 62 MGD



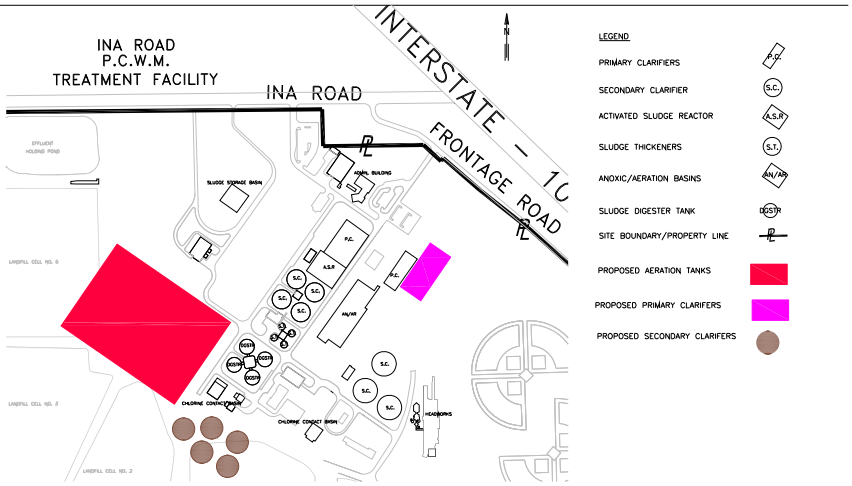
174

Process Type: MBR NdeN
Plant Capacity: 62 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$308,400
Rapid Sand Filters	$0
Estimated Annual Power Cost	$8,000
Estimated Annual Methanol Cost	$0
Present Worth	$386,900

175

Process Type: MBR NdeN
Plant Capacity: 82 MGD



176

Process Type: MBR NdeN
Plant Capacity: 82 MGD

Item	*Cost ($1000's)*
Primary Clarifiers, Aeration Tanks and Secondary Clarifiers	$419,700
Rapid Sand Filters	$0
Estimated Annual Power Cost	$10,600
Estimated Annual Methanol Cost	$0
Present Worth	$523,800

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50-mgd Capacity – Nitrification vs. NdeN

Process	*Nitrification* *Present Worth ($1000's)*	*NdeN* *Present Worth ($1000's)*
MLE	$116,000	$115,500
5-Stage Bardenpho	$104,700	$88,100
IFAS	$134,100	$125,800
MBR	$317,300	$305,400

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62-mgd Capacity – Nitrification vs. NdeN

Process	*Nitrification* *Present Worth ($1000's)*	*NdeN* *Present Worth ($1000's)*
MLE	$156,000	$155,400
5-Stage Bardenpho	$142,900	$121,900
IFAS	$180,200	$159,900
MBR	$402,500	$386,900

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82-mgd Capacity – Nitrification vs. NdeN

Process	*Nitrification* *Present Worth ($1000's)*	*NdeN* *Present Worth ($1000's)*
MLE	$222,700	$222,000
5-Stage Bardenpho	$222,700	$177,200
IFAS	$263,300	$219,100
MBR	$550,000	$523,800

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Present Worth Comparison of Existing Plan, Transfer Some and Transfer All – $1000's

Process *Nitrification*	*Existing* *RR = 32 MGD* *IR = 50 MGD*	*Transfer Some* *RR = 20 MGD* *IR = 62 MGD*	*Transfer All* *RR = 0 MGD* *IR = 82 MGD*
MLE	$181,800	$194,100	$222,700
5-Stage Bardenpho	$172,500	$182,000	$227,900
IFAS	$210,900	$221,800	$263,300
MBR	$519,200	$528,400	$550,000

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Present Worth Comparison of Existing Plan, Transfer Some and Transfer All – $1000's

Process *NdeN*	*Existing* *RR = 32 MGD* *IR = 50 MGD*	*Transfer Some* *RR = 20 MGD* *IR = 62 MGD*	*Transfer All* *RR = 0 MGD* *IR = 82 MGD*
MLE	$183,300	$193,200	$222,000
5-Stage Bardenpho	$139,000	$150,200	$177,200
IFAS	$184,200	$192,900	$219,100
MBR	$498,600	$494,300	$523,800

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Matrix Evaluation

Gordon Culp

Matrix Evaluation

ROGER ROAD	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability	+	0	+	0	+	0	-	-
Proven Process	+	+	+	+	0	0	-	-
Present Worth Cost, Capital + O&M								
Site Compatibility								
Resource Consumption								
Ease of Maintaining Treatment Capacity during Construction								
Recommended Process								

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Matrix Evaluation

INA ROAD	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability	+	0	+	0	+	0	-	-
Proven Process	+	+	+	+	0	0	-	-
Present Worth Cost, Capital + O&M								
Site Compatibility								
Resource Consumption								
Ease of Maintaining Treatment Capacity during Construction								
Recommended Process								

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Matrix Evaluation

ROGER ROAD	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability		0		0		0		-
Proven Process		+		+		0		-
Present Worth Cost, Capital + O&M		-		+		-		-
Site Compatibility		0		0		0		0
Resource Consumption		-		+		+		-
Ease of Maintaining Treatment Capacity during Construction		-		-		-		-
Recommended Process								

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Matrix Evaluation

INA ROAD	*MLE NIT*	*MLE NdeN*	*Bardenpho NIT*	*Bardenpho NdeN*	*IFAS NIT*	*IFAS NdeN*	*MBR NIT*	*MBR NdeN*
Operability		0		0		0		-
Proven Process		+		+		0		-
Present Worth Cost, Capital + O&M		-		+		-		-
Site Compatibility		-		+		+		+
Resource Consumption		-		+		-		-
Ease of Maintaining Treatment Capacity during Construction		+		+		+		+
Recommended Process								

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Summary

Anne Smith

Workshop #7 Meeting Notes
Biosolids

1. The Biosolids Workshop for Pima County Regional Optimization Master Plan was held on July 19, 2006. The workshop agenda is attached. Attendance included:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Jackson Jenkins
Mike Bunch
PCWMD Staff
David Bartos
Tom Berry
James Doyle
Houssam Eljerdi
Dennis Froehlich
Frank Gall
Mary Hamilton
Michael Kostrzewski
Frank Luiz
Jing Luo
Byron McMillan
John Munden
Steve Munsell
Jeff Prevatt
Prakash Rao
Helen Rhudy

PCWMD Staff (cont.)
Bill Richardson
Ron Riska, Project Manager
John Sherlock
Jack Van Riper
John Warner
Ken Weber
TUCSON WATER
Tucson Water Staff
Melodee Loyer
Mark Seamans

PEER GROUP
Gary Newman, B&C
Denny Parker, B&C

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Gordon Culp
Carl Koch
Andy Richardson
Steve Sticklen
Beth Vogt

2. Major topics of the workshop were:

- Workshop #7: Biosolids
  - ► Summary of Previous Studies/Condition Assessment
  - ► Current Biosolids Handling at Roger Road and Ina Road Plants
  - ► Current Disposal Options in Pima County
  - ► Future Disposal Options
  - ► Future Biosolids Handling Issues
  - ► Class A Drivers and Status for Pima County
  - ► Class A Options
  - ► Screening of Class A Options
  - ► Development of Most Likely Class A Alternatives
  - ► Next Steps in Biosolids Analysis

A set of handouts were provided to each attendee of the presentation slides used during the workshop.

Throughout the workshop, notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Andy Richardson provided a few opening remarks and defined his role as the facilitator. The group reviewed the meeting goals and provided additional comments on goals for the workshop. Workshop goals included:

   - Review of biosolids regulatory requirements,
   - Shortlist biosolids alternatives,
   - Consider impacts of biosolids on plant operations,
   - Relate biosolids options to the plant liquid stream options,
   - Discuss timing of Class A conversion, and
   - Discuss biosolids plan for the satellite facilities.

   Agenda, ground rules and objectives/goals of the workshop were presented and covered on pages 1 through 4 of the handout.

4. Beth Vogt identified and summarized previous study results as they relate to biosolids processing and disposal. Discussions on the previous studies included: one gravity belt thickener (GBT) is on order for Roger Road WWTP to increase solids concentration to the digesters, dissolved air flotation thickeners have been returned to service at Roger Road WWTP, Operations is looking at converting Digester 5 at Roger Road WWTP into a primary digester, and Pima County does not have any acreage registered for land application (all land is registered by the private contractor). In addition, Mike Gritzuk indicated that the project team needs to look at making money from Class A biosolids products, if possible.

   Summary of the previous studies were covered on pages 4 through 6 of the handout.

5. Beth Vogt provided a summary of the condition assessments for both Ina Road WPCF and Roger Road WWTP with respect to solids handling facilities. The most significant issue discussed was the unknown structural condition of Digester 3 at Roger Road WWTP. Digester 3 is the oldest digester, from the 1950's, with a flat concrete roof. There are known leaks at the gas box atop the digester. As the digester has not been inspected inside for some time, there is concern about the stability of this digester. The County can not currently take a digester offline for cleaning and maintenance or they will be unable to meet Class B processing requirements.

   John Sherlock indicated that contingency plans have been developed to deal with the unknown condition of Digester 3. They include: addition of the GBT to thicken sludge to the digesters to 5%, conversion of Digester 5 to a primary, or pumping waste activated sludge (WAS) from Roger Road WWTP to Ina Road WPCF for digestion.

Other current sludge processing issues discussed included:

- Only one (20+ year old) bladder at Ina Road WPCF -- no redundancy (John Munden),
- Truck loading facilities need improvements (John Munden),
- Centrifuge facility is marginally capable of handling current sludge quantities (Jackson Jenkins),
- Ina Road WPCF can now produce and pump cake from dewatering, but it is not desirable to the land applicator (land owner wants the water in the sludge),
- By contract the current disposal plan using a private contractor is good for next 8 years
- Pinal County disposal sites are of concern due to potential road damage, and
- County is rebuilding vaults and valving on the sludge transfer line between Roger Road WPCF and Ina Road WPCF.

Review of the condition assessment of the solids handling facilities was covered on pages 6 and 7 of the handout.

6. Beth Vogt presented a summary of the information currently received by the project team on existing biosolids handling at Roger Road WWTP, Ina Road WPCF, and outlying facilities. The project team has requested additional solids processing data from each facility, such as sludge flows. Future sludge quantities were developed for the three system options, as well as, the future outlying facilities. Over time there will be substantially more sludge generated in the outlying facilities.

At this time Randolph Park WRP sludge is processed at Ina Road WPCF. It was noted that current treatment plants are relatively high rate processes that generate more sludge than most nitrification/denitrification facilities. So values used in the screening analysis are high compared to probable future sludge generation. However, competing issues, such as phosphorus removal requiring chemicals will increase sludge quantities. Denny Parker indicated that P removal, if ever required, may be lower than 1.0 mg/L assumed in the process evaluation. The standard may be as low as 0.2 mg/L or 0.1 mg/L. From the discussion it was agreed that for screening purposes, the sludge quantities presented were acceptable.

Frank Gall noted that Avra Valley WWTP sludge goes to Roger Road WWTP not Ina Road WPCF, and currently Corona de Tucson WWTP sludge is thickened and goes directly to landfill. Trucking costs for transporting sludge from the outlying plants are considerable and the County would like this to be addressed in the long term planning of these facilities. Currently, plants of about 1 MGD require 5 to 6 tanker trucks per day and the sludge is transported to the nearest manhole, which may be 20 miles away. Also, there is no overall biosolids handling strategy in place for the outlying areas, although Dennis Froehlich indicated that one is underway. Mike Gritzuk asked how the solids at the Tucson Water Sweetwater wetland facilities were handled. Residual solids are periodically dredged and dispose of in a landfill.

It was suggested that at a minimum that each of the outlying areas have the capacity to dewater and haul. In all cases, centrate recycle and tanker truck discharges of sludge must be considered as an impact for alternative(s) selected for the plan.

The existing biosolids handling operations were summarized on pages 8 through 10 of the handout.

7. Beth Vogt summarized current disposal options available to the County. Most sludge is taken to land application at about 2% to 3% solids. Land owners like the water content of the sludge. There is one owner of the majority, if not all, of the land available for sludge disposal. Currently the haul distance is less than 25 miles, but as growth continues, hauls to Pinal County and elsewhere will require a haul distance of approximately 40 miles over the next 5 years. Paul Bennett indicated that landfilling is available, but the currently utilized landfill (Tangerine) is going to close soon and the remaining landfill is owned by the County, which is farther away. Landfilling should continue to be a backup option, as having a multiple outlet approach for sludge disposal is essential.

   Green Valley WWTP sludge is dried and hauled for mine reclamation through the University of Arizona demonstration project. Frank Gall believes that the Green Valley WWTP demonstration program is good for 5 to 10 years. Mine disposal is a good option for the mines will continue with closure mitigation programs, but most likely will not be a stable enough market for all sludge generated at the County wastewater facilities.

   Future Class A disposal options include all of the existing disposal outlets plus non-traditional markets such as, landscapers, golf courses, DOT, forest fire reclamation areas and direct sales to customers depending on the type of end-product. All non-traditional markets require a market analysis prior to investing in a process to support them. A step-by-step approach would be required to enter into these other markets. Each analysis will need to consider the labor required to handle the solids for these other market products.

   John Warner asked if co-generation with sludge, as a fuel source, is viable. It was noted that co-generation has been considered elsewhere (Baltimore, MD and Stamford, CT), but high solids concentration (80% to 90% solids) is required. It was further noted by Houssam Eljerdi that Arizona prohibits incineration.

   Current and future potential biosolids disposal options were covered on pages 10 through 12 of the handout.

8. Carl Koch presented information on future biosolids handling issues to be considered in the master plan. These include:

   - Class A anaerobic digester conversion and future status of anaerobic digestion as Class A,
   - Central processing of solids versus continued processing at each plant (Roger Road WWTP and Ina Road WPCF), and
   - Contract processing of biosolids.

   Producing Class B biosolids advantages are less expensive operations, simpler to operate and is consistent with the County's current disposal method. Class A biosolids has less restrictive management and monitoring requirements, lower odor potential from the biosolids, and is perceived by the public to be superior. Thus, Class A may open up more disposal options.

Centralizing processing provides economy of scale and consolidates labor. On the other hand, centralizing facilities will concentrate and increase recycle loads on the wastewater treatment at that location.

Contract processing is a current trend with utilities, particularly with providing dry Class A products. In these applications the digester gas is used as a fuel to dry the sludge. It is important to realize that contract operations do not completely transfer the responsibility for the biosolids disposal to others.

Major Class A drivers for Pima County seem more likely to be public/political or from involvement with public through EMS program than regulatory driven. Paul Bennett indicated that Pima County has applied to be part of the EMS program. There was discussion on whether this would drive the County to Class A. The group discussed that a move toward Class A makes sense for them.

Future biosolids issues and Class A drivers were covered on pages 12 through 16 of the handout.

9. Carl Koch presented descriptions of major Class A processes: digestion, alkaline stabilization, composting, heat drying, and advanced air drying. An example from each process category of an alternative considered appropriate for the County was outlined. Advantages and disadvantages of the alternatives were provided along with a qualitative cost comparison. This information was utilized in the screening of Class A options that followed.

Major issues and concerns of the options included the following. There was a desire by the County for an analysis of the Cambi process, a predigestion thermohydrolysis process. The County has a proposal for the Cambi process that will be forwarded to the project team. The methane gas from anaerobic digestion could be used in heat drying or Cambi. Dennis Froehlich asked if there was any advantage to the separation of sludges prior to processing. Gary Newman indicated that products from heat drying have less odor if the sludge is first digested.

It was noted that anaerobic digestion may not be a good fit for outlying facilities since they employ extended aeration treatment systems and the volatile solids content of the sludge is partially destroyed.

John Sherlock suggested that disposal of the alkaline stabilized biosolids is not viable in Arizona as the soils are alkaline and there is no market for land application of the product.

It was suggested that flow-through thermophilic digestion should be considered for the advanced digestion process. It was noted that this process would require process review and data to be provided to prove Class A compliance.

It is currently unclear how much of a market there will be for a dry product. Land applicators like the water in the biosolids. A market assessment study would be required before this would be implemented in the County.

A proposal for accelerated air drying has been provided to the County for the Green Valley WWTP. Two structures would be required to process the sludge to Class A. The County will provide the project team with a copy of the proposal.

It was noted that Marana does not allow composting. This has a direct impact on Ina Road WPCF which is in Marana.

Dennis Froehlich asked about separating the primary and waste activated sludge and using aerobic digestion. This has been done elsewhere with mixed success. Tampa, Florida, had applied aerobic digestion to its waste activated sludge but discontinued it because of high operating costs and the achievement of less than 40% volatile suspended solids (VSS) destruction. Primary sludge was anaerobically digested. Eventually Tampa converted their aerobic digesters to anaerobic to produce more methane for electrical power generation.

It was agreed that the County is committed to anaerobic digestion for the Ina Road WPCF and Roger Road WWTP sludges as a part of any Class A alternative.

Class A biosolids alternatives were covered on pages 17 through 23 of the handout.

10. Gordon Culp led the group through a screening of Class A options. Each criterion for the screening was defined. It was suggested that a criterion for the acceptability of the final product to the public should be added. An evaluation matrix for the alternatives which was filled in by the project team prior to the workshop was presented. Through discussion with the group some of the -, 0, and + values were modified. Results of the screening evaluation matrix analysis follow.

Matrix Evaluation

	Stages Anaerobic Digestion	*Alkaline Stabilization*	*Composting*	*Heat Drying*	*Advanced Air Drying*
Operability	+	–	–	–	0
Proven Process	+	+	+	+	–
Present Worth Cost, Capital + O&M	+	0	–	–	–
Marketability	–	–	+	+	–
Resource Consumption	+	–	–	–	+
Ease of Maintaining Treatment Capacity during Construction	0	+	0	+	0
Recycle Impacts	0	0	0	0	0
Recommended Process					

The screening evaluation for biosolids handling at Roger Road WWTP and Ina Road WPCF eliminated alkaline stabilization, composting and advanced air drying. The remaining options for Ina Road WPCF and Roger Road WWTP sludges were: anaerobic digestion (phased or flow through), Cambi, and heat drying. Other processes, such as advanced air drying and composting, may be appropriate for some of the outlying facilities.

The evaluation criteria and screening matrix analysis were covered on pages 24 through 27 of the handout.

11. Beth Vogt discussed development of the most likely biosolids handling options. Staying with Class B (mesophilic digestion) land application is the most cost effective approach (while land is available) and should continue until public/political/regulatory pressure requires otherwise.

    Layouts for staged anaerobic digestion facilities for both Ina Road WPCF and Roger Road WWTP facilities to achieve Class A were presented to show space requirements. In addition, a layout of heat drying facilities with sludge digestion at Ina Road WPCF was shown for space requirements.

    It was noted that Tucson Water needs 10 acres at Ina Road WPCF for their future use.

    Other biosolids processing issues for consideration include: recycle streams, odors, and methane utilization.

    The most likely biosolids treatment layouts and other issues of concern were covered on pages 28 through 33 of the handout.

12. Andy Richardson wrapped up the workshop by summarizing the next steps. These include: defining intermediate processing requirements for alternatives, coordinating biosolids layouts with liquid processes, determining recycle load processing requirements and adjusting influents for recycle loads for the options.

Agenda
Workshop #7 – Biosolids
July 19, 2006

Time	Topic	Presenter
8:00 am	*Continental Breakfast – Pima County Parks and Recreation Facility* *3500 West River Road, Tucson, AZ*	
8:15 am	Opening Session • Welcoming Remarks • Review Agenda • Workshop Goals	 Mike Gritzuk Andy Richardson
8:30 am	Previous Biosolids Studies	Beth Vogt
8:45 am	Biosolids Handling at Roger Road WWTP and Ina Road WPCF • Digestion • Solids Handling • Methane Handling/Use • Odors	Beth Vogt
9:15 am	Current Disposal Options in Pima County	Beth Vogt
9:30 am	Future Biosolids Handling Issues	Carl Koch
9:45 am	Class A Drivers and Status for Pima County	Carl Koch
10:00 am	Break	
10:15 am	Class A Options	Carl Koch
10:45 am	Screening of Class A Options	Gordon Culp
11:15 am	Development of Most Likely Class A Alternative(s)	Beth Vogt
11:30 am	Other Issues	Beth Vogt
1145 am	Summary Wrap-Up • Comments by Group • Closing Remarks	Andy Richardson Mike Gritzuk
12:15 pm	Adjourn / Lunch	

Flip Chart Notes – July 19, 2006

Objectives

- Are we sure we need to go to Class A?
- Is there money to be made by selling a Class A product?
- Disposal of screenings and grit was not considered for this workshop.
- Status of private solids disposal contractor
- What are Class A disposal options
- Land registration for biosolids disposal only in Contractor's name?
- Continue with land applications
- Have we overlooked "co-generation"?

Previous Studies

- Precipitation of struvite will impact sludge quantities
- They are looking at conversion of Digester 5 to a primary digester at Roger Road
- Pumping to Ina from Roger Road is 200,000 gal/day at 2100 mg/L
- Structural condition of Digester 3 is ?; grout joint at gas box leaking
- Cannot take digester off line at Roger Road
- Improving pumping system from bladder that loads trucks – change out pumps – bladder is an Air Force fuel tank surplus - 25 years old.
- Ina Road only has one bladder
- Gravity belt thickener on order
- CIP project awarded for sludge force main rehab of valves and structures
- Contractor not able to handle cake (only liquid) from Ina Road
- One Schwing pump at Ina Road to pump cake
- Ina Road – 8 percent sludge able to be pumped, have pumped up to 24 percent with Schwing pump
- Loading facility needs improvements
- Ina Road centrifuge system marginal; needs upgrade
- Get copy of material on Class A evaluation
- Acceptability of land application in future is ?
- Beholding to only one guy; some land used for disposal is in Pinal County. Concern of the future possibility to dispose.

Biosolids Handling

- Make sure we consider ***centrate*** handling as we determine biosolids solutions
- Piloting of high anaerobic process – look at energy generation
- Roger Road volatile solids destruction is 65 percent
- Corona is like Avra Valley outlying areas
- Avra Valley biosolids goes to Roger Road
- Green Valley and look at capacity

- Outlying facilities achieve Class A on site to avoid hauling
- Regional site to handle, compost
- Need step-by-step approach; leading indicators

Current Disposal Options

- What is the regional plan on solid waste?
- Tangerine landfill is going to close – current landfill site for sludge
- Remaining landfill is County owned which is farther away
- Forest fire burn area reclamation
- What other options are available?
- Is there a contract anywhere in nation to develop biosolids as an alternative fuel source?

Class A Options

- Not sure alkaline stabilization is good for this location; existing alkaline soils
- Add Cambi Process to the alternatives
- Consider primary vs. secondary sludge handling separately
- Heat drying may need digestion to improve product results
- Is there a market in Arizona for a "dry" product?
- Accelerated air drying – may be good for a transition process – Pima County has had some experience and success
- Staged as opposed to batch digestion options

Evaluation Criteria

- Include public acceptance – of both product and facility
- Get biosolids study from Houssam
- O&M cost on hauling is major consideration
- Alkaline stabilization is out
- Continue to digest – has an impact on recycle
- Need to consider what is the long-term Class "B" program; projected farm land availability
- On heat drying and air drying, what are the air quality issues?
- Do not want to be hauling limited
- Need to get agreement on design assumptions

Shortlist

- Staged anaerobic digestion
- Cambi process
- Heat drying
- Continue to look at Class B – what factors would require change

Pima County
Regional Optimization
Master Plan

Workshop #7
Biosolids

July 19, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Beth Vogt	Biosolids Handling
Carl Koch	Biosolids Handling Options
Gordon Culp	Alternative Technologies Evaluation

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop objectives
- Summary of biosolids studies
- Existing facilities
- Future disposal options
- Evaluation of alternatives
- Timing of Class A

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Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

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Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

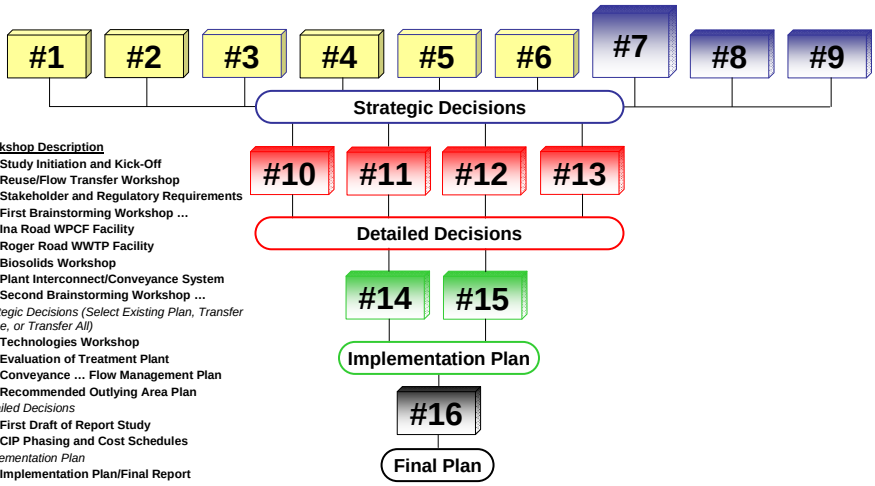
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop Objectives

- Review biosolids regulatory requirements
- Review biosolids state-of-the-art technologies/operation considerations
- Shortlist biosolids alternatives
- Impacts of biosolids on plant operations
- Relate biosolids options to transfer options
- Timing of Class A conversion
- Biosolids plan for satellite facilities

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Previous Biosolids Studies

Beth Vogt

Summary of Previous Studies

- 2002 biosolids management system evaluation
- 2005 facility plan update
- 2006 Roger Road thickening facility PDR
- 2006 Roger Road digester contingency planning

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Previous Study Conclusions

- 2002 biosolids management system evaluation
  - Cavitation issues with Roger Road transfer pumps during line flushing
  - Possible corrosion issues in transfer forcemain
  - Ina Road centrifuge maintenance schedule issues
  - Inability to pump 20-30% cake from centrifuge building
  - Centrate line struvite build up
  - Significant sludge storage and transfer station problems

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Previous Study Conclusions

- 2005 facility plan update
  - Process all solids at Ina Road (decommission Roger Road digesters as sludge storage)
  - Add digester capacity at Ina Road and upgrade digesters to be able to produce Class A
  - Upgrade Ina Road dewatering facilities to produce higher % solids
  - Upgrade Ina Road treatment process to handle additional centrate (if necessary)
  - Upgrade Ina Road co-generation facilities to handle increased gas

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Previous Study Conclusions

- 2006 Roger Road thickening facility PDR
  - Separate WAS thickening in GBTs
  - 2, 3.0 meter, covered GBTs
  - Operating at 1,200 gpm each
  - Thickened WAS: 5.5-6.0% solids

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Previous Study Conclusions

- 2006 Roger Road digester contingency planning
  - Sludge production is increasing
  - If GBT is operating for total sludge = 5% to digesters, 3 digesters would provide 15 day HRT
  - Pump some WAS from Roger Road to Ina Road for digestion
  - Truck thickened sludge from Roger Road to Ina Road for digestion (up to 30%)
  - Modify Digester 5 as secondary or primary

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Summary of Condition Assessment – Roger Road

- Gravity thickeners
  - Possible structural stability issues
  - Corrosion issues
- Digesters
  - No. 3 roof leakage
  - Unknown condition inside all digesters
  - Likely solids deposition reducing active volume
  - No. 6 mixing maintenance issues

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Summary of Condition Assessment – Roger Road

- Sludge transfer station/forcemain
  - Cavitation issues with pumps during line flushing
  - Possible corrosion issues in forcemain
  - Single element – no redundancy

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Summary of Condition Assessment – Ina Road

- Thickeners
  - Wear on support facilities (corrosion)
- Digesters – no major issues
- Thickening/dewatering facility
  - Centrate return capacity and struvite build up issues
  - Lack of sludge cake pumping equipment
  - Odors
- Sludge storage
  - Aging and inadequate storage

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Summary of Condition Assessment – Ina Road

- Sludge transfer facilities
  - Odor issues
  - Electrical system issues
  - Safety issues

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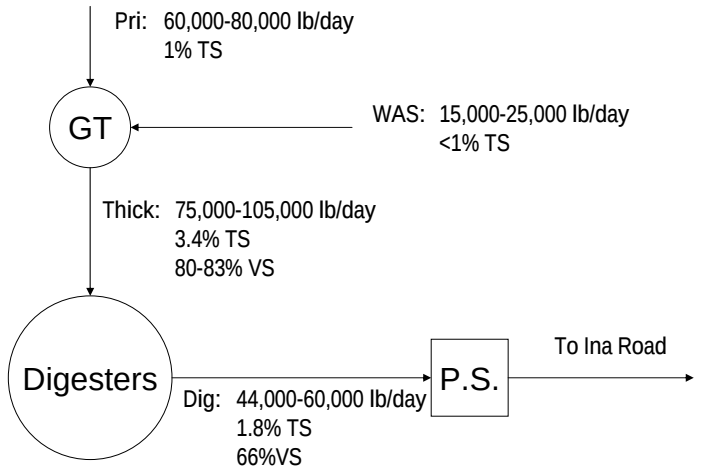
Biosolids Handling at Roger Road WWTP and Ina Road WPCF

Beth Vogt

Current Biosolids Handling – Roger Road (Infl. Flow = 38.3 mgd)



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Current Biosolids Handling – Roger Road (Infl. Flow = 38.3 mgd)

- Data yields:
  - Raw: 2000-2700 lbs/day/mgd
  - Digested: 1150-1600 lbs/day/mgd
- Will be impacted by future methanol and possible phosphorus removal
- For screening assessment use: 2800 lbs/day/mgd raw sludge and 1700 lb/day/digested

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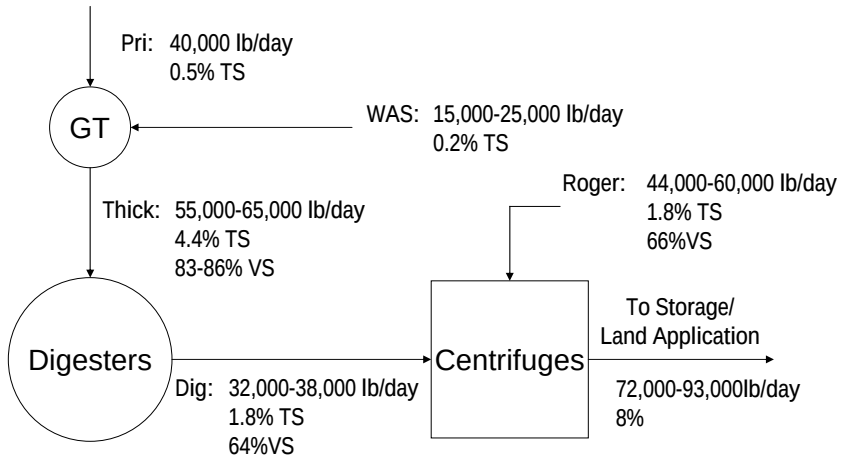
Current Biosolids Handling – Ina Road (Infl. Flow 23.4 = mgd)



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Current Biosolids Handling – Ina Road (Infl. Flow = 23.4 mgd)

- Data yields:
  - Raw: 2300-2800 lbs/day/mgd
  - Digested: 1400-1600 lbs/day/mgd
- Will be impacted by future methanol and possible phosphorus removal
- For screening assessment use: 2800 lbs/day/mgd raw sludge and 1700 lb/day/digested

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Sludge Quantities for Screening

Alternative	*Roger Road Sludge*	*Ina Road Sludge*
1 – Roger 32 mgd Ina 50 mgd	Raw: 90,000 lb/day Dig: 55,000 lb/day @2% = 330,000 gpd	Raw: 140,000 lb/day Dig: 85,000 lb/day @2% = 510,000 gpd
2 – Roger 20 mgd Ina 62 mgd	Raw: 56,000 lb/day Dig: 34,000 lb/day @2% = 204,000 gpd	Raw: 174,000 lb/day Dig: 105,000 lb/day @2% = 630,000 gpd
3 – Roger 0 mgd Ina 82 mgd	Raw: 0 lb/day Dig: 0 lb/day	Raw: 230,000 lb/day Dig: 140,000 lb/day @2% = 840,000 gpd

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Outlying Facilities Biosolids

Location	*Current, tpd(1)*	*Future, tpd(1)*	*Processing, Disposal*
Marana	0.28	6.16	storage, hauled ⇒ Ina
Rillito Vista	0.014	0.00	---
Avra Valley	2.2	4.13	storage, hauled ⇒ Ina
Green Valley	5.7	8.5	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction	0.09	0.000	---
Corona de Tucson	0.16	3.7	Evaporation
Pima Co. Fairgrounds	0.004	0.004	Evaporation
Mt. Lemmon	0.018	0.018	storage, hauled ⇒ Ina
Southlands	0.0	19.2	None
Total	8.466	41.712	

(1) Based on 2,800 dry lb/d raw biosolids produced/mgd flow treated

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Outlying Facilities Impacts

- Total future outlying plant sludge = 40 ton/day dry
- Future Roger and Ina Road = 115 ton/day dry
- Outlying plant sludge = 26% future total production
- Must be considered in sizing Ina and Roger biosolids handling facilities if continuing with current approach

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Current Disposal Options in Pima County

Beth Vogt

Current Disposal Options

- Land application
  - Digested Class B, liquid (8%)
  - < 25 miles round trip now, expecting 40 miles in the future
- Landfill
  - Need higher % solids, dewatering to 12-15%
  - No stabilization required
  - No methane gas for energy if digesters unused
  - Landfill space is available in Arizona
  - Could be a short-term backup plan

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Current Disposal Options

- Mine tailings
  - Green Valley/University of Arizona project
  - Requires dewatered/dried product
  - Availability depends on market conditions/may not be stable enough as primary outlet

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Future Disposal Options

- All of the existing options
- If Class A:
  - Sale as natural fertilizer
  - DOT
  - Golf courses
  - Landscaping
- All non-traditional options will require market analysis
  - Could be DBO for Class A disposal

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Future Biosolids Handling Issues

Carl Koch

Future Biosolids Handling Issues

- Class A conversion
- Anaerobic digestion
- Central processing versus each plant treats its own
- Contract handling

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Why Continue with Class B?

- Less expensive
- Simpler to operate
- Satisfies EPA regulations
  - Acceptable risk
- Consistent with current market conditions

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Why Consider Class A Process?

- Less restrictive management and monitoring requirements
- Lower level of pathogens
- Lower odor potential
- Perceived superior product
- More utilization options
- Public pressure

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Class A Drivers and Status for Pima County

Carl Koch

Class A Pressures

- Public reaction
- Political pressures
- Regulatory pressure
- National biosolids partnership EMS program

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National Biosolids Partnership

- Advance environmentally sound and accepted management practices
- Comprehensive environmental management system (EMS)
- Demonstration of commitment to community
- Involving community in defining performance improvements

40

National Biosolids Partnership

- Pima County committed to EMS certification
- NBP goals to be considered in Master Plan Biosolids Assessment
- Community involvement from NBP goals – could be the trigger/gage for Class A timing?

41

Recycle Streams

- Ammonia-laden recycle can impact plant treatment
- Particularly an issue in plants that handle biosolids from other facilities (imbalance of recycle to influent, increased % of load)
- If recycle stream part of selected biosolids alternative – must evaluate
  - Handle in main plant process
  - Provide flow equalization prior to return to main process
  - Sidestream treatment process

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Odor Issues

- Significant complaints at Roger Road
- Increasing complaints at Ina Road as neighbors get closer
- Outlying Green Valley facility experiencing continued growth closing in on site
- General interest in “good neighbor” practices
- Odor control project to address current needs
- Odor generation considered with biosolids alternatives

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Methane Gas Utilization

- Not currently used at Roger Road
- Currently used at Ina Road
- Some options would eliminate methane gas
- Is gas utilization cost effective?
- Is gas utilization a “green” procedure important to continue whether or not cost effective?
- Will siloxanes become a maintenance issue that make methane use less desirable?

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Digestion Issue - WERF Fecal Coliform Re-Growth Research

- Digestion followed by centrifuges
- Evidence of re-growth after dewatering (several orders of magnitude)
- More pronounced with Class A
- Confirmed with DNA testing
- Possible explanations
  - Digestion inhibits culturing/hibernation (VBNC)
  - Centrifuge Shear creates growth medium
- More research needed?
- Could affect future certification of digestion as Class A process

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Central versus Individual Plant Processing

- Centralization consolidates processing/ economy of scale
- Centralization concentrates recycle streams
- Centralization makes sense for outlying plant
- Requires transport of solids from Roger Road to Ina Road

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Contract Processing

- Current trend to let other handle biosolids
- Places responsibility in specialized hands
- Results in reliance on other and loss of control
- Does not completely transfer responsibility

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Class A Options

Carl Koch

Major Types of Class A Processes

- Digestion
- Alkaline stabilization
- Composting
- Heat drying
- Advanced air drying

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Digestion Prescreening

- Thermophilc aerobic
- Thermophilc anaerobic
- Phased anaerobic digestion

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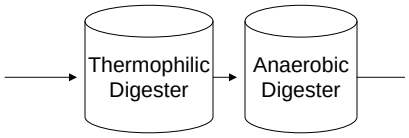
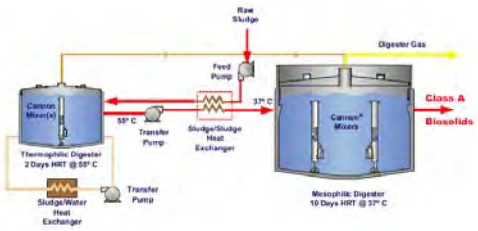
Staged Thermophilc Digestion

- Produce Class A Product
- Gas Production





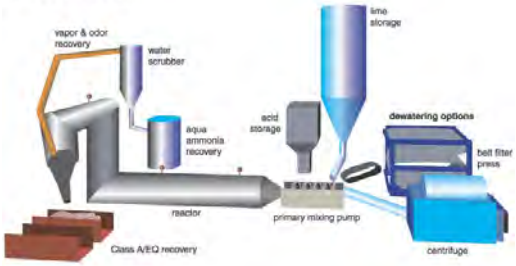
Alkaline Stabilization

Process	*Additive*	*Source of Heat*	*Number Installations*
N – Viro	Lime/Kiln Dust	Hydration	> 50
Biofix	Lime	Hydration	<10
Leopold	Lime	Hydration	<10
Envessel	Lime	Hydration + Electric	<10
Chemfix	Lime/Cement Silicate	Hydration	<10
Bioset	Lime/Acid	Hydration/Acid Reaction	<5

Bioset

- Requires dewatering to >15%
- Does not require digestion
- Portable/compact
- Acid + lime stabilization
- Class A granular product

Bioset Process



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Types of Composting Systems

- Windrow
- Extended pile
- In-vessel

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Silo In-Vessel (Taulman)

- Requires dewatering to >15%
- Does not require digestion
- Quality product
- Requires bulking agent
- Significant material handling

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Types of Heat Drying Systems

- Direct – sludge in immediate contact with drying fluid
- In-Direct – uses intermediate exchange surface
- Direct/In-Direct combination

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In-Direct Dryers

- Typically use oil or steam as transfer media
- Screw/paddle dryers
  - Stortz-Bartz
  - Komline Sanderson
  - Bethlehem
  - Fenton
- Katy-Seghers (multiple hearth trays)
- U.S. Filter
- Carver-Greenfield (multiple effect evaporation)

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Direct Dryers

- Flash dryers (CE Reynolds)
- Fluid bed dryers (Sulzer Escher Wyss)
- Ball mill dryers
- Rotary drum dryers
  - Largest number of installations

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Rotary Drum Dryers

- Has evolved as the most prominent technology
  - Can form pellets in the process
  - Largest number of US installations (large installations)
  - Largest number of foreign installations
  - Enclosed/controlled emissions
  - Relatively simple technology/system suppliers
  - Has evolved from once through to recirculating gas to save energy

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Rotary Dryers

- Synagro (Acquired Enviro-Gro)
- Andritz
- New England Fertilizer (Baker Rullman)
- Vandenbrock
- Swiss-Combi (Berlie)
- MEC/FEECO
- BER/Harmony (commercial fertilizer manufacturer)

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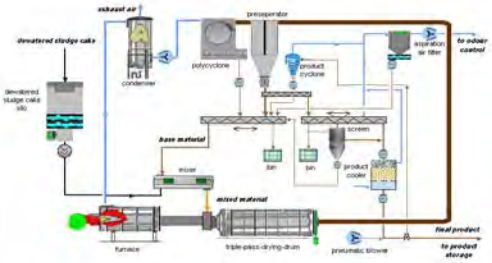
Heat Drying

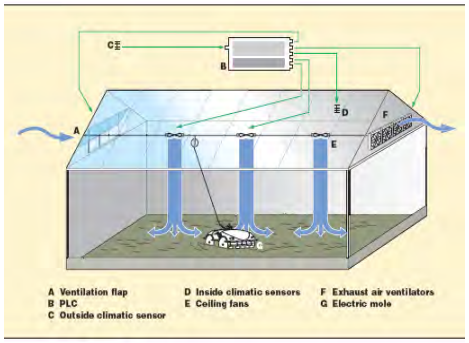
- Produce Class A product
- 90% solids
- Requires dewatering to >15%
- Does not require digestion



61

Accelerated Air Drying

- Enclosed solar drying
- Robot turning machine speeds up drying
- Low chemical/energy requirements
- Class A product
- 75% TSS



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Anaerobic Phase Thermophilic Digestion

- Advantages
  - Process familiarity
  - Produces gas for fuel
  - Reduces volume of solids
  - Can generate liquid or cake
  - Reduce product odor
- Disadvantages
  - Potential re-growth could jeopardize future Class A status
  - Generates both ammonia and phosphorus recycle
  - Methane handling potential safety issues

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Alkaline Stabilization

- Advantages
  - Small footprint
  - Fully enclosed/moderate system complexity
  - Can process raw of digested biosolids
- Disadvantages
  - Increase volume of solids
  - Consumes chemicals
  - Odor potential
  - Could generate ammonia recycle from odor scrubber

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Composting

- Advantages
  - Generate well accepted quality product
  - Considered “green” process
  - Can process raw or digested sludge
- Disadvantages
  - Odor potential
  - Complex and significant material handling
  - Fire potential issue

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Heat Drying

- Advantages
  - Small footprint
  - Largest volume reduction
  - Produces high quality multiple use product
  - Product can be used as low grade fuel
  - No nutrient significant recycle to wastewater treatment process
  - Can process raw or digested biosolids
- Disadvantages
  - Large energy consumption
  - Complex equipment
  - Fire and explosion safety issues

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Advanced Air Drying

- Advantages
  - Lowest energy consumption
  - Lowest nutrient recycle
  - No nutrient significant recycle to wastewater treatment process
  - Can process raw or digested biosolids
- Disadvantages
  - Largest footprint
  - Need to establish Class A performance
  - Limit experience (require piloting)

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Qualitative Cost Comparison

Process	*Cost per Dry Ton Processed*
Staged Digestion	$300
Alkaline Stabilization	$350
Composting	$450
Heat Drying	$470
Advanced Air Drying	??

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Screening of Class A Options

Gordon Culp

Class A Screening Analysis Criteria

- Operability
- Proven process
- Present worth cost, capital + O&M
- Marketability
- Resource consumption
- Ease of maintaining treatment capacity during construction
- Recycle impacts

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Evaluation Criteria

- Operability
  - Readily operable = (+)
  - Some operational concerns = (0)
  - Significant operational concerns = (-)

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Evaluation Criteria

- Proven process
  - Process successfully used in a large number of similar capacity facilities meeting similar effluent quality requirements, costs well documented = (+)
  - Process successfully used in only a few similar capacity facilities = (0)
  - Process successfully used in only significantly smaller capacity facilities = (-)

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Evaluation Criteria

- Present worth costs
  - Lowest cost and costs within 10% of lowest cost = (+)
  - Costs within 20% of lowest cost = (0)
  - Costs more than 20% greater than lowest cost = (-)

    (Costs are for added equipment, structures, conveyance systems, mixing system, chemical and bulking agent addition and storage, product storage, and air emission and odor control)

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Evaluation Criteria

- Marketability
  - High quality product with wide range of markets = (+)
  - Quality product with more than one market for product = (0)
  - Product market limited to land application = (-)

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Evaluation Criteria

- Resource consumption
  - Lowest resource consumption and consumption within 10% of lowest consumption = (+)
  - Consumption within 20% of lowest consumption = (0)
  - Consumption more than 20% greater than lowest consumption = (-)

    (Annual resource consumption includes fuel, power, chemical, bulking agents and other)

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Evaluation Criteria

- Ease of maintaining treatment capacity during construction
  - Construction of new units has little or no impact on operating units = (+)
  - Construction of new units has some temporary impact on operating units = (0)
  - Construction of new units requires that operating units be concurrently demolished = (-)

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Evaluation Criteria

- Recycle Impacts
  - Process results in limited recycle impacts on wastewater treatment process = (+)
  - Process results in ammonia recycle impacts on wastewater treatment process = (0)
  - Process results in both ammonia and phosphorus recycle impacts on wastewater treatment = (-)

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Evaluation Criteria

- Ease of maintaining treatment capacity during construction
  - Construction of new units has little or no impact on operating units = (+)
  - Construction of new units has some temporary impact on operating units = (0)
  - Construction of new units requires that operating units be concurrently demolished = (-)

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Matrix Evaluation

	Stages Anaerobic Digestion	*Alkaline Stabilization*	*Composting*	*Heat Drying*	*Advanced Air Drying*
Operability					
Proven Process					
Present Worth Cost, Capital + O&M					
Marketability					
Resource Consumption					
Ease of Maintaining Treatment Capacity during Construction					
Recycle Impacts					
Recommended Process					

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Matrix Evaluation

	Stages Anaerobic Digestion	*Alkaline Stabilization*	*Composting*	*Heat Drying*	*Advanced Air Drying*
Operability	+	0	–	–	0
Proven Process	+	+	+	+	–
Present Worth Cost, Capital + O&M	+	0	–	–	–
Marketability	–	0	+	+	–
Resource Consumption	+	–	–	–	+
Ease of Maintaining Treatment Capacity during Construction	–	+	0	+	0
Recycle Impacts	–	0	0	+	+
Recommended Process					

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Development of Most Likely Class A Alternative(s)

Beth Vogt

Most Likely Biosolids Treatment Options

- Digestion Class B
  - Mesophilic digestion (what you are doing now)
- Digestion Class A – liquid processes
  - Staged thermophilic digestion
  - Accelerated air drying
- Dewatering sludge Class A – processes
  - Staged thermophilic digestion
  - Heat drying
  - Bioset

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Biosolids and Treatment Options

- Transfer biosolids to Ina Road
  - No biosolids processing at Roger Road
  - Could be done even with flow treatment at Roger Road
- Separate biosolids processing at Ina Road and Roger Road
  - Applicable to Transfer Some at Ina Road
  - Can still transfer sludge to Ina Road
  - Roger Road
    - Digestion/liquid application?
    - Dewatering?
    - Class A process?

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Solids Generation Assumptions

- Historical data
  - 2,800 lbs/day undigested solids per MGD
  - 1,700 lbs/day digested solids per MGD
- Increase dry tons to account for P removal and methanol feed
- Liquid 8% TSS
- Cake at least 15% TSS

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Solids Processing Rates

Flow (MGD)	*Raw Solids (Dry TPD)*	*Digested Solids (Dry TPD)*
20	28	17
32	45	28
50	70	43
62	87	53
82	115	70

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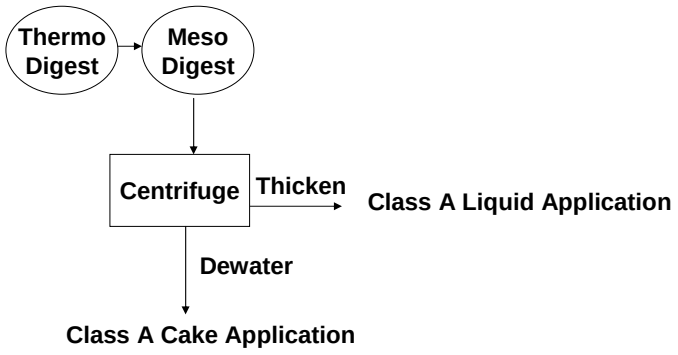
Biosolids Processing – Roger Road Option



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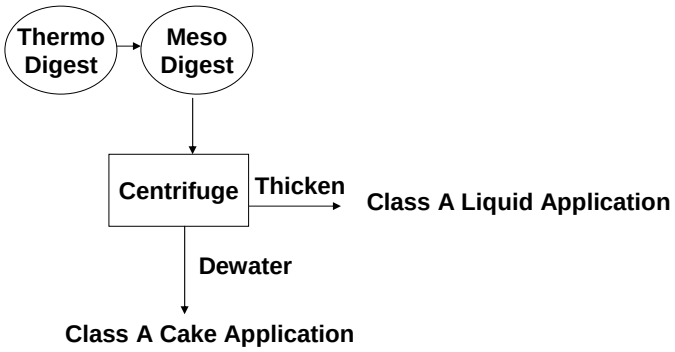
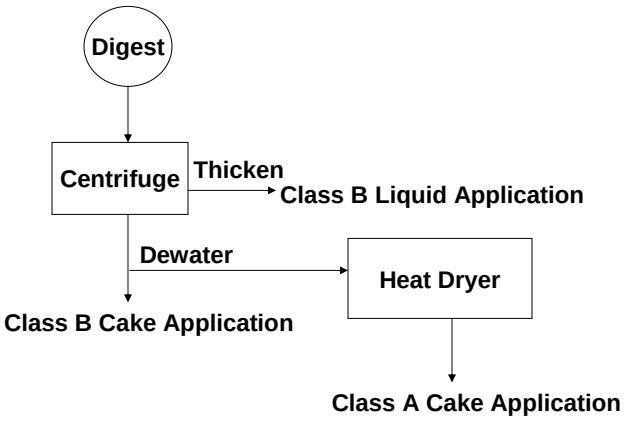
Biosolids Processing – Ina Road Option 1



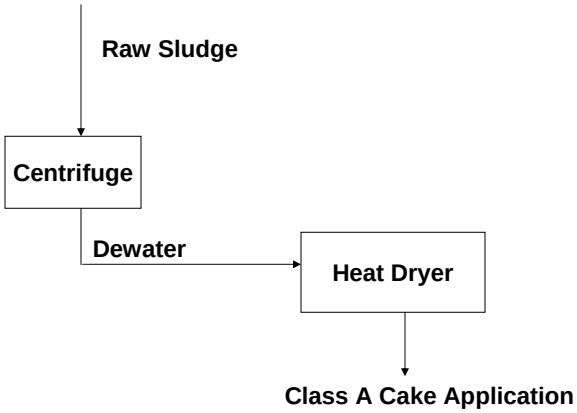
87

Biosolids Processing – Ina Road Option 2



88

Biosolids Processing – Ina Road Option 3



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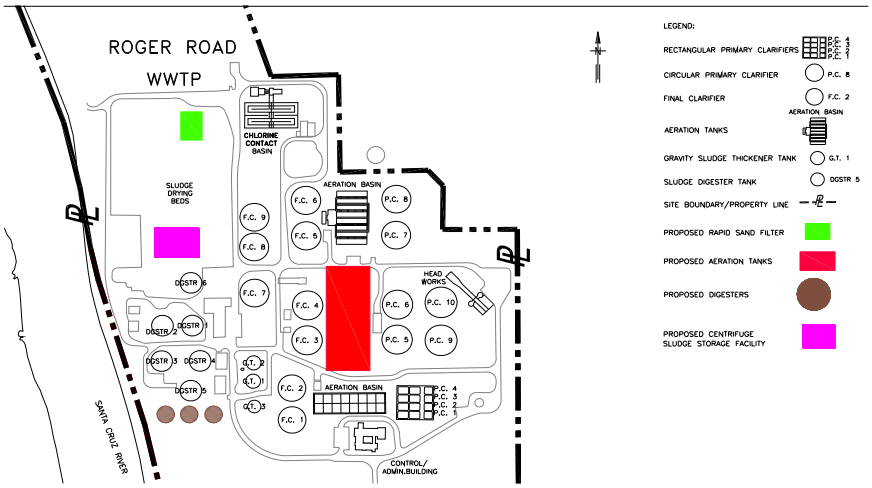
Roger Road Site Layout

- Assumed sludge thickening to 5%
- Based on 20 mgd treated
- Class A produced using thermo/meso digestion
- 3 new thermophilic digesters
- Need 2 MG mesophilic capacity (enough available on site)
- Includes centrifuge dewatering/sludge storage

90

Roger Road Layout



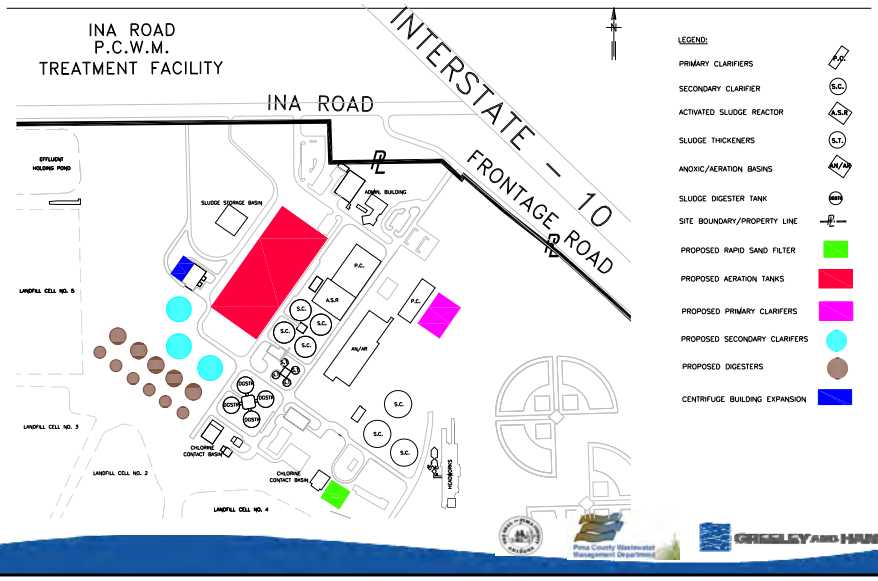
91

Ina Road Site Layouts

- Shown with NdeN 62 mgd wastewater site plan
- Assumed sludge thickening to 5%
- All sludge handling at Ina Road
  - Demonstrates 82 mgd treated at Ina Road
  - Demonstrates options with treatment at Roger Road but no solids handling at Roger Road
- Layout for thermo-meso digestion
- Layout for heat drying

92

Ina Road Thermo-Meso Layout



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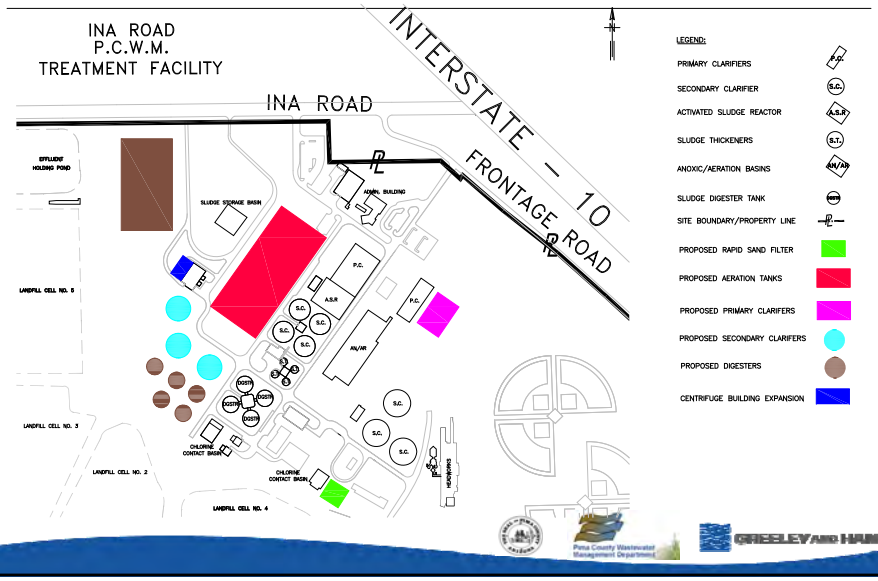
Ina Road Heat Drying Layout



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Decisions Made

- When to Implement Class A?
  - Digest to Class B until Class A required
  - Watch for triggers to Class A
- Selected Class A approach?
  - Phased digestion or heat drying
  - Depending on outcome of re-growth research
- Location for Class A
  - Ina Road

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Pima County Wastewater Management Department

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Other Issues

Beth Vogt

Next Steps

- Define intermediate processing steps
  - Transfer lines
  - Thickening/dewatering
- Coordinate layout with liquid processing
- Determine needed recycle process
- Adjust influent to account for recycles

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Pima County Wastewater Management Department

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Workshop #8 Meeting Notes
Plant Interconnect/Conveyance System

1. The Plant Interconnect/Conveyance System Workshop for Pima County Regional Optimization Master Plan was held on July 19, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
PCWMD Staff
Bob Buecher
Bob Decker
Frank Luiz
Mary Hamilton
Michael Kostrzewski
Byron McMillan
John Munden
Steve Munsell
Bill Richardson
Ron Riska, Project Manager
Robert Shay
John Warner
Legal
Harlan Agnew

TUCSON WATER
Tucson Water Staff
Sandy Elder
Melodee Loyer
Mark Seamans
Tim Thomure
Alan Forrest, CH2M Hill

PEER GROUP
Gary Newman, B&C
Denny Parker, B&C

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Gordon Culp
Andy Richardson
Steve Sticklen

2. Major topics of the workshop were:

- Workshop #8: Plant Interconnect/Conveyance System
  - Existing System Summary
  - Plant Interconnect
  - Operational Considerations
  - Population Growth / Outlying Facilities
  - Recommended Approach
  - Evaluation Criteria
  - Information Transfer Summary

A set of handouts were provided to each attendee which included presentation slides used during the workshop.

Throughout the workshop notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, welcomed the attendees to the workshop and invited all to participate

4. Andy Richardson defined his role as facilitator with the task of moving the group through the agenda and to encourage participation. The purpose of this workshop was to develop an evaluation framework, reach an agreement on the conceptual layout of alternative configurations, and refine the list of monetary and non-monetary criteria to be given consideration during the alternative evaluation process.

   Agenda, ground rules and purpose of the workshop were presented and covered on pages 1 through 4 of the handout

5. Steve Sticklen reviewed of the current issues with the conveyance system. A map was presented that indicated where capacity issues exist or had recently existed as stated in the 2006 Facilities Plan. Those pipes flagged on the map as having capacity issues were based on a q/Q of 85%, which translates into a d/D of 75%. Also, the current plan is to leave 15% of pipe capacity remaining to accommodate wet weather flows. Paul Bennett commented that there have been several sewer rehab projects completed since the 2006 Facilities Plan. For example, bids were opened Monday (07/17/06) for the Santa Cruz Interceptor construction project that is expected to take 2 years to complete. Ron Riska was tasked to provide additional information on updates to conveyance system and furnish the contractor's bids with cost breakdowns for the Santa Cruz Interceptor project.

   Steve Sticklen indicated the capacity of the North Rillito Interceptor (NRI) limits the current maximum diversion rate to approximately 5 mgd. It was indicated that pushing more could potentially blow manhole covers. Bob Buecher thought the NRI could handle flows greater than 5 mgd and indicated that Pete Mulvey had run tests on the flow management structure. Additional information will provided to the project team on the capacity of the NRI. Fixing limitations in the NRI could move up to an additional 6 mgd through the sewer.

   Paul Bennett asked whether the project team for system-wide odor control study will use the conveyance system information developed from this workshop. It was confirmed that the information from this workshop will be used in the conveyance model for that project.

   Tucson Water indicated that by 2030 they would need for reclaimed water distribution 30 mgd at Roger Road WWTP and 20 mgd at Ina Road WPCF. This did not include the water allocated to the Santa Cruz River according to SAWRSA.

   The current conditions of the conveyance system were covered on pages 4 through 7 of the handout.

6. Steve Sticklen summarized the three system interconnect options – Existing Plan, Transfer Some, and Transfer All. On a plan three potential plant interconnect routes currently under consideration were presented. Alternative 1 for the plant interconnect follows the existing sludge pipeline between Roger Road WWTP and Ina Road WPCF. Paul Bennett said that the survey of the existing sludge line easement should be completed within the next month to six weeks and will most likely indicate that approximately 50% of the route is wide enough for a parallel line, the other half may have space limitations.

   A fourth plant interconnect alternative was proposed for consideration and is a combination of alternative 1 and alternative 3.

   Michael Kostrzewski asked when the plant interconnect needed to be completed. Mike Bunch suggested that the critical path for construction of facilities at Roger Road WWTP will be the completion of the plant interconnect to offload existing facilities during construction. Another suggestion was made that perhaps media could be added to the existing aeration systems to increase treatment capacity at Roger Road WWTP to forestall the need of a plant interconnect. Timing of the plant interconnect will remain unknown until the system option is selected.

   Melodee Loyer mentioned that the 24" reclaimed water distribution line from Ina Road WPCF to Roger Road WWTP has the capacity to convey 10 mgd, which could be used to move Class A effluent from Ina Road WPCF to the Sweetwater facilities at Roger Road.

   Mike Bunch said that it might be possible to shave peak flows by storing flow within the system (in-system storage). Michael Gritzuk concurred and said that an equalization basin could also be used to capture wet weather flows.

   Bob Decker said there are spikes in flow in the NRI and Aviation Corridor Interceptor during rainfall events, and that there is some dry weather infiltration in a few areas (foothills). Also, it was noted that mid-size (8" to 12") sewers are the most likely to have capacity issues. Ron Riska stated that the system should have 100% reliability to prevent SSOs. John Warner said the CMOM application permit standard is no surcharging during a 10-year storm.

   Steve Sticklen suggested that the peaking factor curve could be adjusted to account for wet weather flows. A presentation slide indicated how the design capacity of the plant interconnect could be reduced by providing ± 6 million gallons flow equalization at or near Roger Road WWTP. Denny Parker suggested that flow equalization at Roger Road WPCF might be provided after primary treatment and that wet weather flows could be blended.

   Steve Sticklen displayed the hydraulic grade lines for three possible interconnect flows. Bob Buecher mentioned that there is a stub out at Roger Road WWTP from the existing system to accommodate a potential interconnect.

   John Munden mentioned that at Ina Road WPCF that there is an intermediate pump station, before the flow goes to the west train, where raw sewage is lifted again to the east train. Connecting the plant interconnect downstream of the headworks (ahead of the intermediate pump

station) may reduce pumping costs, but would increase pipe size. This is a consideration for the final arrangement.

The plant interconnect routes, schematics and hydraulics were covered on pages 8 through 12 of the handout.

7. Steve Sticklen presented information on unit construction costs for estimating costs of piping alternatives. Costs are based on open cut, do not include right–of-way easements and are in need of adjustment to the Tucson construction market. Recent pipeline construction costs in Tucson will be used to calibrate the costs curves.

   The estimated pipeline cost information was covered on page 13 of the handout.

8. Locations of outlying facilities were presented along with the area topography. It was suggested that the only outlying area for pioneering interceptors (extend sewers to direct location of growth) would be in Marana. Further, at this time the existing sewer system is accommodating the HAMP area.

   The Sonoran Desert Conservation Plan was developed after the outlying treatment plants were constructed. There is no connection between the Plan and planned growth for the outlying facilities.

   John Munden inquired as to who uses the water after treatment. Sandy Elder said Tucson Water is increasingly getting inquiries about reuse in the outlying areas. It was agreed that the locations of the Tucson Water facilities should be added to the map along with the Continental Ranch Pump Station.

   There are three approaches to the outlying facilities. 1) Keep the existing plants and expand as necessary, 2) combine all flows in the south into a subregional facility (maximize reuse potential), and 3) a combination of 1 and 2.

   The outlying areas information was covered on pages 12 and 13 of the handout.

9. Steve Sticklen outlined approach to performing the evaluation for the recommended approach. This would include a review of the existing basin model and the development of a skeletal hydraulic model (model-lite) to evaluate flows and costs of alternatives.

   The recommended evaluation approach was covered on page 14 of the handout.

10. Gordon Culp reviewed and discussed the criteria to be used in evaluation of conveyance alternatives. Mark Seamans mentioned that the peaking factor equations were not displayed properly, and that it should be "$p^{0.231}$", not "p – 0.231". Byron McMillan requested that regulatory deadlines should be added as a criterion. Tim Thomure mentioned that many of the "non-monetary" criteria have cost implications, and requested that water reuse be added to the list. Bob Buecher said that utility conflicts and traffic control have cost implications only, and should not be considered non-monetary. Gary Newman requested that odor control be added to

the list. Frank Luiz suggested consideration be given to conveyance time and hydrogen-sulfide production. Sewers that are 37 miles are too long. Address operations and maintenance, not just maintenance as a criterion. The evaluation criteria will be adjusted based on the comments.

The evaluation criteria were covered on pages 14 and 15 of the handout.

11. Steve Sticklen presented a list of information that had been received and what additional information that the project team had outstanding to be received. Steve Munsell will provide the project team with TAZ and Basin Model data. It was stated that in some areas the total pipe capacity is 200 mgd, far greater than actual flow, indicating opportunities for in-system storage. Also, there is a 2-mile stretch of sewer with internal weirs at all connecting pipes that is particularly challenging to model. The location of the large capacity sewers and information on the 2-mile sewer with weirs will be forwarded to the project team. Mike Gritzuk asked that the existing system be looked at for efficiency in flow conveyance to eliminate problems and use over capacity effectively.

    Information received and outstanding was covered on page 16 of the handout.

12. Andy Richardson wrapped up the workshop with a summary of actions for the project team:

    - Investigate four (4) plant interconnect options
    - Conduct a sensitivity analysis on peaking factor
    - Look for opportunities for in-system storage
    - For subregional plants provide sewers without long detention times
    - Use “model-lite” approach for conveyance system analysis.:

Agenda
Workshop #8 – Plant Interconnect / Conveyance System
July 19, 2006

Time	Topic	Presenter
12:15 pm	*Lunch – Pima County Parks and Recreation Facility* *3500 West River Road, Tucson, AZ*	
1:00 pm	Opening Session • Welcoming Remarks • Review Agenda • Workshop Goals	 Mike Gritzuk Andy Richardson
1:15 pm	Conveyance System Studies • Existing System Summary • Recommended Improvements	Steve Sticklen
1:30 pm	Known Capacity / Condition Issues	Steve Sticklen
2:00 pm	Plant Interconnect • Existing Transfer Option • Transfer Some Flow to Ina Road WPCF • Transfer All Flow to Ina Road WPCF	Steve Sticklen
2:45 pm	Break	
3:00 pm	Population Growth / Outlying Facilities	Steve Sticklen
3:15 pm	Recommended Evaluation Approach	Steve Sticklen
3:30 pm	Evaluation Criteria	Gordon Culp
3:45 pm	Information Transfer Summary	Steve Sticklen
4:00 pm	Summary Wrap-Up • Comments by Group • Closing Remarks	Andy Richardson Mike Gritzuk
4:30 pm	Adjourn	

Flip Chart Notes – July 19, 2006

Water Reuse

- 30 mgd to SAWRSA
- 7 to 14 mgd for Santa Cruz River at Roger Road
- Sweetwater capacity 10 mgd plant and SAT at 10 mgd
- Expansion of SAT in increments from 9,000 AC/ft to future 20,000 AC/ft

Existing Information

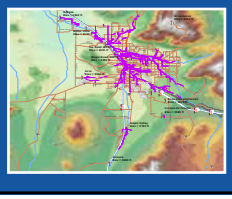
- 3000 manholes identified to be rehabed
- Use collection system data at siphons for odor control study
- Potential to surcharge in certain areas
- Studies on plant interconnect obtain from Ron Riska
- Tucson Water reuse needs dependent on evening flows
- Bids opened Monday on Santa Cruz interceptor – installed in two years
- For analysis, need to look at how flows will increase to 2030
- 10 mgd capacity in 24-inch Tucson Water reclaimed water service from Ina Road to Sweetwater
- 8-inch sludge line is being surveyed; need to get information from PCWMD
- What is the timing of the plant interconnect? What is the trigger?
- Look at what can we do in interim at Roger Road to add capacity and deal with flow increases
- Operational issues and concern for diurnal variations
- Look at flow equalization and economics
- Inflow is an issue; North Rillito is one; aviation area another area
- Foothills is an area with inflow issues
- Look at 5 to 7 mgd of inflow at Roger Road; look at data to verify
- Park Mall area has inflow study underway
- 15 percent ok to handle inflow as design consideration
- Sensitivity analysis on peak factor for smaller lines
- Consider location of equalization basin after primaries at Roger Road
- 60-inch stubout at Roger Road for connection of plant interconnect
- Need to look at location of plant interconnect discharge at Ina Road; connect at intermediate pump station

Plant Interconnect

- Look at a fourth option (combination of 1 & 3)– run portion along sludge pipeline
- At creek crossing could consider stacking pipelines

Outlying Facilities

- Continental Ranch pump station; get rid of
- Marana may be an opportunity for pioneer lines



Pima County
Regional Optimization
Master Plan

Workshop #8

Plant Interconnect / Conveyance System

July 19, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Steve Sticklen	Conveyance
Gordon Culp	Evaluation

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Existing system summary
  - Capacity issues
  - Condition assessment
- Plant interconnect
  - Existing transfer options
  - Future transfer options
    - Existing Plan
    - Transfer Some
    - Transfer All
- Population growth
- Outlying facilities

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

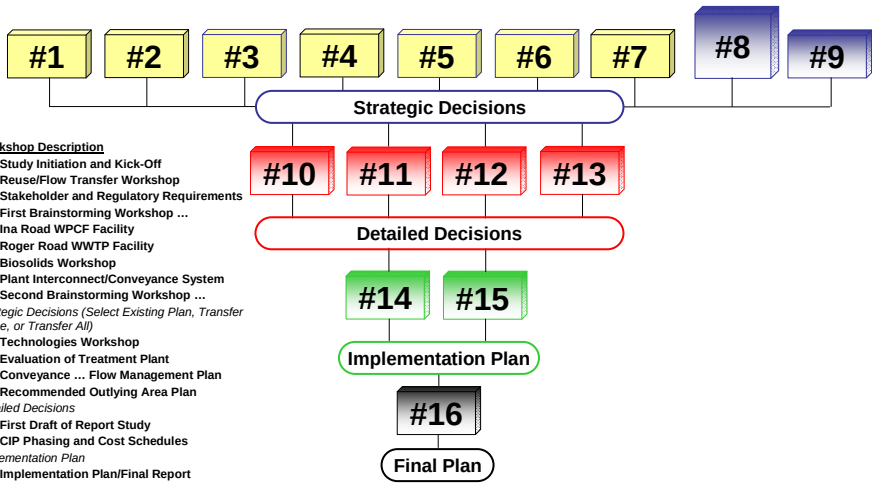
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop Objectives

- Expectations
- Evaluation framework
- Agreement on conceptual layout
- Operational considerations
- Evaluation criteria
  - Monetary
  - Non-monetary

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Pima County Wastewater Management Department

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Conveyance System Studies

Steve Sticklen

Conveyance System Studies

- Existing system summary
- Recommended improvements

13

Pima County Wastewater Management Department

GREELEY AND HANSEN

Known Capacity / Condition Issues

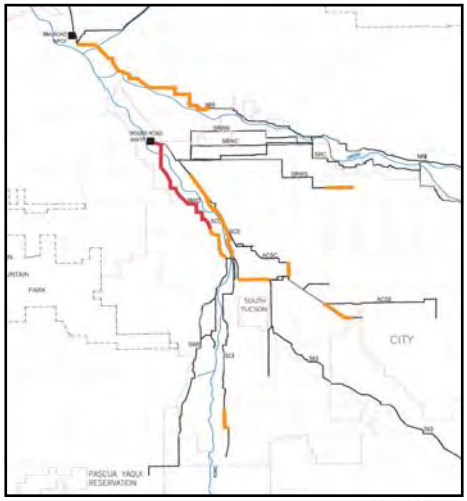
Steve Sticklen

Existing System Summary

- Capacity issues
- Condition assessment
  - Manholes
  - Siphons
  - Pump stations
  - Pipes

15

Existing Capacity Issues



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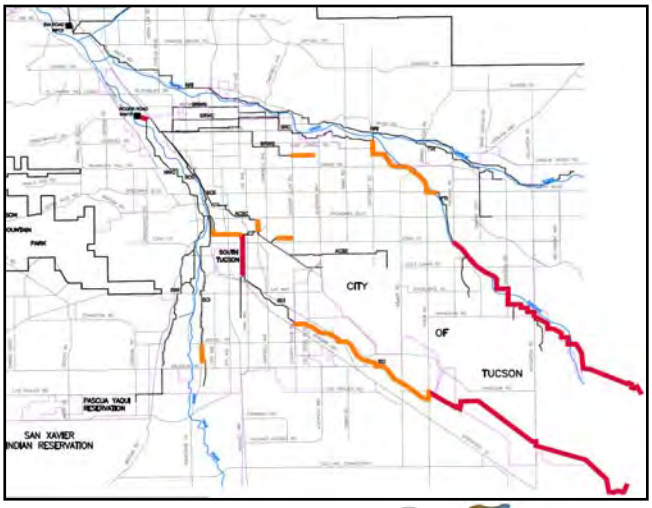
2030 Capacity Issues



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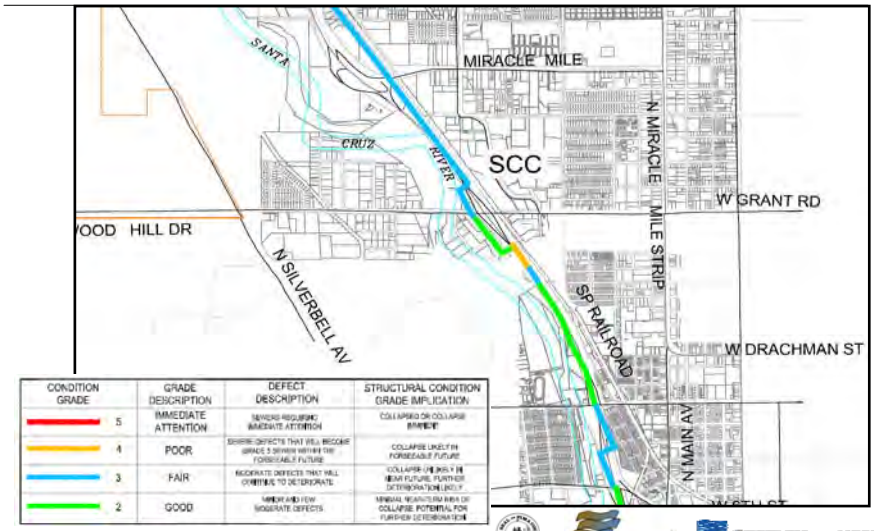
Condition Assessment Summary

- $4.5M to rehab manholes
- Siphons and pump stations
- $13.5M to rehab pipes in poor condition
- $162M to rehab pipes in fair condition

18

Santa Cruz Central Interceptor



CONDITION GRADE	GRADE DESCRIPTION	DEFECT DESCRIPTION	STRUCTURAL CONDITION GRADE IMPLICATION
5	IMMEDIATE ATTENTION	SEWERS REQUIRING IMMEDIATE ATTENTION	COLLAPSED OR COLLAPSE IMMINENT
4	POOR	SEWER DEFECTS THAT WILL BECOME GRADE 5 SEWER WITHIN THE FORESEEABLE FUTURE	COLLAPSE LIKELY IN FORESEEABLE FUTURE
3	FAIR	MODERATE DEFECTS THAT WILL CONTINUE TO DETERIORATE	COLLAPSE UNLIKELY IN NEAR FUTURE, FURTHER DETERIORATION LIKELY
2	GOOD	MINOR AND FEW MODERATE DEFECTS	MINIMAL NEAR-TERM RISK OF COLLAPSE, POTENTIAL FOR FURTHER DETERIORATION

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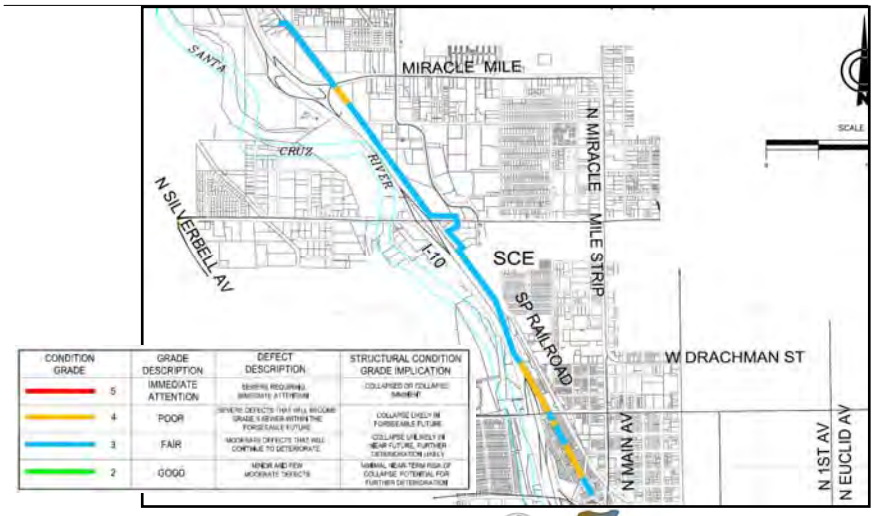
Santa Cruz East Interceptor



CONDITION GRADE	GRADE DESCRIPTION	DEFECT DESCRIPTION	STRUCTURAL CONDITION GRADE IMPLICATION
5	IMMEDIATE ATTENTION	SEWERS REQUIRING IMMEDIATE ATTENTION	COLLAPSED OR COLLAPSE IMMINENT
4	POOR	SEWER DEFECTS THAT WILL BECOME GRADE 5 SEWER WITHIN THE FORESEEABLE FUTURE	COLLAPSE LIKELY IN FORESEEABLE FUTURE
3	FAIR	MODERATE DEFECTS THAT WILL CONTINUE TO DETERIORATE	COLLAPSE UNLIKELY IN NEAR FUTURE, FURTHER DETERIORATION LIKELY
2	GOOD	MINOR AND FEW MODERATE DEFECTS	MINIMAL NEAR-TERM RISK OF COLLAPSE, POTENTIAL FOR FURTHER DETERIORATION

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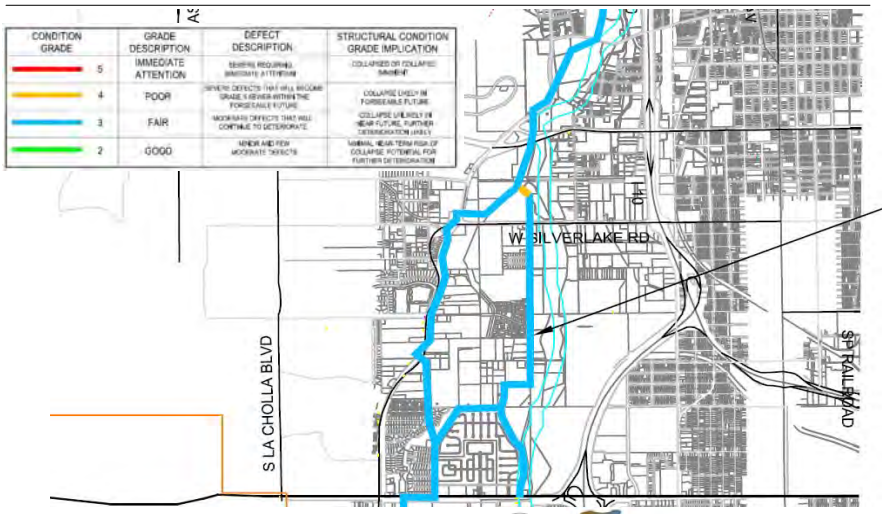
Southwest Interceptor



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Plant Interconnect

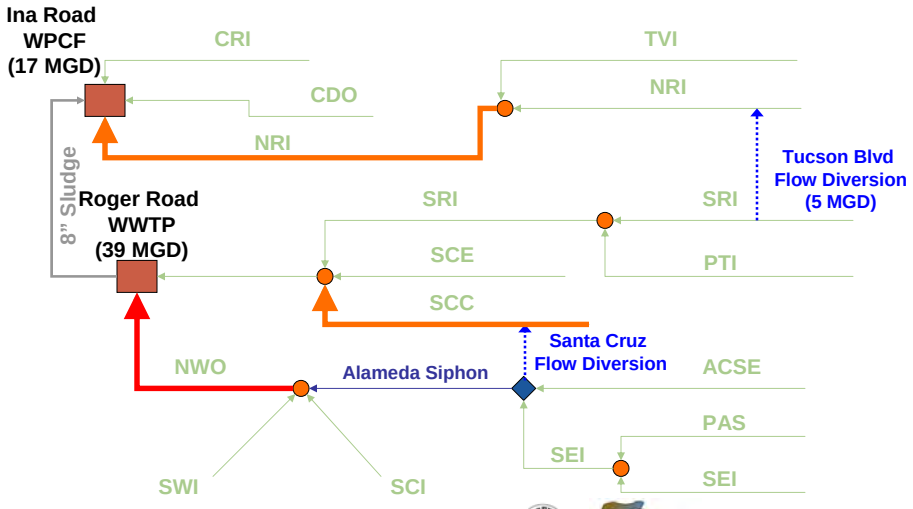
Steve Sticklen

Plant Interconnect

- Current Transfer Options
  - Tucson Blvd and Craycroft Road
  - 8-inch sludge line
- Future Transfer Options
  - Existing Plan
  - Transfer Some
  - Transfer All

23

Mass Balance Schematic
(Existing System Configuration and Flows)



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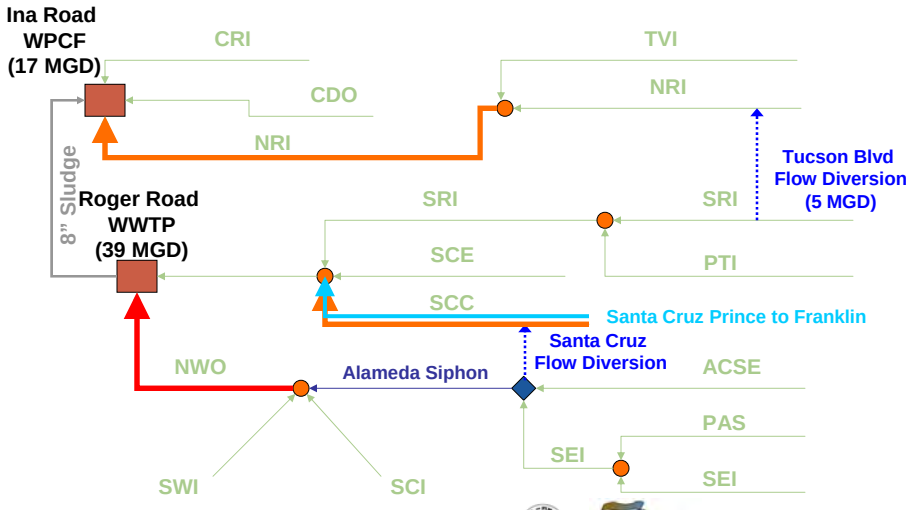
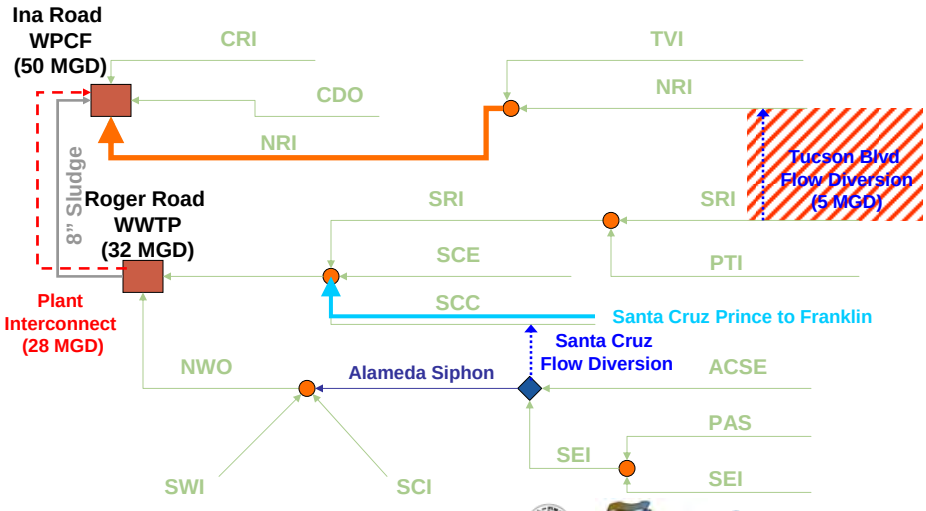
Mass Balance Schematic
(New Santa Cruz Interceptor)



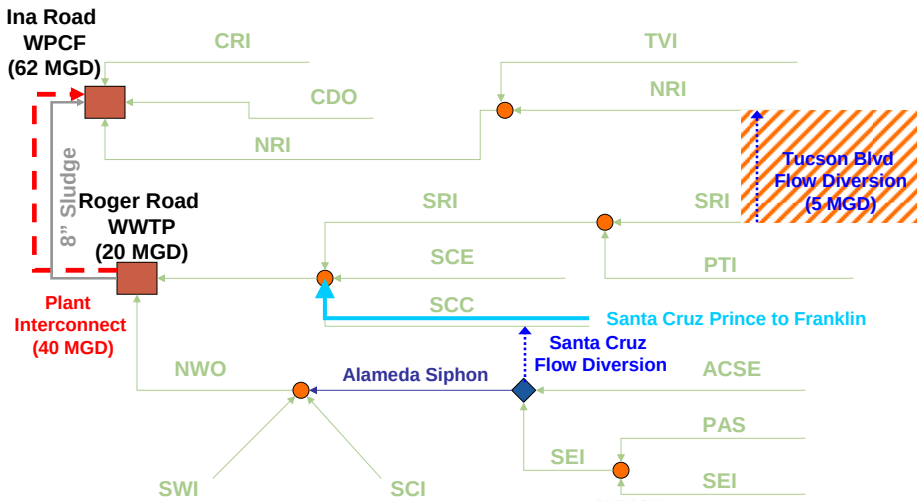
25

Mass Balance Schematic
(Existing Plan, 2030 Flows)



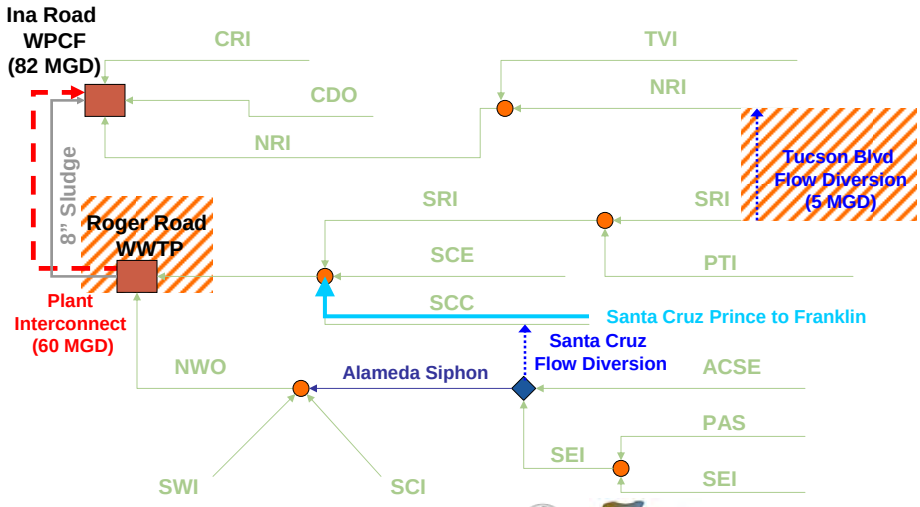
26

Mass Balance Schematic
(Transfer Some)



27

Mass Balance Schematic
(Transfer All)



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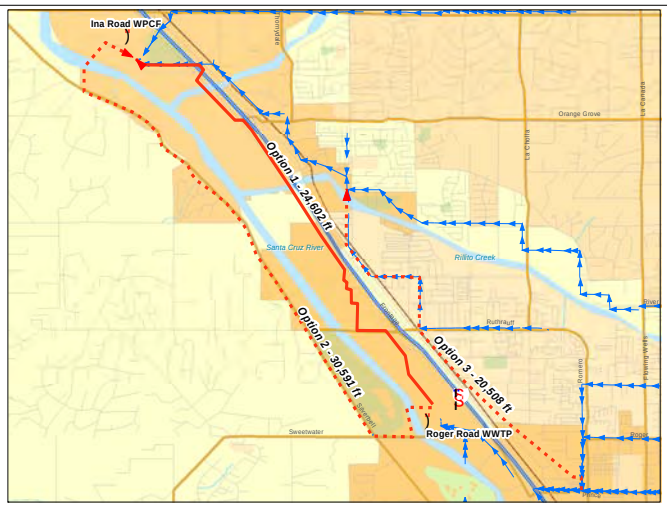
Proposed Interconnect Routes



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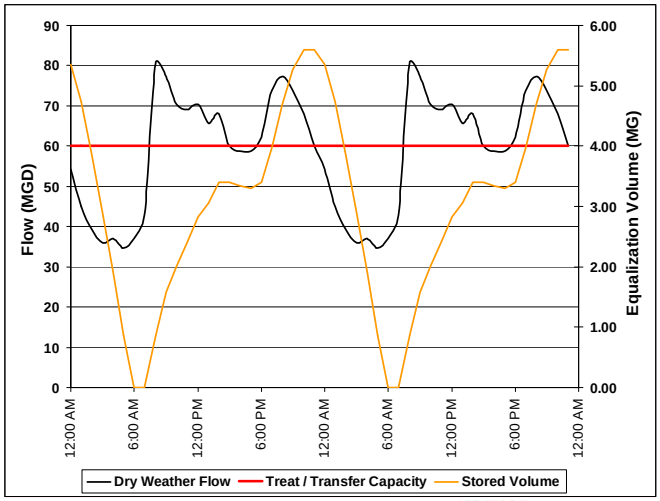
Summary of Interconnect Options

Option	*Roger Road (MGD)*	*Transfer (MGD)*	*Ina Road (MGD)*	*Dia (in)*
Existing	32	28	50	42”
Transfer Some	20	40	62	48”
Transfer All	0	60	82	60”

All options presume 6-10 MG of flow equalization at Roger Road site, without which transfer rates would need to be increased by 35 MGD.

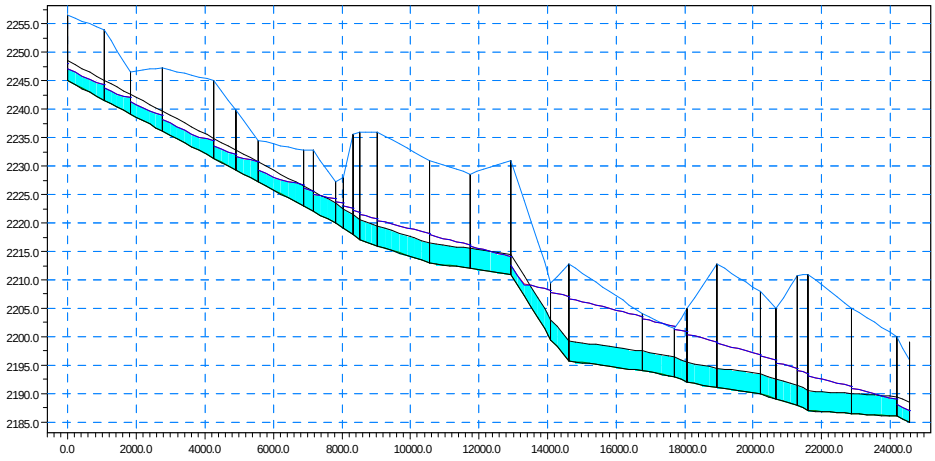
30

Diurnal Flow Equalization



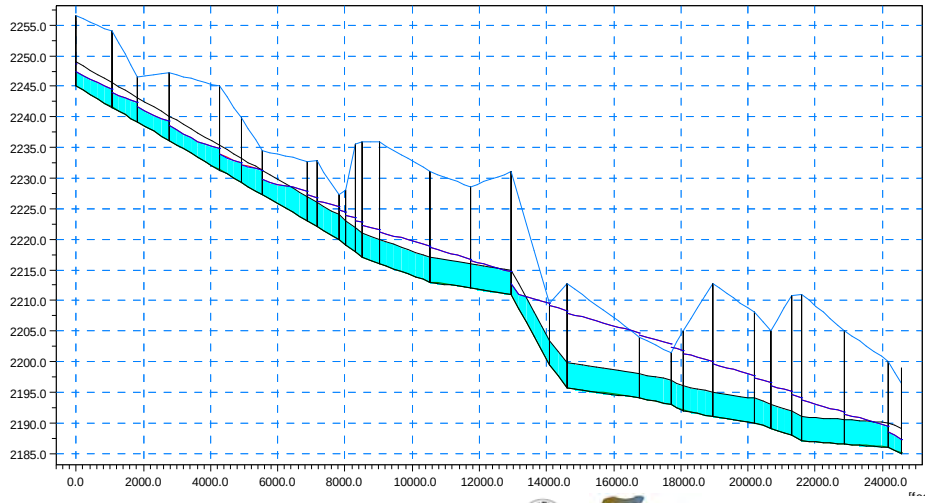
31

Interconnect Profile – Existing Plan
(42-inch pipe, Q=28 MGD)



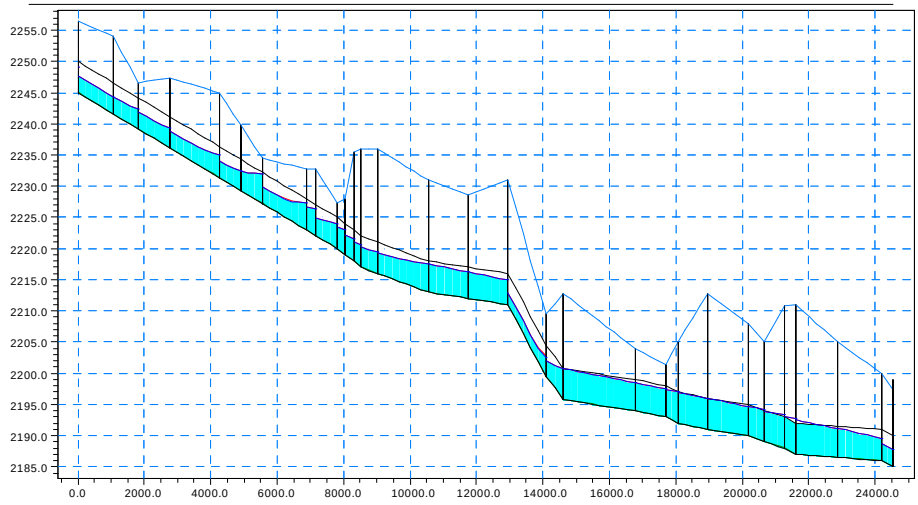
32

Interconnect Profile – Transfer Some
(48-inch pipe, Q=40 MGD)



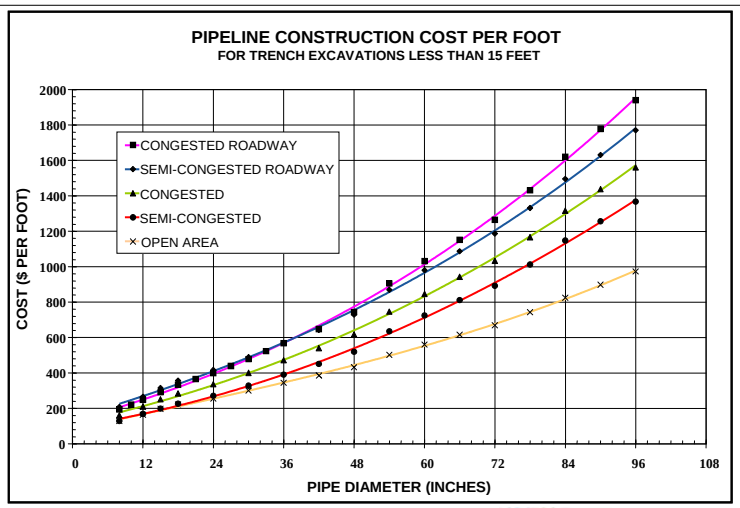
33

Interconnect Profile – Transfer All
(60-inch pipe, Q=60 MGD)



34

Pipe Unit Costs



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Pima County Wastewater Management Department

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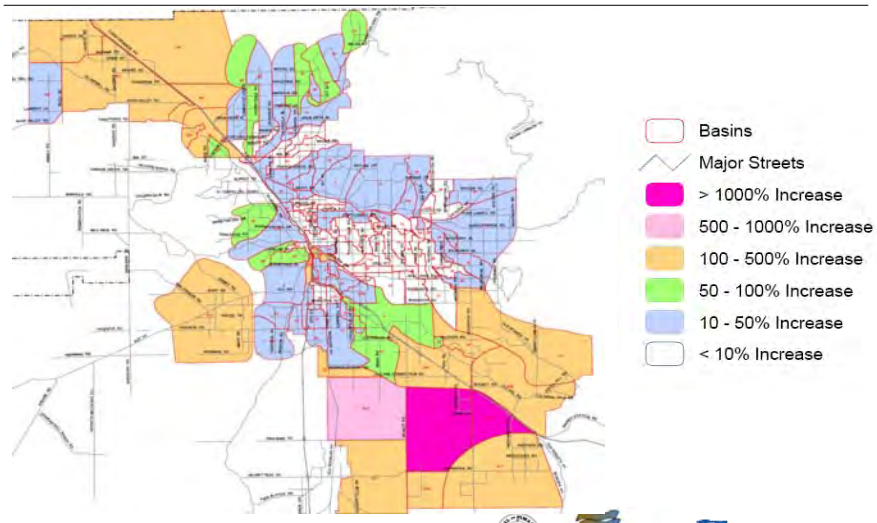
Population Growth Outlying Facilities

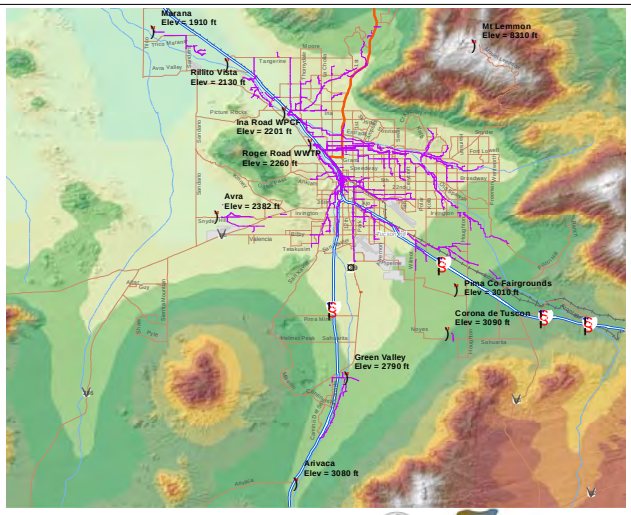
Steve Sticklen

Population Growth, 2005 – 2030

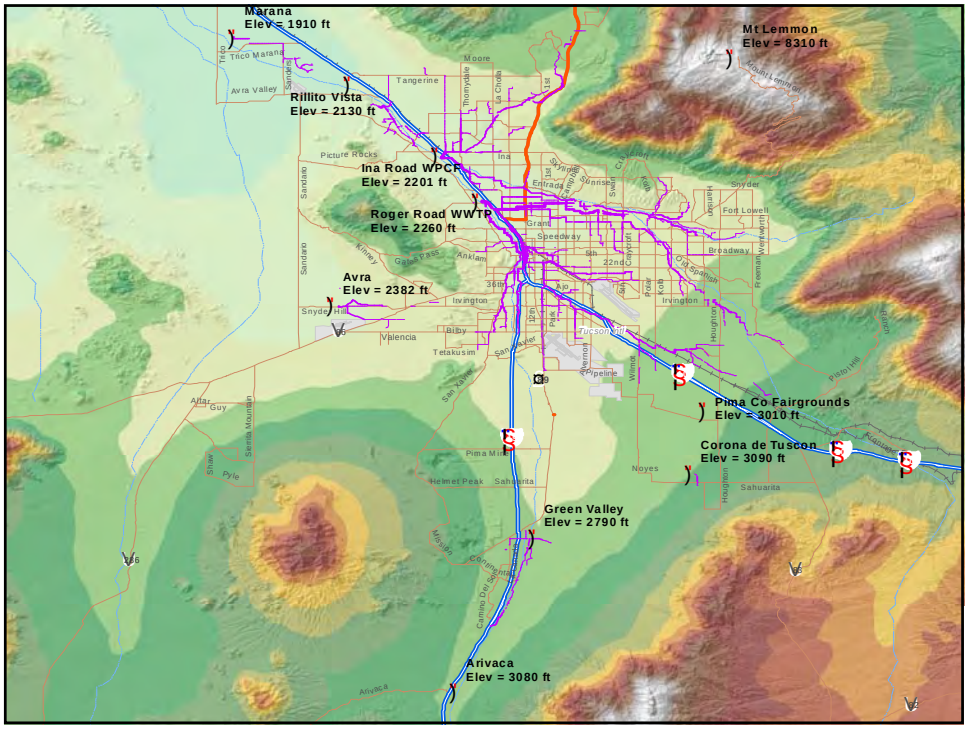


37

Area Topography



38



Pima County Wastewater Management Department

GREELEY AND HANSEN

Recommended Evaluation Approach

Steve Sticklen

Recommended Approach

- Review basin model
- Develop skeletal hydraulic model
  - Identify critical conveyance facilities
  - Request manhole rim and inverts
- Develop diurnal patterns
- Develop existing / future loads
- Identify / confirm hydraulic inadequacies
- Alternative analysis
  - System upgrades
  - Plant interconnect
  - Outlying facilities

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Pima County Wastewater Management Department

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Evaluation Criteria

Gordon Culp

Evaluation Criteria

- Present worth cost
- Non-monetary considerations
  - Constructability
  - Long-range planning
  - Safety
  - Public acceptance
  - Maintenance
  - Rights-of-way
  - Pump stations
  - Utility conflicts
  - Traffic control
  - Environmental impacts
  - Business disruption
  - Archeological / historic sites
  - Permitting

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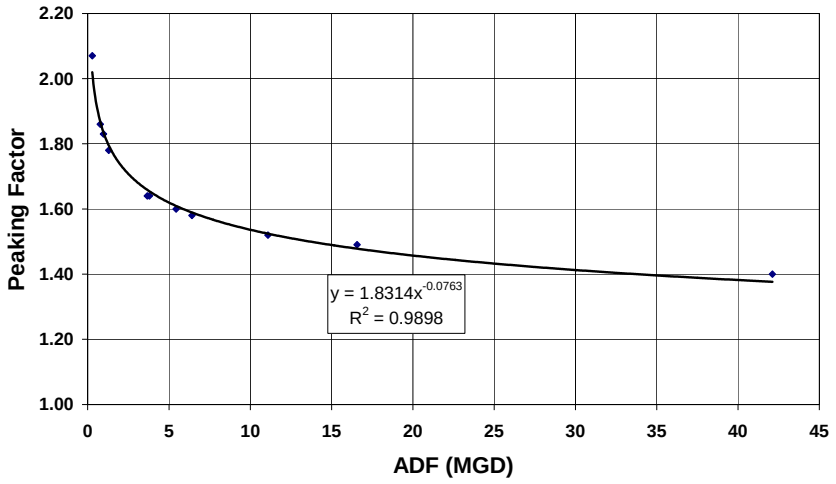
Peaking Factor

Upstream Population	Peaking Factor
1,001 to 10,000	PF = (6.330 x p - 0.231) + 1.094
10,001 to 100,000	PF = (6.177 x p - 0.233) + 1.128
More than 100,000	PF = (4.500 x p - 0.174) + 0.945
PF = Peaking Factor	
p = Upstream Population	

Table 3.4.1 from 2006 Facility Plan

44

Peaking Factor



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Information Transfer Summary

Steve Sticklen

Information Transfer Summary

- Received
  - Land use
  - Roads, parcels
  - Manhole locations, pipe locations and sizes
  - TAZ data (2000 population)
  - Flow data
- Outstanding
  - Basin model
  - TAZ data (population projections)
  - Manhole rim and invert elevations
  - Flow data

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Pima County Wastewater Management Department

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Workshop #9 Meeting Notes
Second Brainstorming Workshop & Facility Oriented Workshop

1. Workshop #9 - Second Brainstorming Workshop & Facility Oriented Workshop for Pima County Regional Optimization Master Plan was held on August 9, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
PCWMD Staff
James Doyle
Houssam Eljerdi
Dennis Froehlich
Frank Gall
Mary Hamilton
Michael Kostrzewski
Byron McMillan
John Munden
Steve Munsell
Jeff Prevatt
Prakash Rao
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
John Sherlock
John Warner
Ken Weber
Legal
Harlan Agnew
Chuck Wesselhoft

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Dennis Rule
Mark Seamans
Linda Smith
Tim Thomure
Ken Thompson, CH2M Hill

PCRFCD
Tom Helfrich

PEER GROUP
Joe Husband, MPI
Gary Newman, B&C
Cindy Wallis-Lage, B&V

GREELEY AND HANSEN PROJECT TEAM
Orrie Albertson
Jerry Bish
Gordon Culp
Joe Popeck
Andy Richardson

2. Major topics of the workshop were:

- Workshop #9: Second Brainstorming Workshop & Facility Oriented Workshop
  - Tres Rios del Norte Project
  - Phosphorus Removal
  - Design Influent/Mass Loadings
  - Process Evaluation Matrix Revisited
  - Key Design Criteria

- Process for System Configuration Evaluation
- Procedure for Estimating Costs
- Risks Associated with Reusing Existing Structures and Facilities

A set of handouts were provided to each attendee which included presentation slides used during the workshop.

Throughout the workshop notes were recorded on a series of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. The flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, welcomed the attendees to Workshop #9. All were invited to drill down on the issues of wastewater treatment processes under consideration for Roger Road WWTP and Ina Road WPCF through the brainstorming process, participate in a robust discussion and narrow down the wastewater treatment process selections.

4. Andy Richardson defined his role as facilitator with the task of moving the group through the agenda and to encourage participation. The group was advised that this workshop was a critical point in the master plan process. This was the last strategic decision workshop before moving on to the detailed decisions for the master plan.

   Throughout the previous workshop there were a number of flow alternatives proposed for Roger Road WWTP and Ina Road WPCF. A chart of flows to each plant and the processes for nitrification and denitrification was presented to the group for discussion later in the workshop. The table is provided below.

Q, mgd			Bardenpho	IF/AS	MLE + deN Filter
IR	RR Rehab	RR Greenfield			
22	60	60			
38	44	44			
45	37	37			
50*	32*	32			
62*	20*(1)	20			
82*	0*	--			

IR = Ina Road WPCF
RR = Roger Road WWTP
* = Flows from Workshop #4
(1) Use of Biotower option at RR

Agenda, groundrules and purpose of the workshop were presented and covered on pages 1 through 4 of the handout.

5. Tom Helfrich, District Study Manager for Pima County Regional Flood Control District (PCRFCD), provided an overview of the Tres Rios Del Norte Project Ecosystem Restoration Feasibility Study. The study is being conducted by the Corps of Engineers with support by PCRFCD, City of Tucson and the City of Marana. The study covers 18 miles of the Santa Cruz River from Prince Road to North Sanders Road and encompasses 19,800 acres. Objectives of the study are:

   - Ecosystem restoration
   - Flood damage control
   - Groundwater recharge
   - Recreation
   - Cultural resource preservation

   The plan has not been finalized, but is expected to be completed this fall. Some of the preliminary features, which are subject to change include:

   - Restoration of 3,000 acres of riparian habitat
   - Seven (7) grade control structures (bottom stabilization)
   - Soil bank protection
   - Three (3) pedestrian bridge crossings
   - Off-channel recharge basins (spreading)
   - In-channel T-berms (recharge feature)

   The study area is divided into three reaches:

   1. Prince Road north to Ina Road,
   2. Ina Road north to Avra Valley Road
   3. Avra Valley Road north to North Sanders Road

   Reach 1 covers the Santa Cruz River from the Roger Road WWTP discharge to the Ina Road WPCF discharge. The recommended plan for reach 1 is to develop cottonwood and willow tree habitat (145 acres), mesquite bosque habitat (438 acres) along with other native plant and shrub species (164 acres) at the edges and to create wetland areas (40 acres) in the river bottom. Open channel flow from upstream projects is unlikely. Wetland areas will have water depths of 6 inches to 9 feet.

   The vegetation in the proposed reach 1 plan will require 2,851 acre-feet/year including consumptive and evaporative losses and direct precipitation. This does not include constructed (groundwater) recharge nor channel losses. If channel losses are estimated to be 4.0 acre-feet per mile per day then an additional 6,905 acre-feet/year is required to sustain the ecosystem restoration. For the recommended plan this equates to a total of 9,756 acre-feet/year, or on average approximately 8.71 mgd. A limited restoration plan, or a plan to maintain the existing habitat would reduce the water needs to 8,384 acre-feet/year (average 7.49 mgd) or 7,632 acre-feet/year (average 6.82 mgd), respectively.

   The Tres Rios del Norte project probably cannot proceed without effluent.

6. Mike Gritzuk asked the status of other ecosystem restoration projects considered by the PCRFCD. Tom Helfrich indicated that the Paseo de las Iglesias (1,000 acre) project, which is up the Santa Cruz River (south of Congress) of the Tres Rios del Norte project. The Paseo de las Iglesias project is completed and is first in line for funding. The Tres Rios del Norte project is second for funding (with a preliminary cost of $300 million) and third is a project that covers the Santa Cruz River from Congress to Prince Road. The latter project is not in the planning stage at this time, but is projected to start in two years. Funding sources are to include the County, City of Tucson, City of Marana, Corps of Engineers and private donations.

   Mike Bunch asked if the funds are available for the projects. Funding for all the projects is not committed. It is expected that some elements of the Tres Rios del Norte project will be funded and constructed, while other elements will go unfunded.

7. Dennis Rule indicated that regard to the Tres Rios del Norte project the Tucson Water was keeping their options open regarding water recharge in the Santa Cruz River. Depending on the timing of events Tucson Water could utilize effluent directly or recover water through a river groundwater recharge program. With managed recharge, the plant effluent would be moved one-half mile upstream (south).

8. Harlan Agnew asked if there were any lakes or ponds created by the projects. Tom Helfrich indicated that there will be wetlands and open water features, but none deep enough to be classified as a lake (minimum depth of 9 feet).

   Tres Rios del Norte program is based on 9,000 AC/ft/yr for consumptive use on the Santa Cruz River, approximately 3,000 AC/ft/yr between Roger Road and Ina Road. Another 6,000 AC/ft/yr is planned below Ina Road. This does not consider recharge allocations.

   Ron Riska asked whether the T-berms would survive a storm event. The response was unknown if they would survive. T-berms will be constructed with local funds. Also, with the vegetation planned, what sorts of nutrients are required in the water? Response from Tom Helfrich was that nutrients were not discussed in the Corps of Engineers' study.

9. Orrie Albertson presented the information on wastewater characteristics and flows. There was discussion whether 85 gpcd was a correct assumption for the future with low flow fixtures and interest in gray water use. Paul Bennett suggested a sensitivity analysis for flows as low as 65 gpcd from the 85 gpcd be used in the planning activity.

   Wastewater characteristics and flows were covered on pages 6 through 11 of the handout.

10. Joe Popeck presented the background and regulatory/other drivers for phosphorus removal in the effluent. Phosphorus can lead to algae growth and hypoxia conditions creating aesthetic and odor problems, and negative impacts on aquatic life. Dennis Froehlich suggested that P removal be designed to treat the entire flow at the plant, but only that portion discharged to the river receive phosphorus removal treatment. But according to AZPDES permits, the whole effluent needs to be treated to the highest standard, which would be for P removal.

Based on the fact that master plan is for 25 years in the future, add bio P removal to the treatment system requirements.

Phosphorus removal was covered on pages 5 and 6, and 15 through 18 of the handout.

11. Gordon Culp reviewed the process evaluation matrix. The selected process from the matrix is to determine the system configuration to determine the total integrated costs of the options. After the options are evaluated, a sensitivity analysis will confirm the final process selection. The group agreed to do the system configuration based on Bardenpho, then do sensitivity with other processes - IF/AS, MLE + deN filters and Biotowers (at Roger Road WWTP for 20 mgd only). This will provide the difference in the process costs, as well as the total system costs. This process does not close doors on any process.

    Jim Doyle reminded the group that the process selected must be operable, maintainable, reliable and be "bullet-proof" with regards to meeting permit requirements.

    Process evaluation was covered in pages 11 through 14 of the handout.

12. Joe Popeck presented key design criteria including schedule, costs, risks and value of existing facilities. An example of risk is the creation of an illogical flow path for adding new aeration tanks. Piping arrangements have pipes crossing other pipes and aeration tanks scattered around the site. Melodee Loyer asked if a "green field" plant could be designed and would the public accept higher costs for construction. A "green field" plant is an option for Roger Road WWTP.

    Valuation methodology uses asset approach to determine investment value of assets to remain in service in the future. Asset values are adjusted on condition and functionality for its intended use. Mike Gritzuk agreed with these factors and added a factor to maintain facilities in service during construction and factors for retrofitting existing structures where existing conditions are unknown. John Sherlock supported the idea of increased construction cost risk because of lack of "as-builts". There was concern over double accounting or over derating an asset, so that assigning values will need to be carried out carefully.

    Key design criteria was covered on pages 18 through 27 of the handout.

13. Gordon Culp presented the flow matrix from the beginning of the workshop. There was discussion on the plants to expand Ina Road WPCF to 50 mgd as Roger Road WWTP has 160 acres available for facilities. After review of the alternatives, the group decided the flows discussed at Workshop #4 would remain for the development of the system configuration options. A sensitivity analysis will be conducted to evaluate the other flows under consideration.

14. Mike Gritzuk summarized the workshop as a good session and thanked everyone for attending and participating.

Agenda
Workshop #9 – Second Brainstorming Workshop & Facility Oriented Workshop
August 9, 2006

Time	Topic	Presenter
7:45 am	*Continental Breakfast – Tucson Main Library, Basement Meeting Rm, 101 N. Stone*	
8:15 am	Opening Session	
	• Welcoming Remarks	Mike Gritzuk
	• Review Agenda	Andy Richardson
	• Workshop Goals	
8:30 am	Tres Rios del Norte Project	PCFCD
8:50 am	Phosphorus Removal	Joe Popeck
	• Background	
	• Regulatory/Other Divers	
9:00 am	Design Influent/Mass Loadings	Orrie Albertson
	• Roger Road WWTP	
	• Ina Road WPCF	
10:00 am	Break	
10:15 am	Process Evaluation Matrix Revisited	Gordon Culp
	• Peer Group Responses	
	• Discussion	
	• Develop/Complete Matrix	
11:15 am	Phosphorus Removal – Part 2	Joe Popeck
	• Bio P Impacts	
	• Chemical Addition Impacts	
	• Ultimate Level of P Removal	
12:00 pm	Lunch	
1:00 pm	Key Design Criteria	Joe Popeck
	• Level of Treatment Plant Detail	
	• Basis of Cost Estimates	
	• Design Criteria Used to Size Treatment Processes	
2:00 pm	Process for System Configuration Evaluation	Gordon Culp
3:00 pm	Second Treatment Process (Sensitivity Testing)	Gordon Culp
3:15 pm	Summary Wrap-Up	Andy Richardson
	• Comments by Group	
	• Closing Remarks	Mike Gritzuk
3:30 pm	Adjourn	

Flip Chart Notes – August 9, 2006

Q, mgd			Bardenpho	IF/AS	MLE + deN Filter
IR	RR Rehab	RR Greenfield			
~~22~~	~~60~~	~~60~~			
~~38~~	~~44~~	~~44~~			
~~45~~	~~37~~	~~37~~			
50*	32*	32			
62*	20*(1)	20			
82*	0*	--			

IR = Ina Road WPCF
RR = Roger Road WWTP
* = Flows from Workshop #4
(1) Use of Biotower option at RR

Tres Rios

- Three Corp restoration projects:
  - Project 1: Six miles south of Congress
  - Project 2: Congress to Prince behind by a couple of years
  - Project 3: Tres Rios
- Reach 1 Prince Road to Ina Road
- Water depths 6 inches to less than 9 feet – River bottom
- 40 Acres of wetlands (over 9 feet is considered a lake)
  - 8 AC/ft/AC cottonwoods/willows (145 acres)
  - 6 AC/ft/AC wetlands (40 acres),
  - 3AC/ft/AC mesquite bosque (438 acres)
  - 2 AC/ft/AC desert scrub (164 acres)
- 8,200 AC/ft/year for groundwater recharge

Tres Rios – $300 million

- Tres Rios construction start 2010? Two-year construction 2012?
- 2,800 AC/ft/yr (2.5 mgd) for existing/new habitat
- 8,384 AC/ft/yr (7.5 mgd) wet channel Roger Road to Ina Road
- May or not need in-channel recharge; Tucson Water has to look at timing
- Total demand
  - Total Restore 2,851 AC/ft/yr
  - Total Water Demand 8,195 AC/ft/yr
  - Losses 6,905
  - Total Water 15,100

  17,951 AC/ft

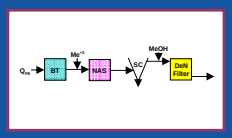
- No lakes or ponds
- River bottom wetlands
- Flowing water feature
- Open body water
- Several elements will go forward, maybe?

Phosphorus

- Need present worth on Bio P added at after construction of original facility

Process

- Use Bardenpho for system configuration with other processes for sensitivity analysis



Pima County Regional Optimization Master Plan

Workshop #9
Second Brainstorming Workshop & Facility Oriented Workshop

August 9, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
PCFCD	Tres Rios del Norte Project
Joe Popeck	Phosphorus Removal / Key Design Criteria
Orrie Albertson	Design Influent / Mass Loadings
Gordon Culp	Process Evaluations

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop objectives
- Tres Rios del Norte Project
- Phosphorus removal
- Design influent/mass loadings
- Process evaluation matrix revisited
- Key design criteria
- Process for system configuration evaluation
- Second treatment process (sensitivity testing)
- Summary wrap-up

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

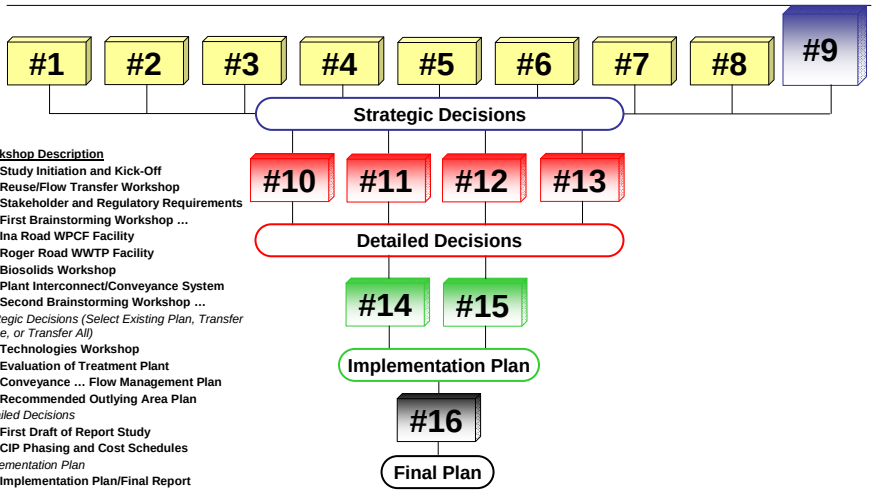
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Workshop Objectives

- Agree on level of phosphorus removal for design
- Agree on influent loadings
- Agree on level of treatment plant detail adequate to select system configuration
- Agree on basis of cost estimates
- Agree on design criteria used to size treatment processes
- Agree on treatment process evaluation matrix
- Address concern that selection of only one treatment process for system configuration evaluation may bias selection of system configuration

11

Pima County Wastewater Management Department

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Tres Rios del Norte Project

PCFCD

Phosphorus Removal

Joe Popeck

Phosphorus Removal

- Background
- Regulatory / other drivers

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Phosphorus Removal Background

- PCWMD has expressed the desire to include P Removal a part of ROMP (preference for Bio – P)
- Neither current nor future (2014/2015) AZPDES Permits require P Removal

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P Removal – Regs/Other Drivers

- Drivers for P Removal
  - Prevent degradation of receiving waters
    - Algae Growth/Hypoxia – negative impacts on fish
    - N/P Ratio < 7.0, promotes growth of blue-green algae with related odor problems in receiving stream
  - Possibly of Tres Rios del Norte Project
  - Regulatory uncertainty/being investigated
  - Others???

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P Removal – Regs/Other Drivers

- Effluent P Requirements may be lower than 1 mg/L, perhaps 0.1 mg/L
  - Bio P not able to achieve the lower limit
  - However, Bio P can be coupled with Chemical P for polishing to lower limits

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Pima County Wastewater Management Department

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Design Influent /Mass Loadings

Orrie Albertson

Preliminary Wastewater Characteristics from WS #4

Parameter	*Units*	*Primary Influent*	*Primary Effluent*
COD	mg/L	649	420
BOD_5	mg/L	300	207
sBOD	mg/L	122	122
TSS	mg/L	281	112
VSS	mg/L	219	92
TKN	mg/L	54.4	51.5
TP	mg/L	9.8	9.2

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Wastewater Characteristics RR 32 MGD

Parameter	*Units*	*Total Raw Influent*	*Recycles*	*Primary Influent*	*Primary Effluent*
Flow	MGD	32.1	1.1	33.2	32.6
COD	mg/L	648	1,011	659	443
BOD5	mg/L	294	506	301	214
SBOD5	mg/L	121	116	121	123
TSS	mg/L	286	1,011	310	126
VSS	mg/L	225	791	243	104
TKN	mg/L	47	51	47	46
TP	mg/L	10	19	10	10

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Wastewater Characteristics
IR 50 MGD

Parameter	*Units*	*Total Raw Influent*	*Recycles*	*Primary Influent*	*Primary Effluent*
Flow	MGD	50.2	2.3	52.6	51.4
COD	mg/L	663	1,265	689	456
BOD5	mg/L	318	456	324	229
SBOD5	mg/L	123	125	123	126
TSS	mg/L	319	1,201	358	146
VSS	mg/L	254	881	282	123
TKN	mg/L	55	219	63	61
TP	mg/L	11	102	15	14

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Wastewater Characteristics
RR 20 MGD

Parameter	*Units*	*Total Raw Influent*	*Recycles*	*Primary Influent*	*Primary Effluent*
Flow	MGD	20.1	0.7	20.8	20.4
COD	mg/L	665	1,014	677	455
BOD5	mg/L	303	507	310	220
SBOD5	mg/L	123	117	123	126
TSS	mg/L	304	1,014	329	134
VSS	mg/L	239	794	258	110
TKN	mg/L	48	51	48	47
TP	mg/L	10	19	10	10

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Wastewater Characteristics
IR 62 MGD

Parameter	*Units*	*Total Raw Influent*	*Recycles*	*Primary Influent*	*Primary Effluent*
Flow	MGD	62.2	2.7	64.9	63.6
COD	mg/L	654	1,238	679	441
BOD5	mg/L	311	461	317	223
SBOD5	mg/L	122	123	122	125
TSS	mg/L	307	1,172	343	140
VSS	mg/L	244	873	270	116
TKN	mg/L	54	196	59	57
TP	mg/L	11	90	14	13

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Wastewater Characteristics
IR 82 MGD

Parameter	*Units*	*Total Raw Influent*	*Recycles*	*Primary Influent*	*Primary Effluent*
Flow	MGD	82.3	3.4	85.7	84.0
COD	mg/L	654	1,184	675	452
BOD_5	mg/L	307	472	314	222
$SBOD_5$	mg/L	121	122	121	123
TSS	mg/L	304	1,140	337	138
VSS	mg/L	241	852	265	115
TKN	mg/L	52	165	56	54
TP	mg/L	10	75	13	12

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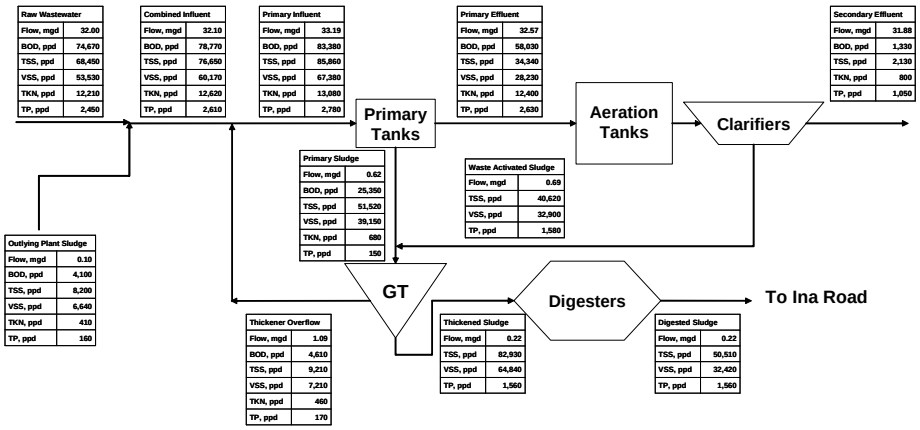
See Appendix

Roger Road Mass Balance – 32 mgd



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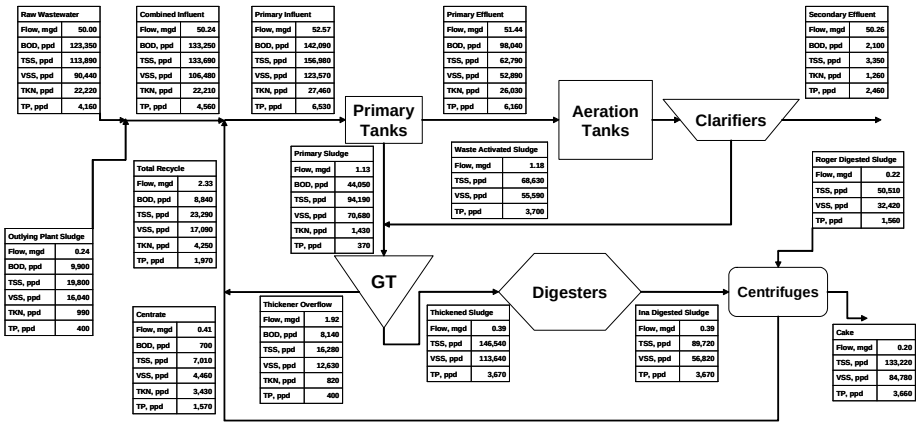
See Appendix

Ina Road Mass Balance – 50 mgd



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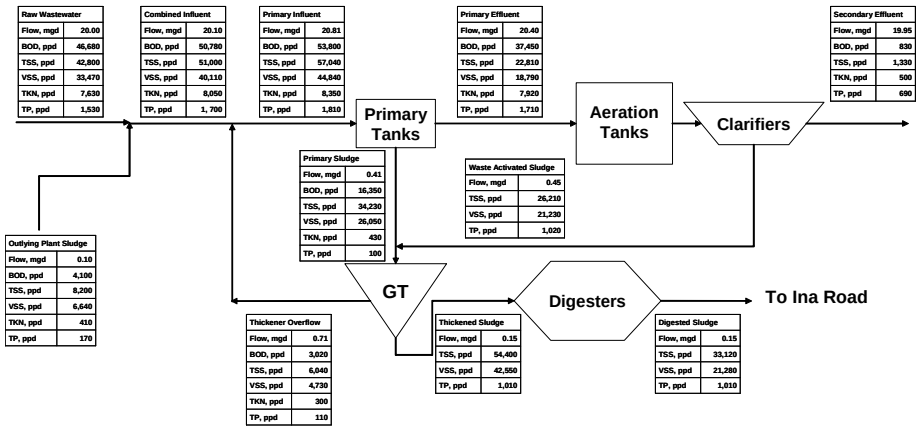
See Appendix

Roger Road Mass Balance – 20 mgd



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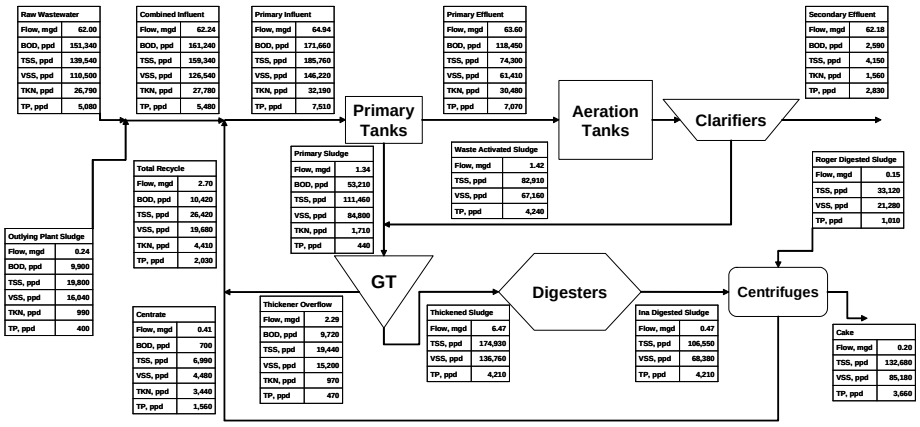
See Appendix

Ina Road Mass Balance – 62 mgd



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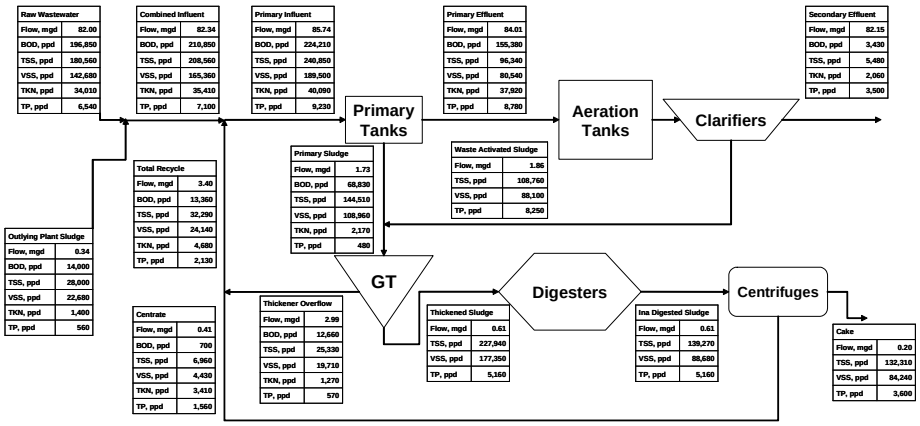
See Appendix

Ina Road Mass Balance – 82 mgd



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Raw Wastewater Characteristic Development

Preliminary vs. Special Testing WW Characteristics RR WWTP				
	RAW		*PRIMARY EFFLUENT*	
Parameter	*Preliminary, mg/L*	*Special Test, mg/L*	*Preliminary, mg/L*	*Special Test, mg/L*
COD	585	594 ± 63	408	352 ± 21
SCOD	-	207 ± 16	-	230 ± 16
BOD_5	261	231 ± 14	195	148 ± 13
$SBOD_5$	116	88 ± 7	117	106 ± 10
TSS	228	234 ± 17	103	57 ± 11
VSS	180	198 ± 11	84	48 ± 9
TKN	39	38.5 ± 2.2	43.4	33.2 ± 2.1
NH_4-N	-	22.7 ± 0.3	-	22.9 ± 0.9
TP	8	6.0 ± 0.3	8.7	4.8 ± 0.2

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Raw Wastewater Characteristic Development

Preliminary vs. Special Testing WW Characteristics IR WPCF				
	RAW		*PRIMARY EFFLUENT*	
Parameter	*Preliminary, mg/L*	*Special Test, mg/L*	*Preliminary, mg/L*	*Special Test, mg/L*
COD	590	557 ± 46	420	286 ± 42
SCOD	-	165 ±19	-	155 ± 21
BOD_5	300	223 ±15	207	106 ± 9
$SBOD_5$	125	63 ± 7	122	49 ± 9
TSS	270	258 ± 15	112	65 ± 14
VSS	220	217 ± 10	92	57 ± 13
TKN	57	40.7 ± 1.6	51.5	45.0 ± 5.3
NH_4-N	-	27.0 ± 7.6	-	33.7 ± 3.2
TP	10	6.6 ± 0.4	9.2	5.8 ± 0.6

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Process Evaluation Matrix Revisited

Gordon Culp

Process Evaluation Matrix Revisited

- Process Evaluation Matrix presents a single majority answer (from Peer Group) for each question for each process
- Questions are separated into "Primary" and "Secondary" considerations
- Process Evaluation Matrix are done separately for Roger Road WWTP and Ina Road WPCF

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See Appendix

Comprehensive Matrix

Legend

Sequence of Response: Joe Husband; Denny Parker (RR@20 mgd); Denny Parker (RR@32 mgd); Denny Parker (IR); Cindy Wallis-Lage (RR); Cindy Wallis-Lage (IR)

Shaded areas were not rated in Workshop #4

Underlined answers notate different rating than made in Workshop #4

Question	MLE	Bardenpho	AS/NTF	BT/NAS	StepNdeN	Biostyr/Biofor	IF/AS	MBR	BT/NdN	MBBR
1. Achieve <8mg/L N with inf = 55 mg/L	N, N, N, N, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, NA, Y	Y, Y, Y, NA, Y	N, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, M, M	Y, Y, Y, Y, M, M	Y, Y	Y, M, M
2. Emerging Contam. Removal	Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, NA, Y	Y, Y, Y, NA, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, DK, DK	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y	Y, Y, Y
3. High Methanol Use	N, N	N, N, N, N, N, N	Y, Y, Y, NA, Y	Y, N, Y, NA, Y	N, N, N, N, N, N	Y, Y, Y, Y, Y, Y	N, N, N, N, N, N	N, N, N, N, N, N	DK, Y	Y, Y, Y
4. Use Existing Biotowers	N, N, N, N	N, N, N, N, N, N	Y, Y, Y, NA, M	Y, Y, Y, NA, Y	N, N, N, N, N, N	Y, N, N, N, M	N, N, N, N, N	N, N, N, N, N, N	Y, Y	N, Y
5. Can use Bio P Removal	Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, NA, Y	N, N, N, NA, N	Y, N, N, N, Y, Y	N, N, N, N, N, N	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	N, N	Y, N, N
6. Capital Costs in Range of Bardenpho	N, DK, DK	Y, Y, Y, Y, Y, Y	DK, Y, Y, NA, DK	DK, Y, Y, NA, DK	DK, Y, Y, Y, DK, DK	N, N, N, N, N, N	Y, Y, Y, Y, Y, Y	DK, N, N, N, Y, Y	DK, DK	DK, DK, DK
7. Can use Existing Tankage	Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, NA, Y	Y, Y, Y, NA, Y	Y, Y, Y, Y, Y, Y	N, N, N, N, N, N	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y	Y, Y, Y
8. Achieve Eff. Turbidity <2 NTU	Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, NA, Y	Y, Y, Y, NA, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y, Y, Y, Y, Y	Y, Y	Y, Y, Y
9. Can use HPO System	Y, NA, NA, N, N	Y, NA, NA, N, N	N, NA, NA, NA	N, NA, NA, NA	N, NA, NA, N, N	N, NA, NA, N, M	Y, NA, NA, N, N	Y, NA, NA, N, N	N	N, M
10. O&M Costs in Range of Bardenpho	N, N, N	Y, Y, Y, Y, Y, Y	DK, N, N, NA, N	DK, N, N, NA, N	DK, Y, Y, Y, DK, DK	N, N, N, N, N, N	Y, Y, Y, Y, Y, Y	N, N, N, N, N, N	DK, N	N, N, N
11. Has been used in Bio N Removal in Plants >20 mgd, >3 yrs	Y, Y, Y	Y, Y, Y	DK, DK	DK, DK	Y, Y	Y, DK, DK	DK, N, N	DK, N, N	DK, DK	DK, DK, DK

Roger Road Matrix

See Appendix

Legend
Sequence of Response: Joe Husband; Denny Parker (RR@20 mgd); Denny Parker (RR@32 mgd); Cindy Wallis-Lage (RR);

Shaded areas were not rated in Workshop #4
Underlined answers notate different rating than made in Workshop #4

Question	MLE	Bardenpho	AS/NTF	BT/NAS	StepNdeN	Biostyr/Biofor	IF/AS	MBR	BT/NdN	MBBR
1. Achieve <8mg/L N with inf = 55 mg/L	N, N, N, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	N, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, M	Y, Y, Y, M	Y, Y	Y, M
2. Emerging Contam. Removal	Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, DK	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y	Y, Y
3. High Methanol Use	N	N, N, N, N	Y, Y, Y, Y	Y, N, Y, Y	N, N, N, N	Y, Y, Y, Y	N, N, N, N	N, N, N, N	DK, Y	Y, Y
4. Use Existing Biotowers	N, N, N, N	N, N, N, N	Y, Y, Y, M	Y, Y, Y, Y	N, N, N, N	Y, N, N, M	N, N, N, N	N, N, N, N	Y, Y	N, Y
5. Can use Bio P Removal	Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	N, N, N, N	Y, N, N, Y	N, N, N, N	Y, Y, Y, Y	Y, Y, Y, Y	N, N	Y, N
6. Capital Costs in Range of Bardenpho	N, DK	Y, Y, Y, Y	DK, Y, Y, DK	DK, Y, Y, DK	DK, Y, Y, DK	N, N, N, N	Y, Y, Y, Y	DK, N, N, Y	DK, DK	DK, DK
7. Can use Existing Tankage	Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	N, N, N, N	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y	Y, Y
8. Achieve Eff. Turbidity <2 NTU	Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y, Y, Y	Y, Y	Y, Y
9. Can use HPO System	Y, NA, NA	Y, NA, NA	N, NA, NA	N, NA, NA	N, NA, NA	N, NA, NA	Y, NA, NA	Y, NA, NA	N	N
10. O&M Costs in Range of Bardenpho	N, N	Y, Y, Y, Y	DK, N, N, N	DK, N, N, N	DK, Y, Y, DK	N, N, N, N	Y, Y, Y, Y	N, N, N, N	DK, N	N, N
11. Has been used in Bio N Removal in Plants >20 mgd, >3 yrs	Y, Y	Y, Y	DK, DK	DK, DK	Y	Y, DK	DK, N	DK, N	DK, DK	DK, DK

Roger Road Matrix Difference of Opinions

Process	*Question*	*Peer Group Answers*	*GH Team Answer*
MLE	Achieve <8 mg/L N with Inf = 55 mg/L	*3 Ns and 1 Y*	N
BT/NAS	High Methanol Use	*3 Ys and 1 N*	Y
StepNdeN	Achieve <8 mg/L N with Inf = 55 mg/L	3 Ys and 1 N	Y
StepNdeN	Can use Bio P	2 Ys and 2 Ns	N
Biostry/Biofor	Use Existing Biotowers	1 Y, 2 Ns and 1 M	N
IF/AS	Achieve <8 mg/L N with Inf = 55 mg/L	3 Ys and 1 M	Y
MBR	Achieve <8 mg/L N with Inf = 55 mg/L	3 Ys and 1 M	Y
MBR	Capital Cost in Range of Bardenpho	2 Ns and 1 Y	N
MBBR	Achieve <8 mg/L N with Inf = 55 mg/L	1 Y and 1 M	Y
MBBR	Use Existing Biotowers	1 Y and 1 N	N
MBBR	Can Use Bio P	1 Y and 1 N	N

Ina Road Matrix

See Appendix

Legend
Sequence of Response: Joe Husband; Denny Parker (IR); Cindy Wallis-Lage (IR)
Shaded areas were not rated in Workshop #4
Underlined answers notate different rating than made in Workshop #4

Question	MLE	Bardenpho	AS/NTF	BT/NAS	StepNdeN	Biostyr/Biofor	IF/AS	MBR	BT/NdN	MBBR
1. Achieve <8mg/L N with inf = 55 mg/L	N, N, Y	Y, Y, Y	Y, NA	Y, NA	N, Y, Y	Y, Y, Y	Y, Y, M	Y, Y, M	Y	Y, M
2. Emerging Contam. Removal	Y	Y, Y, Y	Y, NA	Y, NA	Y, Y, Y	Y, Y, DK	Y, Y, Y	Y, Y, Y	Y	Y, Y
3. High Methanol Use	N	N, N, N	Y, NA	Y, NA	N, N, N	Y, Y, Y	N, N, N	N, N, N	DK	Y, Y
4. Use Existing Biotowers	N	N, N	Y, NA	Y, NA	N, N	Y, N	N, N	N, N	Y	N
5. Can use Bio P Removal	Y, Y	Y, Y, Y	Y, NA	N, NA	Y, N, Y	N, N, N	Y, Y, Y	Y, Y, Y	N	Y, N
6. Capital Costs in Range of Bardenpho	N, DK	Y, Y, Y	DK, NA	DK, NA	DK, Y, DK	N, N, N	Y, Y, Y	DK, N, Y	DK	DK, DK
7. Can use Existing Tankage	Y, Y	Y, Y, Y	Y, NA	Y, NA	Y, Y, Y	N, N, N	Y, Y, Y	Y, Y, Y	Y	Y, Y
8. Achieve Eff. Turbidity <2 NTU	Y, Y	Y, Y, Y	Y, NA	Y, NA	Y, Y, Y	Y, Y, Y	Y, Y, Y	Y, Y, Y	Y	Y, Y
9. Can use HPO System	Y, N, N	Y, N, N	N, NA	N, NA	N, N, N	N, N, M	Y, N, N	Y, N, N	N	N, M
10. O&M Costs in Range of Bardenpho	N, N	Y, Y, Y	DK, NA	DK, NA	DK, Y, DK	N, N, N	Y, Y, Y	N, N, N	DK	N, N
11. Has been used in Bio N Removal in Plants >20 mgd, >3 yrs	Y, Y	Y, Y	DK	DK	Y, Y	Y, DK	DK, N	DK, N	DK	DK, DK

Ina Road Matrix Difference of Opinions

Process	*Question*	*Peer Group Answers*	*GH Team Answer*
MLE	Achieve <8 mg/L N with Inf = 55 mg/L	2 Ns and 1 Y	N
Bardenpho	Can use HPO System	1 Y and 2 Ns	N
StepNdeN	Achieve <8 mg/L N with Inf = 55 mg/L	1 N and 2 Ys	Y
StepNdeN	Can use Bio P	2 Ys and 1 N	N
IF/AS	Achieve <8 mg/L N with Inf = 55 mg/L	2 Ys and 1 M	Y
IF/AS	Can use HPO System	1 Y and 2 Ns	N

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Ina Road Matrix Difference of Opinions

Process	*Question*	*Peer Group Answers*	*GH Team Answer*
MBR	Achieve <8 mg/L N with Inf = 55 mg/L	2 Ys and 1 M	Y
MBR	Capital Cost in Range of Bardenpho	1 N and 1 Y	N
MBR	Can use HPO System	1 Y and 2 Ns	N
MBBR	Achieve <8 mg/L N with Inf = 55 mg/L	1Y and 1 M	Y
MBBR	Can use Bio P	1 Y and 1 N	N
MBBR	Can use HPO System	1 N and 1 M	N

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See Appendix

Roger Road Matrix – Majority Answers

Shaded areas were not rated in Workshop #4

Question	MLE	Bardenpho	AS/NTF	BT/NAS	StepNdeN	Biostyr/Biofor	IF/AS	MBR	BT/NdN	MBBR
Primary Considerations										
1. Achieve <8mg/L N with inf = 55 mg/L	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
3. High Methanol Use	N	N	Y	Y	N	Y	N	N	Y	Y
5. Can use Bio P Removal	Y	Y	Y	N	Y/N	N	Y	Y	N	Y/N
6. Capital Costs in Range of Bardenpho	N	Y	Y	Y	Y	N	Y	N	DK	DK
7. Can use Existing Tankage	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
10. O&M Costs in Range of Bardenpho	N	Y	N	N	Y	N	Y	N	N	N
11. Has been used in Bio N Removal in Plants >20 mgd, >3 yrs	Y	Y	DK	DK	Y	Y	N	N	DK	DK
Secondary Considerations										
2. Emerging Contam. Removal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4. Use Existing Biotowers	N	N	Y	Y	N	N	N	N	Y	Y/N
8. Achieve Eff. Turbidity <2 NTU	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9. Can use HPO System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

See Appendix

Ina Road
Matrix – Majority Answers

Shaded areas were not rated in Workshop #4

Question	MLE	Bardenpho	AS/NTF	BT/NAS	StepNdeN	Biostyr/Biofor	IF/AS	MBR	BT/NdN	MBBR
Primary Considerations										
1. Achieve <8mg/L N with inf = 55 mg/L	N	Y			Y	Y	Y	Y		Y
3. High Methanol Use	N	N			N	Y	N	N		Y
5. Can use Bio P Removal	Y	Y			Y	N	Y	Y		Y/N
6. Capital Costs in Range of Bardenpho	N	Y			Y	N	Y	N		DK
7. Can use Existing Tankage	Y	Y			Y	N	Y	Y		Y
10. O&M Costs in Range of Bardenpho	N	Y			Y	N	Y	N		N
11. Has been used in Bio N Removal in Plants >20 mgd, >3 Yrs	Y	Y			Y	Y	N	N		DK
Secondary Considerations										
2. Emerging Contam. Removal	Y	Y			Y	Y	Y	Y		Y
4. Use Existing Biotowers	NA	NA			NA	NA	NA	NA		NA
8. Achieve Eff. Turbidity <2 NTU	Y	Y			Y	Y	Y	Y		Y
9. Can use HPO System	N	N			N	N	N	NN		N

Process Evaluation Matrix Revisited

- Based upon the majority answers, Bardenpho is recommended for System Configuration Analysis
- MLE NdeN is recommended for Sensitivity Testing of System Configuration

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Phosphorus Removal – Part 2

Joe Popeck

Phosphorus Removal

- Capital Costs for P Removal
- Annual Costs for P Removal
- Summary and Previous Recommendations

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Phosphorus Removal

- Capital Costs for P Removal
  - Bio P – Range of $60K to $70K per MG to achieve 1.0 mg/L in effluent
  - Chemical P - About $10K per MG to achieve 1.0 mg/L in effluent

45

Phosphorus Removal

- Bio P
  - If included now…
    - Capital Cost may be viewed as insurance
    - Operation in Bio P mode enhances receiving stream
    - Additionally, Operation in Bio P mode increases Sludge Settle-ability (SVI)
  - If added later…
    - Space would have to be reserved
    - Capital Cost will be far greater

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Phosphorus Removal

- Chemical P
  - If included now…
    - Capital Cost lower than providing for Bio P
  - If added later…
    - Space would have to be reserved
    - Capital Cost will be lower than providing for Bio P

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Phosphorus Removal

- Annual Costs for P Removal
  - Bio P – Range of $4K to $6K per MG to achieve 1.0 mg/L P in effluent
    - Assumes that some Chemical P treatment is necessary to consistently meet effluent standard of 1 mg/L P
  - Chemical P – Range of $100K to $110K per MG to achieve 1.0 mg/L P in effluent

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P Removal Costs – $1000's

Cost Element (per MG)	*Bio P*	*Chemical P*
Additional AT	$66	$0
Chemical S and H	$4	$10
Total Add'l Capital	$70	$10
Annual Chemical Cost	$4	$80
Add'l Annual Sludge Cost	$2	$25
Total Add'l Annual Cost	$6	$105
Present Worth	$130	$1,000

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P Removal Costs – $1000's

Phosphorus Removal PW Cost Summary		
Plant Capacity	*Bio P*	*Chemical P*
20 MGD	$2,600	$20,000
32 MGD	$4,200	$32,000
50 MGD	$6,500	$50,000
62 MGD	$8,100	$62,000
82 MGD	$10,700	$82,000

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Phosphorus Removal

- Summary:
  - Small, but real possibility of a regulatory P standard in the future
  - Bio P requires a relatively small capital investment to provide "insurance policy"
  - Operation in Bio P mode will enhance receiving stream
  - Operation in Bio P mode will improve sludge settle-ability (SVI)

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Phosphorus Removal

- Recommendations from WS #4
  - Include Bio P as a primary issue regarding Process Alternative Screening
  - Include Bio P in Process Alternative Cost Evaluations

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Phosphorus Removal

- Should the PCWMD ROMP include Bio P removal as a primary consideration in the selection of process alternatives?

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Key Design Criteria

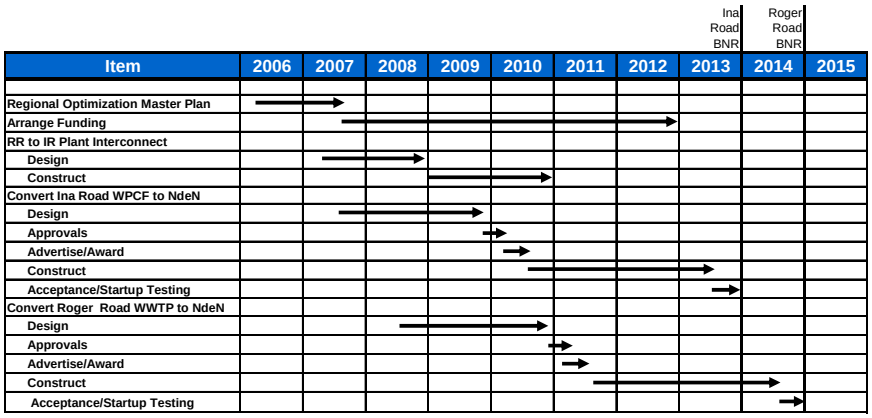
Joe Popeck

Key Design Criteria

- Schedule
- Level of detail for layouts of treatment plant alternatives
- Capital costs
- Strategic risk elements
- Value of existing facilities
- Annual costs/ present worth
- Design criteria used to size treatment processes

55

Project Implementation Schedule



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Level of Detail for Layouts of Treatment Plant Alternatives

- Show underground conduits and other significant physical constraints on site plans
- Identify capital cost associated with reconfiguration of underground conduits and other significant physical constraints in evaluation of alternatives
- Include requirements and costs for demolition/removal in evaluation of alternatives

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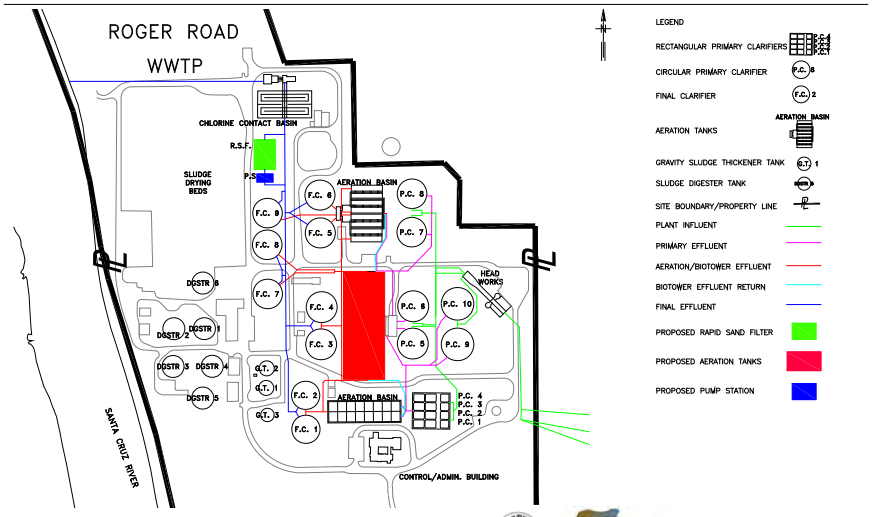
Example Layout – Roger Road Bardenpho 20 MGD



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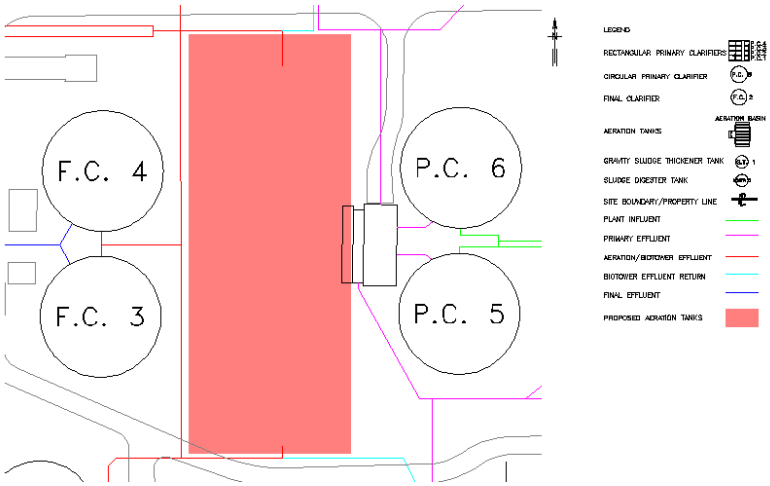
Example Layout – Roger Road Bardenpho 20 MGD



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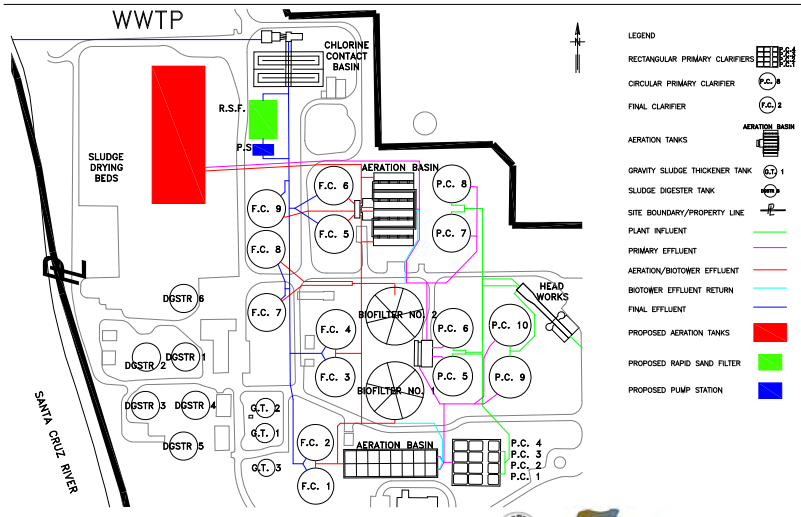
Example Layout - Roger Road Bardenpho 20 MGD



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Capital Costs

- Basis of capital cost estimates for process evaluations summarized in the Overview of W/W Costs Program
- Capital costs for IF/AS and Membrane Process alternatives - media, membranes and ancillary equipment not normally associated with conventional processes based on costs provided by vendors.

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Strategic Risk Elements

- Mission Risk
  - Will PCWMD be able to delivery without interruption, wastewater treatment by depending on existing structures to meet the department's overall mission and goals?

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Strategic Risk Elements

- Operational Risk
  - Will PCWMD be able to ensure continuity of operations and the safety of those operating the facilities?
    - Functionality
    - Obsolescence
    - Maintaining treatment while constructing upgrades

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Strategic Risk Elements

- Systems Risk
  - Will PCWMD be able to ensure that all unit processes will operate as intended in an overall wastewater treatment system?
    - Information Adequacy
    - Remaining useful life

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Strategic Risk Elements

- Physical Risk
  - Will PCWMD have to deal proactively with any risks (unknowns) related to the long term utility of existing structures?
    - Latent Defects
    - Subsurface Risk
    - Time and access for inspections
    - Timing between planning, design and construction

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Strategic Risk Elements

- Political Risk
  - Will PCWMD risk exposing the department to bad publicity by not being able to delivery the services the elected officials and the public expect?

66

Value Of Existing Facilities

- Existing facilities to be incorporated into the new scheme may have value
- However, determining the value of existing facilities requires risk adjusted pricing techniques to be employed

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Risk Adjusted Pricing

- Utilizes standard utility valuation methodology
- Recognizes risks associated with use of existing assets
- Takes into consideration both condition and functionality of existing assets

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Pricing Without Risk

If you DO NOT recognize risk associated with using existing assets, total cost of additional aeration basins would be priced:

Facility	*Total Capacity Needed (MG)*	*Existing Capacity (MG)*	*Additional Capacity Needed (MG)*	*Total Cost New at $1,000/MG*
Aeration Tank	**40**	**20**	**20**	**$ 20,000**

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Valuation Methodology

- Utilizes asset approach to determine investment value of existing assets
- Investment value recognizes value to a specific owner as opposed to the value to the marketplace as a whole

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Risks Associated With Existing Assets

- Condition Risk – Poor condition of assets limits their usefulness
- Functional Risk – Design, configuration, or location may limit their usefulness

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Determining Risk Adjusted Value

- Determine value if new:

Facility	*Existing Capacity (MG)*	*Value If New at $1,000/MG*
Aeration Tank	**20**	**$ 20,000**

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Recognize Condition Risk

- Assign a condition factor to the asset that approximates its remaining useful life based on inspection of the asset
- Accuracy and precision of the condition factor affected by availability of information about the asset, and scope of the inspection performed

Condition	*Condition Factor*
Excellent	**90%**
Good	**70%**
Marginal	**40%**
Poor	**10%**

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Recognize Functional Risk

- Assign a functionality factor to the asset that characterizes its functionality and compatibility with respect to the rest of the new system. This factor should take into consideration asset's configuration and location as well as asset's potential for premature obsolescence

Functionality	*Functionality Factor*
Properly located and/or configured; compatible; newer technology	**75%**
Marginally located and/or configured; marginally compatible; older technology	**50%**
Poorly located and/or configured; incompatible outdated technology	**25%**

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Develop Risk Adjusted Value

- Apply risk adjustment factors to value of asset if new to determine risk adjusted value:

Facility	*Existing Capacity (MG)*	*Value If New*	*Condition Factor*	*Condition Adjusted Value*	*Functionality Factor*	*Risk Adjusted Value*
Aeration Tank	**20**	**$ 20,000**	**70%**	**$ 14,000**	**75%**	**$ 10,500**

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Develop Risk Adjusted Pricing

- Risk adjusted cost of the facility, using existing assets, is the cost new, less the risk adjusted value of existing assets

Facility	*Total Capacity Needed (MG)*	*Cost New at $1,000/MG*	*Risk Adjusted Value of Existing Assets*	*Risk Adjusted Cost*
Aeration Tank	**40**	**$ 40,000**	**$ 10,500**	**$ 29,500**

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Annual Costs

- Power @ 8.7 cents per kWh
- Methanol @ 15 cents per pound ($1.00 per gallon)
- Alum @ $400 per ton (dry basis), $1.00 per gallon, liquid basis

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Present Worth

- Present worth
  - The present worth analysis is based on 20 years with an 8 percent discount rate

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Design Criteria Used to Size Treatment Processes

- Step 1: Use GPS-X model for each plant to determine NdeN capacity existing of primary and secondary tankage if converted to the process alternative
  - Based on the ratio of the process specific NdeN capacity per MG of existing tank volume, computes volume of additional tankage required for each flow regime of a specific process alternative
  - Primary clarifier area – 1,000 gpsfpd
  - Secondary clarifier area – 600 gpsfpd
  - Rapid sand filter surface loading rate – 3 gpm/sf (equates to 6 gpm/sf @ peak hydraulic flow conditions)
  - Denitrification filter surface loading rate – 2 gpm/sf (equates to 4 gpm/sf @ peak hydraulic flow conditions)

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Design Criteria Used to Size Treatment Processes

- Step 2: Conduct "reasonableness" check with Process Team Members, based on:
  - Comparison of GPS-X model results to actual experience
  - Comparison of GPS-X model results to experience based hand calculations

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Design Criteria Used to Size Treatment Processes

- Step 3: Revise treatment process sizes based on consensus opinion of Process Team Members after Steps 1 and 2

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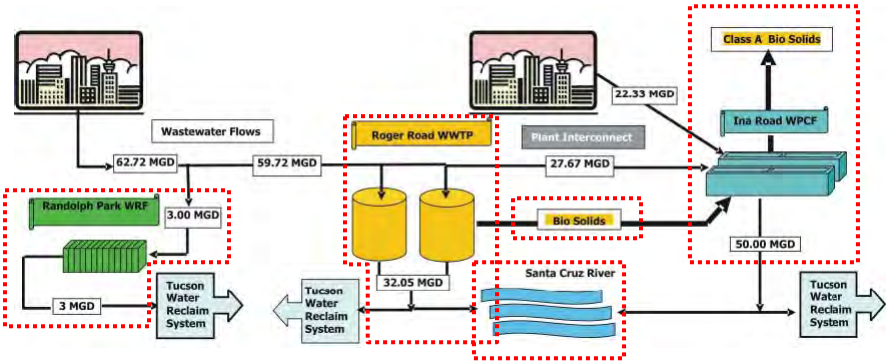
Pima County Wastewater Management Department

GREELEY AND HANSEN

Process System Configuration Evaluation & Second Treatment Process (Sensitivity Testing)

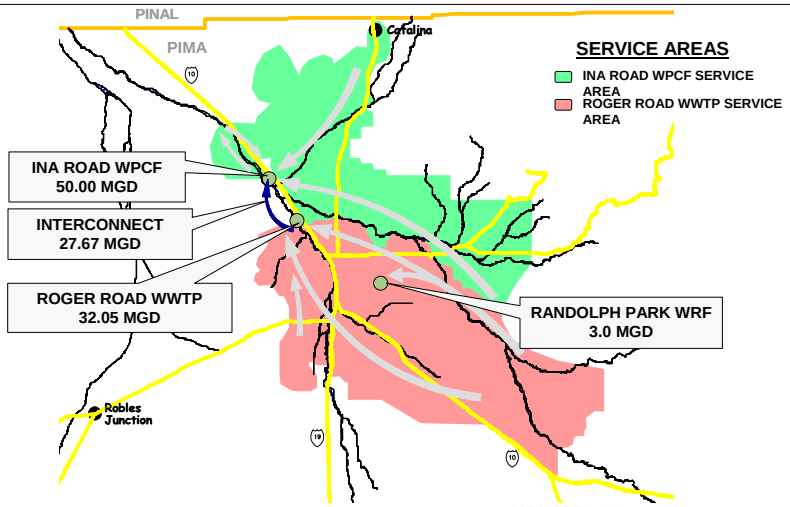
Gordon Culp

Existing Plan Schematic



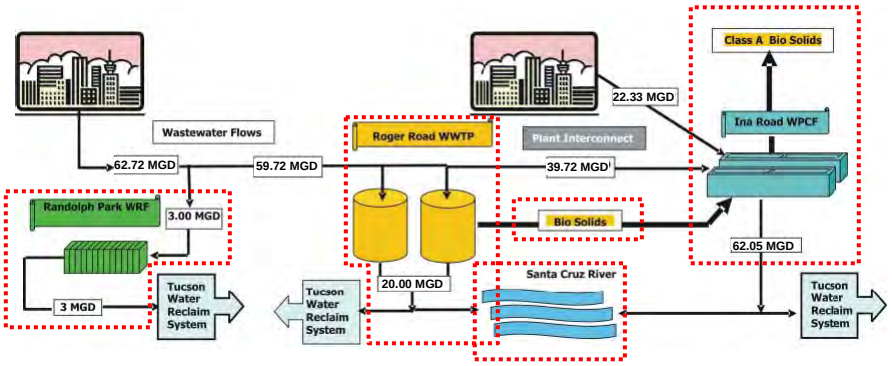
83

Existing Plan (2030)



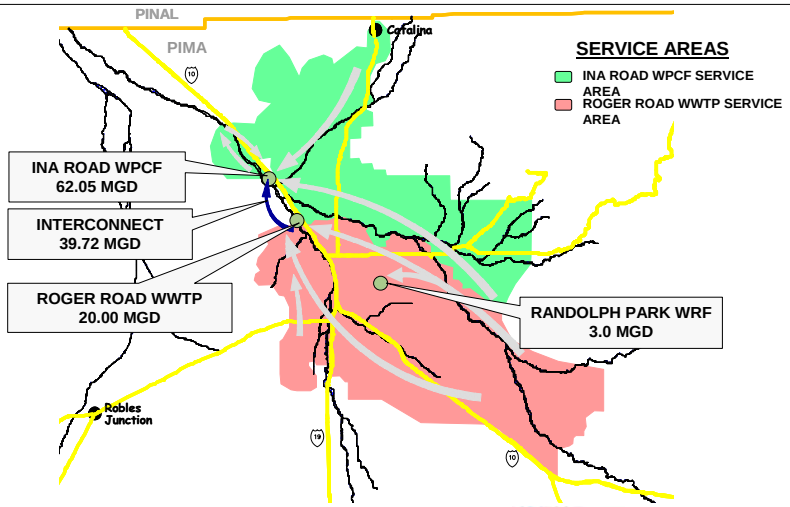
84

Transfer Some Schematic



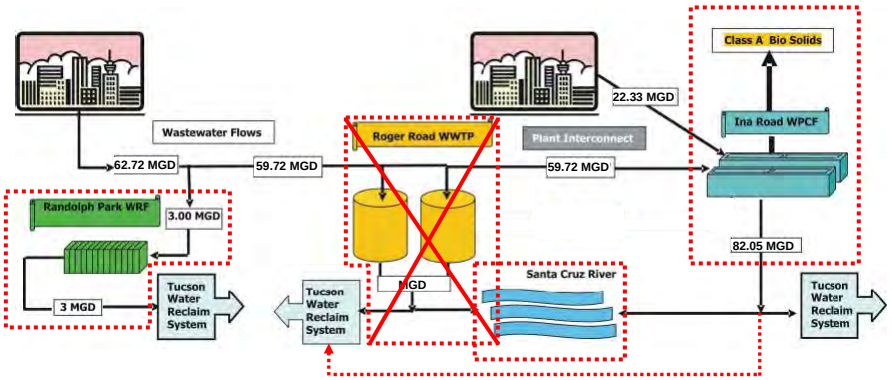
85

Transfer Some (2030)



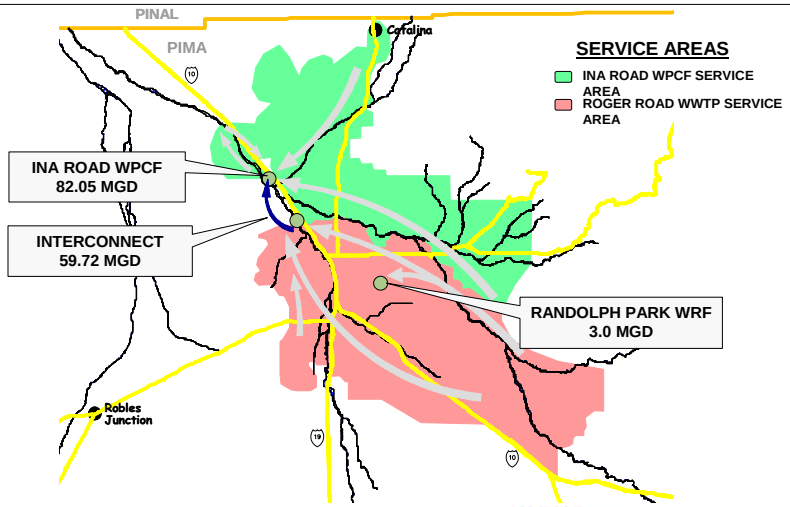
86

Transfer All Schematic



87

Transfer All (2030)



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System Configuration Evaluation

- Layout and evaluate Bardenpho and one other treatment approach for each site for the three system configuration options including a greenfield option at Roger Road WWTP
- Prepare cost evaluation matrices, one based on Bardenpho and one based on the second treatment approach
- Prepare non-economic evaluation matrix
- Select system configuration

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System Configuration Cost Evaluation

Criteria	*Existing Plan*	*Transfer Some – Rehab RR*	*Transfer Some – Greenfield RR*	*Transfer All*
Plant Interconnect	$	$	$	$
Conveyance to RR and IR	$	$	$	$
Rehab Roger Road WWTP	$	$		
Provide NdeN Removal at RR	$	$	$	
Demolish RR			$	$
Provide NdeN Removal at IR	$	$	$	$
Expand IR WPCF	$	$	$	$
Convey Effluent Back to RR for Reuse	(Depends)	(Depends)	$	$
Convey Effluent to Other Points of Reuse	$	$	$	$
Sludge Transfer to IR	$	$	$	$
TOTAL COST	$	$	$	$

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System Evaluation Matrix

Complete System Evaluation Matrix for Non-Economic Factors							
Criteria		*Ranking*			*Weighted Ranking*		
	Criteria Weight	*Existing Plan*	*Transfer Some*	*Transfer All*	*Existing Plan*	*Transfer Some*	*Transfer All*
Cost	5						
Schedule	5						
Constructability	3						
Flexibility	4						
Env. Impacts	4						
Water Reuse	5						
Public Acceptability	5						
Employee Safety	4						
Cost Sharing Potential	3						
Effects on Financing	3						
System Reliability	5						
TOTAL							

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Summary Wrap-Up

Andy Richardson

Summary Wrap-Up

- Comments by Group
- Closing Remarks

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Workshop #10
Technologies Workshop (System Configuration)

1. Workshop #10 – Technologies Workshop (System Configuration) for Pima County Regional Optimization Master Plan was held on September 26, 2006. For the record the agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
Controller
Jeff Nichols
PCWMD Staff
Bob Decker
Houssam Eljerdi
Laura Fairbanks
Dennis Froehlich
Frank Gall
Mary Hamilton
Michael Kostrzewski
Byron McMillan
Jeff Prevatt
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
John Sherlock
John Warner
Ken Weber
Eric Wieduwilt
Legal
Chuck Wesselhoff

PIMA COUNTY PARKS & RECREATION
Rafael Payan, Director, Natural Resources
Stephen Dean

PIMA COUNTY
Deputy County Administrator
John Bernal (afternoon only)

TUCSON WATER
Tucson Water Staff
Mitch Basefsky
Melodee Loyer
Dennis Rule
Tim Thomure
Dean Trammel
Wally Wilson
Alan Forrest, CH2M Hill
Ken Thompson, CH2M Hill

PEER GROUP
Joe Husband, MPI
Gary Newman, B&C
Cindy Wallis-Lage, B&V

GREELEY AND HANSEN PROJECT TEAM
Orrie Albertson
Jerry Bish
Gordon Culp
Eric Petersen
Joe Popeck
Andy Richardson
Dave Stensel

2. Major topics and goals of the workshop were:
   - Topics
     - Review previous decisions regarding system configuration options and selected wastewater treatment processes
     - Review costs bases for cost development for options and alternatives
     - Examine the wastewater treatment processes considered and recommended
     - Examine conceptual site layouts for each option and process alternative
     - Review the present worth costs of each system configuration option and selected processes
     - Review impacts of Sports Park Complex at Roger Road
     - Discuss and agree on completed cost, process and evaluation matrices

   - Goals
     - Decide system configuration among the options for Roger Road WWTP and Ina Road WPCF
     - Decide process for wastewater treatment among selected alternatives at each facility

   A set of handouts were provided to each attendee which included presentation slides used during the workshop.

   Throughout the workshop notes were recorded on a set of "flip-charts". Those notes summarize questions, comments, and notes to be utilized by the project team while conducting the study. Those flip-chart notes are attached.

3. Mike Gritzuk, Director of the Wastewater Management, welcomed the attendees to Workshop #10 and invited those attending to spend the day drilling down on the issues and details of the system configuration options and the wastewater treatment processes for Roger Road WWTP and Ina Road WPCF. It is time to make decisions on the system configuration and process at each plant to meet ADEQ requirements in January. During the workshop Rafael Payan, Director of Pima County Natural Resources, will make a presentation on the Sports Park Complex that is planned on the County and City owned land along I-10 and around the Roger Road WWTP. Included in that presentation will be summary of the recreational and economic development opportunities that it brings to Pima County, the City of Tucson and the region.

   As in the other workshops, Tucson Water is welcome to the workshop to participate and contribute. In addition, John Bernal, Deputy County Administrator, will join the workshop in the afternoon as the discussion moves toward decisions on system configuration and treatment process selection.

4. Andy Richardson defined his role as facilitator with the task of moving the group through the agenda and to encourage participation. Pre-workshop materials provided to the attendees for review prior to the workshop included:

- Overview of wastewater costs program
- Cost estimate methodology
- MLE/Bardenpho preliminary designs
  - Roger Road
  - Ina Road
- IFAS design
- BT/NAS-deN filter with ME^{+3} and MeOH flow sheet
- Cost of condition risk
- Process evaluation cost data
- Presentation slide materials

Decisions from previous workshops (Workshops #4, #5/6 and # 9) regarding the system configuration and wastewater treatment process needed to the meet the ADEQ permit were reviewed. In addition, the goals of the workshop to make decisions on the system configuration and wastewater treatment process were summarized.

Agenda, groundrules, previous workshop decisions and goals of the workshop were presented and covered on pages 1 through 6 of the handout.

5. Gordon Culp reviewed the evaluation methodology for system configuration cost, process sensitivity comparisons and system evaluation that are used by the project team. The evaluation criteria for non economic factors and weighting of each criterion was developed with the workshop participants over several previous workshops and were applied to the data and information developed for the Pima County alternatives and options. The ranking of the criteria and the results will be discussed later in the meeting summary. Attendees were reminded that the system cost and evaluation matrices are indicators of the relative strengths and weakness of the each option, and provide a structure for discussion of the options. Judgment must be applied to the resulting rankings of the options.

   System configuration and process evaluations were covered on pages 6 and 7 of the handout.

6. Jerry Bish provided an overview of basis of the capital and operating costs used in development of the system configuration options and alternative costs. Construction costs for new systems were developed from various sources and applied uniformly across the alternatives and options. A risk adjusted pricing was applied to re-use of existing structures and systems to account for condition and functionality within the future system arrangement or scheme.

   Based on recent evaluations of the conveyance system it was stated that the interconnect pipeline sizing should be based on 2 times average flow to accommodate for diurnal and wet weather flows rather than the 1.4 times average flow. Alternatively, flow equalization would need to be provided at the Roger Road WWTP to address wet weather. The subsequent presentation of costs will demonstrate that the relative costs of the alternative system configuration would not be affected by increasing the size of the interconnect pipeline. The change in pipeline costs is a very small part of the present worth costs for the system configuration options.

Gary Newman indicated the existing 8-inch pipeline may be inadequate to convey all the sludge from Roger Road WWTP to Ina Road WPCF. It was pointed out that primary sludge would be collected and removed at Roger Road WWTP, and conveyed to Ina Road WPCF through the plant interconnect. The project team will check the capacity of the existing sludge force main to handle secondary sludge.

There was a feeling among several attendees that the estimated construction costs of approximately $4 to $5/gallon/day for the "greenfield" project at Roger Road may be low. Some stated that the current "rule of thumb" for construction costs may be closer to $8 to $10/gallon/day. It was pointed out that the "greenfield" plant does not include sludge thickening/dewatering and digestion facilities, which are major costs of wastewater facilities. It was further indicated that when costs of the 32 mgd "greenfield " facility at Roger Road are combined with the associated sludge digestion and thickening capacity at the Ina Road WPCF that the average cost is $8.50 per gallon per day for construction.

The capital costs used for evaluation are not for use in a capital improvement program, but are for comparison of costs related to the wastewater treatment process elements. Common elements to each system configuration were not included in the capital costs and when those elements are included, the planning level costs per gallon of capacity will increase further. Joe Husband observed that applying common element costs to each of the systems would bring the percentage of costs for each system closer together. It was suggested that the project team specifically identify the common elements not included in the system evaluations.

The costs bases for capital costs were covered on pages 8 through 10 of the handout.

7. Eric Petersen presented why it is important to recognize risk and its related cost when utilizing existing facilities for future use. Information inadequacy, latent defects, subsurface unknowns, maintenance of existing operations at high performance levels during construction, and other factors need to be considered. Risk consequences fall into three general categories: increased costs, schedule delays (possible permit violation and fines), and non-performance issues. Contractors translate unknowns into risk costs to cover their probable costs which inflate construction costs. The owner can reduce risk costs by accepting more risk for the unknowns to existing structures, but usually will pay a premium for change orders during construction if the unknowns cause additional work. There are some techniques to transfer "manageable" risk through different project delivery systems.

   There is uncertain cost exposure for contractor and owner from "open-ended" risk. With structures at Roger Road WWTP at 50 years of age, there may "open-ended" risks with the buried assets, as well as, risks in modifying or adapting existing structures into new uses.

   Condition risk, risk consequences and pricing of risk were covered on pages 11 through 13 of the handout.

8. Jerry Bish covered the bases of the operation and maintenance costs and the risk adjusted costs for existing structures utilized in the development of the present worth costs for the options and alternatives. Ken Weber indicated that Pima County is paying $2.40 for a gallon of methanol. Dave Stensel indicated that New York City is currently paying about $2.00 a gallon for methanol. These

methanol costs are higher than those used in the cost estimates, which were based on the current cost paid by Tampa, Florida, for their wastewater treatment plant.

Risk adjusted costs has two basic components. One component is for condition of the asset to be re-used and the other is for functionality of that asset in the final system arrangement. The risk adjusted cost represents the costs required to bring the asset up to a condition that will be compatible or operationally comparable with new assets incorporated into the process or system.

Risk adjusted pricing, and values for energy, chemicals and labor used for determining present worth for system options and alternatives were covered on pages 13 through 15 of the handout.

9. Orrie Albertson presented the information on the system configurations (existing plan, transfer some or transfer all) and processes considered with each system configuration option. The wastewater treatment process systems evaluated included Bardenpho, as the base case, and for sensitivity analysis the evaluation of MLE + denitrification filters, IFAS, BT/NAS (at 20 mgd for Roger Road WWTP only). Different wastewater characteristics are to be used for Roger Road WWTP than Ina Road WPCF. The project team is to review that it is was consistent in the application of wastewater characteristics. Under all alternatives biosolids treatment and processing are centralized and undertaken at the Ina Road WPCF.

   It was reported that the new BNRAS system which is in start-up at Ina Road was performing well. Effluent TKN values are 6.3 mg/L at a flow of 12.5 mgd. Dennis Froehlich indicated that the primary TKN is averaging 27 to 28 mg/L, a value lower than the assumed concentration in the process evaluations. In that regard Cindy Wallis-Lage asked if the historical TKN values had been reviewed. The response was that the historical information had been reviewed and was similar to the special testing program undertaken recently. For additional historical laboratory information, Joe Husband indicated that the Ina Road WPCF Effluent Denitrification Study, August 2004, had 3 months of information regarding influent COD and BOD for use in the process evaluation.

   Eric Weiduwilt asked how does different wastewater characteristics impact the system sizing and development and does it impact them equally. Cindy Wallis-Lage indicated that the aeration systems would be impacted the same, but that there may be some other impacts to the MLE + deN filters. Joe Husband saw a possible change in phasing of construction, but not necessarily on the system design. Both agreed that the sizing of the second anoxic zone would be impacted by the amount of TKN in the influent. Dennis Froehlich indicated that the handling of future flow and concentrations at 65 gcpd or 85 gcpd have implications on the design. Joe Popeck stated the values used are for planning purposes. While it will be valuable to discuss this further in the design phase, the results of the system configuration options evaluation will demonstrate that this is not a significant factor when comparing system configurations.

10. For the IFAS design a SRT of 3.5 days was used in the development of the system. The manufacture of the Kaldnes media recommends a SRT of 3.26 days. Denny Parker, although not present at the workshop indicated in a correspondence that an aggressive SRTs of 2 to 3 days should be evaluated in a pilot test. Those SRT values are well below the manufacture's recommendation. Another approach is to pre-bid a process with a manufacture, like Kaldnes, and negotiate a performance criteria. Cindy Wallis-Lage thought the original purpose for considering IFAS was to maximize the usage of existing tankage at Roger Road WWTP and believes that IFAS would be viable at Roger Road WWTP in the

existing tankage providing a capacity of 20 mgd plus or minus. If the flows at Roger Road WWTP are 32 mgd, then IFAS would probably not be cost effective.

11. For the MLE + deN filters process Frank Gall asked why the clarifiers are similar in size to the IFAS. The reason is that both systems have MLSS that needs to be separated from the treated wastewater. Mike Kostrzewski asked if the biogas will be produced at Ina Road only. The answer is yes, but until there is a need for Pima County to move to a Class A biosolids, biosolids would continue to be digested at the Roger and Ina Road facilities. Cindy Wallis-Lage suggested that there appears to be an inconsistency in the pre-workshop write-up on MLE and Bardenpho page 16, Table 8. The project team will review the write-up for consistency. Gary Newman asked if the rectangular primary tanks at Roger Road WWTP were to be used in the future. The answer is no for primary clarifer service, but would continue to be used for overflow service at the plant.

    Wastewater processes were covered on pages 15 through 21 of the handout.

12. Joe Popeck presented the site layouts and costs for the different system configuration options and process alternatives. System configurations included a "greenfield" facility at Roger Road for 20 and 32 mgd along with the rehabilitation and expansion of the existing facilities. Further the "greenfield" alternatives were looked at with circular and rectangular (for space saving purposes) clarifiers. The "greenfield" site was arbitrarily shown on the north side of the County property. The system configuration costs of the options indicate the least costly option to be the 32 mgd at Roger Road WTTP and 50 MGD at Ina Road WPCF.

    The amount of redundancy to be provided at a "greenfield" plant at Roger Road WWTP was raised as a concern. The concept to date has been to provide limited redundancy at the "greenfield" plant and rely on the plant interconnect to transfer flow to Ina Road WPCF during emergencies. Tucson Water indicated that if there were outages due to lack of redundancy at Roger Road that the pipeline for reclaimed water would need to be made larger to meet the demands for a reliable supply of reclaimed water at Roger Road. Joe Husband suggested providing more parallel unit processes at the "greenfield" facility to mitigate the effects of any unit out of operation would be prudent.

    John Warner suggested instead of placing a new plant in the middle of a park that it be moved immediately south of the existing plant at Roger Road. Paul Bennett indicated that there is a "greenspace" in front of the existing Roger Road plant on City and County property that is available to site a new facility. Melodee Loyer indicated that Tucson Water needs the pump station and reservoir to remain in service at Roger Road for the reclaimed water operations. Also, a question why 10 acres is needed by Tucson Water at Ina Road WPCF, if Class A+ water is discharged from the Ina Road WPCF. The response was that the area is needed at Ina Road WPCF for a reservoir and pump station system to serve the reclaimed water system.

    Dennis Froehlich asked why the cost of rectangular clarifiers was more expensive than circular tanks. Although common wall construction reduces space and construction costs, rectangular tank equipment and maintenance and operations expenses are more than circular tanks. The circular versus rectangular tanks is a debatable issue even amongst the project process team. Joe Husband asked about the sizing of filters. In response denitrification filters were sized on 2 gpm at average flows and 4 gpm at maximum flows, and rapid sand filters were sized at 3 gpm at average flows and 6 gpm at maximum flows. Joe Husband cautioned that phosphorus in the recycle flows at Ina Road WPCF

will need to be carefully addressed and that cost of chemicals to remove phosphorus from those flows need to be considered. Gary Newman observed that O&M costs were close for all options.

Site layouts for the system configuations and associated costs for capital, annual and present worth were coverd on pages 21 through 31of the handout.

13. Rafael Payan presented the current opportunity that the County and City has to provide the community with extraordinary multi-faceted recreational and ecological facilities for use by the region. The plan includes the construction of tournament grade facilities for amateur soccer, softball and baseball along I-10 at the site of the Roger Road WWTP and the restoration of riparian habitat along the Santa Cruz River. Walking and biking trails, picnicking areas and other features would connect Columbus Park to the new recreational areas and the surrounding communities. In addition, the plan offers a connection to the Silver Bell golf course to make one large public space for community use. The Transportation Department has targeted the intersection of Camino del Cerro and I-10 for improvement to increase access to the park site.

    The new recreational facilities would have the capacity to attract out-of-region events that in turn would support economic development to the area, including a hotel and restaurant facilities to serve the events. The recreational facilities would include: 12 baseball fields, 18 soccer fields and 12 softball fields.

    The University of Arizona is undertaking of the economic benefit analysis and their agriculture department is looking at the turf issues for the playing field. The site would be a world class park with approximately 375 acres that stretches along the main access corridor to the City of Tucson to further enhance one of the most livable cities in the U.S.

    Dennis Froehlich commented that the recreational fields would become an additional reclaimed water customer and offered that the Randolph Park Water Reclamation Facility is an example of a good neighbor plant that does not smell.

    Mike Gritzuk stated that the new “greenfield” wastewater treatment facility could be located on City or County owned land, and further commented that the existing Roger Road WWTP would not work as well into the park plan. The next steps for the PCWMD are to finalize the plan on the preferred option and treatment process, submit the plan to the Board of Supervisor for approval, and transmit the plan in a letter to ADEQ. The ADEQ letter does not specifically require a location of the treatment facilities at Roger Road which could give the park planners some more time to coordinate the location of facilities.

14. Gordon Culp presented the system configuration cost evaluation, process evaluation and system evaluation with the results of project team evaluation. The value of each criterion for each system configuration option was reviewed with the workshop attendees. After discussion by the group, adjustments were made in the criteria. The revised system evaluation matrix is provided below. Changes from the project team values are noted by shading.

Criteria	Weighting Factor	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5	5	4	2	4	3	25	20	10	20	15
Schedule	5	3	3	5	5	5	15	15	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	4	4	4	12	12	16	16	16
Environmental Impacts	4	3	3	4	4	4	12	12	16	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	1	2	2	3	2	5	10	10	15	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	5	4	2	4	3	15	12	6	12	9
TOTAL		39	36	39	49	43	158	147	159	199	175

Mary Hamilton suggested the title of the criterion for Water/Wastewater System Optimization be retitled to reflect the criterion definition.

Paul Bennett suggested that the value of costs needed to be increased from 5 to 10 to test cost sensitivity. If the cost criteria weighting was changed from 5 to 10, the ranking of alternatives would not change except for rehabilitating Roger Road WWTP at 32 mgd moves from 4th to 3rd in ranking (see table below).

Cost	RR = 32 IR = 50 $431M	RR = 20 IR = 62 $464M	RR = 0 IR = 82 $514M	RRGF = 32 IR = 50 $457M	RRGF = 20 IR = 62 $480M
WT 5 Ranking	158	147	159	199	175
WT 10 Ranking	183	167	169	219	190

The evaluation matrices were covered on pages 32 through 37 of the handout.

15. The system configuration evaluation matrix indicates that the option to treat 32 mgd at Roger Road WWTP and 50 mgd at Ina Road WPCF is the preferred arrangement. In addition, there are clear indications in the evaluation matrix that a "greenfield" facility at Roger Road is preferred over rehabilitation and upgrades to the existing facilities. The "greenfield" facility eliminates the rehabilitation and sequencing of construction challenges within an existing operational facility. The "greenfield" also would work best within a Sports Park Complex.

    It was noted that the new aeration tanks for the Ina Road facility were located next to the property line and do not meet setback requirements. Joe Popeck indicated that the aeration tanks located along the property line could be moved to achieve the 350-foot setback requirements. In addition, Roger Road could probably be located south of the existing plant provided setbacks can be met.

Cindy Wallis-Lage indicated although that the ratings would not change, but asked at what cost differential would the "greenfield" plant become less attractive than the costs to rehabilitate and upgrade the existing Roger Road WWTP. It was agreed to review the construction cost difference between the "greenfield" and rehabilitation and upgrade at Roger Road WWTP, and make an assessment of the differential in costs to confirm the system arrangement at Roger Road.

16. Dennis Rule indicated that the recommended system configuration is consistent with the goals of Tucson Water, Pima County, and is consistent with the Sports Park Complex and that he could support the results. The peer group each agreed with the recommendation. Gary Newman opined that he hated to "jack hammer" existing infrastructure, but could accept the results.

    Ron Riska expressed concern over the estimated construction costs. John Bernal had thought the treatment facilities would be centralized at one location, which would allow addressing the land area between the plants for other uses. With this not being the case, it is important that the key points be developed to educate the public. Key points are:

    - Frees up property for economic development
    - Eliminates cost/schedule risk associated with rehabilitation of the Roger Road WWTP
    - System more flexible, reliable, operable
    - Better integration with reclaimed water
    - Least risk for regulatory non-compliance
    - Keeps eco-system in Santa Cruz River

    The recommended system configuration option was covered on page 38 of the handout.

17. For the process decision, Jeff Nichols indicated that the "end-users" should weigh in on their choice for process. The operations staff and the peer group were individually polled on the process choice. The operations staff and the peer group agreed that Bardenpho is the right answer. Several commented that Bardenpho eliminates or minimizes the need to utilize methanol in the process, as well as, eliminating the need to add alum or other coagulants to remove phosphorus in the future.

18. Mike Gritzuk indicated additional work was required to develop the economic plan for financing and determining the project delivery methods for the plan, and considering the regulatory deadlines it was fortunate that a system configuration and treatment process were selected during Workshop # 10. The meeting closed with a reference to the next workshop on October 11, 2006 on conveyance and flow management.

Agenda
Workshop #10 – Technologies Workshop (System Configuration)
September 26, 2006

Time	Topic	Presenter
7:45 am	*Continental Breakfast – The Historic Manning House, 450 W. Paseo Redondo*	
8:00 am	Opening Session	
	• Welcoming Remarks	Mike Gritzuk
	• Review Agenda	Andy Richardson
	• Previous Process Decisions	
	• Workshop Goals	
	• Evaluation Process Review	Gordon Culp
8:35 am	Cost Basis	Jerry Bish
	• Capital Cost	
	• Condition Risk	Eric Petersen
	• Risk Adjusted Cost Evaluations	
	• O&M Costs	
	• Present Worth Cost	
9:20 am	Processes	Orrie Albertson
	• System Configuration	
	• Biosolids and Bio Gas	
	• Bardenpho	
	• Sensitivity Evaluation	
9:45 am	Break	
10:00 am	Site Layouts and Costs	Joe Popeck
	• Bardenpho 32/50	
	• Bardenpho 20/62	
	• Bardenpho 0/82	
10:30 am	Sports Park	Rafael Payan/Andy Richardson
11:00 am	Site Layouts and Costs, continued	Joe Popeck
	• Bardenpho 32/50 (Green Field at Roger Road)	
	• Bardenpho 20/62 (Green Field at Roger Road)	
	• IF/AS 32/50	
	• MLE + deN Filters 32/50	
	• BT/NAS 20/62	
12:30 pm	Lunch	
1:00 pm	Evaluation Matrices	Gordon Culp
3:00 pm	Break	
3:15 pm	System Configuration Recommendation	Andy Richardson
3:30 pm	Process Recommendation	Andy Richardson
3:45 pm	Next Steps	Andy Richardson
4:00: pm	Summary Wrap-Up	Andy Richardson
	• Comments by Group	
	• Closing Remarks	Mike Gritzuk
4:15 pm	Adjourn	

Flip Chart Notes – September 26, 2006

Overview
- P removal criteria is included in the process
- Wastewater characteristics are different for Roger Road than Ina Road

Cost Estimate
- Cost number appears low – $4/gal/day
- Comparative cost elements – some elements not included
- What elements not included?
- Concern on demand costs

Cost Overview
- How much will plants be automated - not addressed in detail at this level of planning
- All costs numbers include "soft costs"
- Need to consider sludge transfer costs
- Easement costs are not included in conveyance costs

Risks
- Operation during construction meeting permit concerns
- Question on how factors (risk adjusted pricing) applies; provide an example in supplemental information
- Are MOPO costs included? No

Site Layout
- Over estimated rehabilitation and under estimated "greenfield" costs

Process
- Has COD data been reviewed? Yes
- Pilot plant data for effluent denitrification is available

Site Layouts
- Chances of setback varying are slim; may want to consider being within setbacks
- List assumptions on cost on what is included and is not included

Evaluation Matrix Discussion
- What happens if weighting for costs were changed from 5 to 10:

Cost	RR = 32 IR = 50 $431M	RR = 20 IR = 62 $464M	RR = 0 IR = 82 $514M	RRGF = 32 IR = 50 $457M	RRGF = 20 IR = 62 $480M
WT 5 Ranking	158	147	159	199	175
WT 10 Ranking	183	167	169	219	190

Pima County
Regional Optimization
Master Plan

Workshop #10
Technologies Workshop
(System Configuration)

September 26, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator/Previous WS Decisions
Jerry Bish	Cost Basis
Orrie Albertson	Processes
Joe Popeck	Site Layouts and Costs
Rafael Payan	Sports Park Update
Gordon Culp	Cost Matrix/Evaluation Matrix
Andy Richardson	System/Process Recommendation/Next Steps/Wrap-Up

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop Goals
- Previous Workshop Decisions
- Cost Basis
- Processes
- Site Layouts and Costs
- Sports Park Update
- Cost and Evaluation Matrices
- System Configuration Recommendation
- Process Recommendation
- Next Steps
- Summary Wrap-Up

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

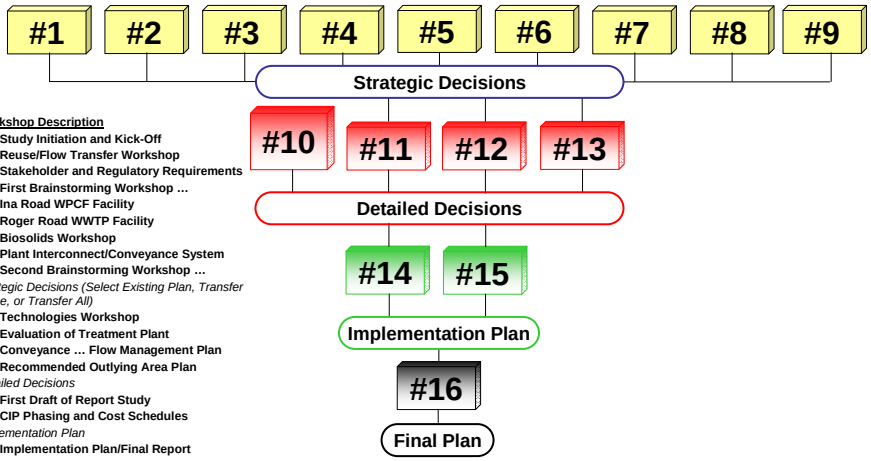
8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

9

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

10

Previous Workshop Decisions

- Workshop #4 – June 5, 2006
  - Agreed on viable process alternatives
  - Agreed on matrix evaluation criteria
  - Agreed on matrix evaluation criteria weighting
  - Agreed to continue evaluating Bardenpho, MLE and IFAS and MBR
  - Agreed that P removal was a process criteria
  - Agreed to drop AS/NTF, BT/NAS, Step NdeN, Biostyr/Biofor and MBBR from further consideration

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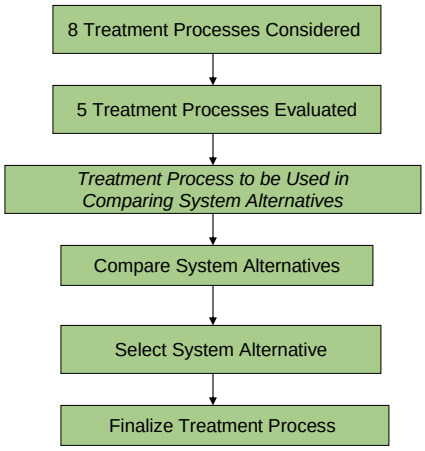
Treatment Process Selection



12

Previous Workshop Decisions

- Workshop #5/6 – July 12, 2006
  - Processes with nitrification only were eliminated
  - Agreed to further evaluation Bardenpho for system configuration options
  - Agreed to consider other processes with denitrification for sensitivity testing

13

Previous Workshop Decisions

- Workshop #9 – August 8/9, 2006
  - Reaffirm P removal as a process criteria
  - Agreed on system evaluation matrix
  - Agreed no time available for pilot testing
  - Reaffirm Bardenpho for system configuration options

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Previous Workshop Decisions

- Workshop #9 – August 8/9, 2006 *(continued)*
  - Agreed on the flows for the system configuration options
    - Agreed upon 32/50, 20/62 & 0/82
    - Discarded 37.5/44.5,50/32 & 60/22
  - Agreed on WW characteristics for each plant
  - Agreed on MLE + deN filters, IFAS and Biotowers at RR (20 MGD only) for process sensitivity testing

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Workshop Goals

- Agree on system configuration
  - Existing Plan
  - Transfer Some
  - Transfer All
- Within system configuration
  - Rehab existing RR WWTP
  - Green Field RR WWTP
- Agree on process for NdeN

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System Configuration Evaluation and Process Evaluation

Gordon Culp

System Configuration Evaluation

- Layout and evaluate Bardenpho for each site for the three system configuration options including a greenfield option at Roger Road WWTP
- Prepare cost evaluation matrix comparing Bardenpho, IFAS, MLE +deN Filters and BT/NAS
- Prepare non-economic evaluation matrix
- Select system configuration

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System Configuration Cost Evaluation

COST MATRIX					
	RR=32 mgd	RR=20 mgd	RR=0 mgd	RRGF=32 mgd	RRGF=20 mgd
	IR=50 mgd	IR=62 mgd	IR=82 mgd	IR=50 mgd	IR=62 mgd
Capital Cost					
Plant interconnect					
RR Demolition and Removal					
Roger Road treatment plant					
Ina Road Treatment Plant					
Reclaimed water return					
Tucson Water Booster PS					
Tucson Water Reservoir					
Total Capital Cost	$0	$0	$0	$0	$0
Annual O&M Cost					
Labor					
Methanol					
Polymer-sludge thicken/dewater					
Alum for P removal					
Power-treatment					
Power-rec. water return + booster PS					
Interconnect line maint.					
Total annual cost					
Present Worth of Annual Costs					
Total Present Worth Cost	$0	$0	$0	$0	$0

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Process Evaluation

PROCESS SENSITIVITY COMPARISONS

PROCESS	FLOW RR/IR		PRESENT WORTH		CAPITAL
BARDENPHO	32/50				
IFAS @ RR & IR	32/50				
MLE + deN FILTERS @ RR & IR	32/50				
BARDENPHO/GREENFIELD-RR	32/50				
BARDENPHO	20/62				
BT/NAS RR + BARDENPHO IR	20/62				
BARDENPHO/GREENFIELD-RR	20/62				

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System Evaluation Matrix

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5										
Schedule	5										
Constructability	3										
Flexibility	4										
System Reliability	4										
System Operability	4										
Environmental Impacts	4										
Water/Wastewater System Optimization	5										
Public Acceptance	5										
Potential for Cost Sharing	3										
Effects on Financing	3										
TOTAL											

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Cost Basis Overview

Jerry Bish

Cost Basis Overview

- Capital costs
- Cost of condition risk
- Risk adjusted pricing
- O&M costs
- Present worth costs

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Capital Costs

- Summary of bases in cost estimate memorandum
  - W W cost model
  - Quantity takeoffs/contractor bids
  - RS means
  - Vendor quotes
  - Other

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Capital Costs

- Demolition and removal costs
  - RS Means for various elements (concrete, steel, etc.)
- New influent screening facility – WW cost model
  - $60K per MGD
- New grit facilities – WW cost model
  - $50K per MGD
- Odor control – quantity takeoffs/contractor bids
  - $200 per sq. ft. for building enclosures
  - $75 per sq. ft. of alum covers
  - $50 per cfm for scrubbers

Capital Costs

- Aeration tanks – WW cost model
  - Cost = $14.00 per cu. ft. of required aeration volume
- Primary and secondary clarifiers – quantity takeoffs/contractor bids
  - Cost = $ 350.00 per sq. ft. of required area
- Denitrification filters - quantity takeoffs/contractor bids
  - Filter Cost = $3000 per sq. ft. of required area
- Rapid sand filters – WW cost model
  - Cost = $2300 per sq. ft. of required area

Capital Costs

- In plant pump stations – WW cost model
  - $60K per MGD
- UV disinfection facilities – based on UV disinfection costs developed for MWRDGC UAA analysis
  - $60 K per MGD
- Sludge thickening & dewatering – quantity takeoffs/contractor bids
  - Site specific
- Sludge digestion – quantity takeoffs/contractor bids
  - $35,400,000

Capital Costs

- IFAS media
  - Cost = $20 per cu. ft. of required volume

Capital Costs

- Plant interconnect
  - 60 feet of available head
  - Distance = 5 miles
  - $11 per inch foot, gravity flow
  - Peak flow factor = 1.4 x average Q

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Capital Costs

- Reclaimed water return line and PS
  - Pipeline velocity = 5 fps
  - $11 per inch foot
  - 37-MGD flow to be available at RR
  - 85% pump efficiency
  - Pump station cost from WW cost model

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Condition Risk

- Information adequacy
  - Drawings, plans and specifications
- Remaining useful life
  - Estimates of various remaining useful lives
- Functionality

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Condition Risk *(continued)*

- Latent defects
  - Design defects
  - Construction defects
- Subsurface risks
  - Buried infrastructure
  - Operating tankage
- Obsolescence
  - Equipment, structures or processes

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Condition Risk *(continued)*

- Time and access for inspections
- Timing
  - Asset condition deterioration
  - Capital maintenance following asset evaluation
- Maintaining treatment while constructing upgrades
  - Construction sequencing plans

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Risk Consequences

- Three general risk consequences
  - Increased cost
  - Schedule delays
  - Non-performance issues
- Example
  - The "Big Dig" highway rebuild in Boston

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Risk Assumption Under Various Delivery Methods

- Traditional "Bid-Build"
  - Owner retains condition risks
- Construction Manager at Risk
  - Owner retains condition risks

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Risk Assumption Under Various Delivery Methods *(continued)*

- D/B and D/B/O
  - Large construction or operating firms may accept some condition risk
  - Senior management analysis of condition risk
  - Hedging the assumption of risk

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Pricing of Condition Risk

- Manageable risk
- Above-ground assets v. buried infrastructure
- Uncertain cost exposure from open-ended risk

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Risk Adjusted Pricing

- Utilizes standard utility valuation methodology
- Recognizes risks associated with use of existing assets
- Takes into consideration both condition and functionality of existing assets

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Risks Associated with Existing Assets

- Condition Risk – Poor condition of assets limits their usefulness
- Functional Risk – Design, configuration, or location may limit their usefulness

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Recognize Condition Risk

- Assign a condition factor to asset that approximates its remaining useful life based on inspection of asset
- Accuracy and precision of condition factor affected by availability of information about the asset, and scope of inspection performed

Condition	*Condition Factor*
Excellent	**90%**
Good	**70%**
Marginal	**40%**
Poor	**10%**

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Recognize Functional Risk

- Assign a functionality factor to an asset that characterizes its functionality and compatibility with respect to the rest of the new system. This factor takes into consideration asset's configuration and location as well as asset's potential for premature obsolescence

Functionality	*Functionality Factor*
Properly located and/or configured; compatible; newer technology	75%
Marginally located and/or configured; marginally compatible; older technology	50%
Poorly located and/or configured; incompatible outdated technology	25%

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O&M Costs

- Power Cost @ 8.7 cents per kWh
- Methanol @ $1.00 per gallon
- Alum @ $1.00 per gallon
- Polymer @ $2.00 per pound
- Labor @ $35.00 per hour
  (2080 hrs per year per person)

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Present Worth

- Present worth
  - Present worth analysis is based on 20 years with an 8 percent discount rate

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Processes

Orrie Albertson

Processes

- System configuration
- Biosolids and bio gas
- Bardenpho
- Sensitivity analysis

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System Configuration

- Existing Plan
- Transfer Some
- Transfer All

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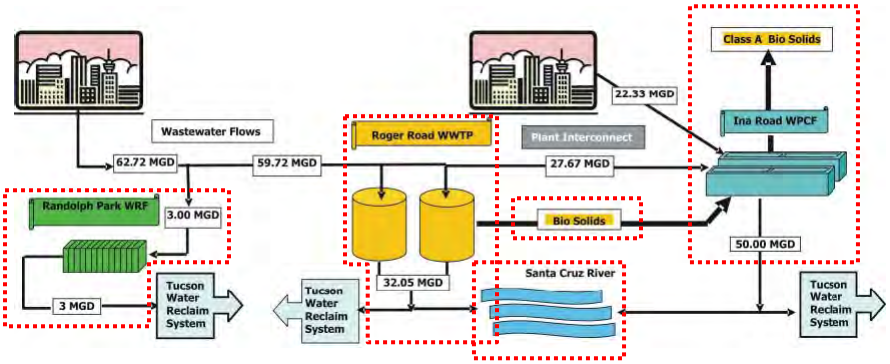
Existing Plan Schematic



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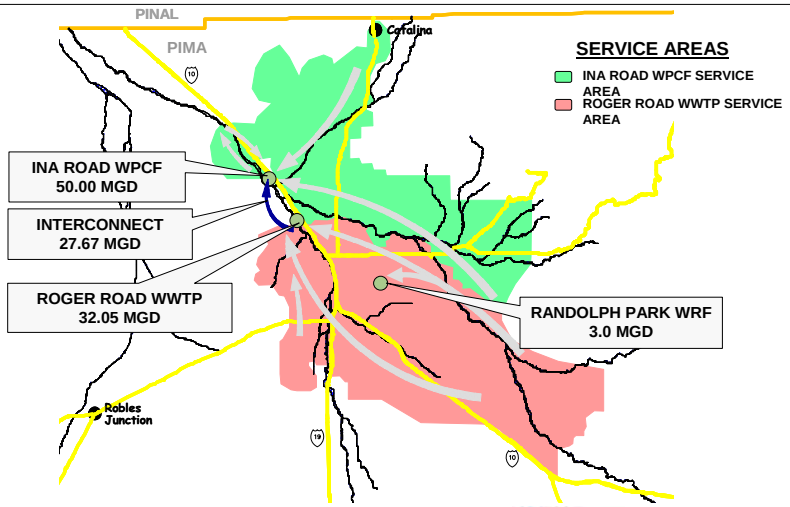
Existing Plan (2030)



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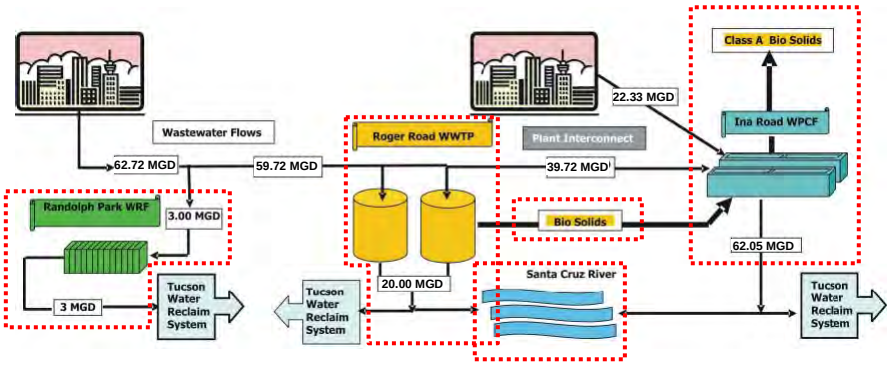
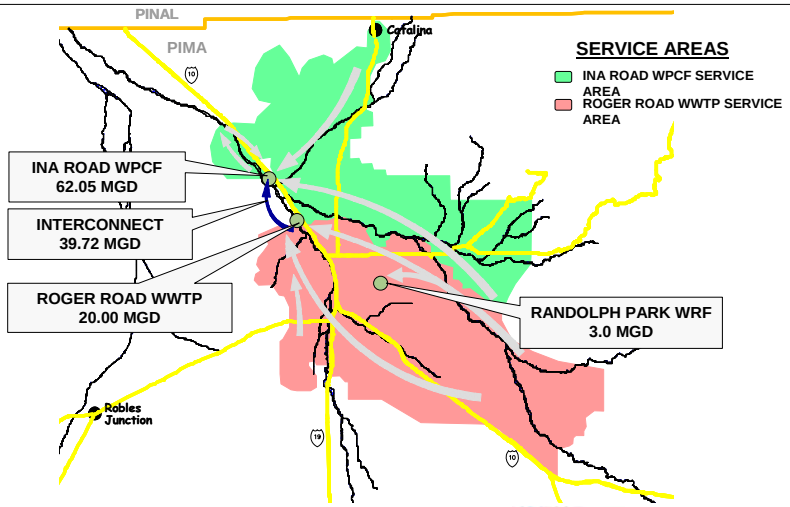
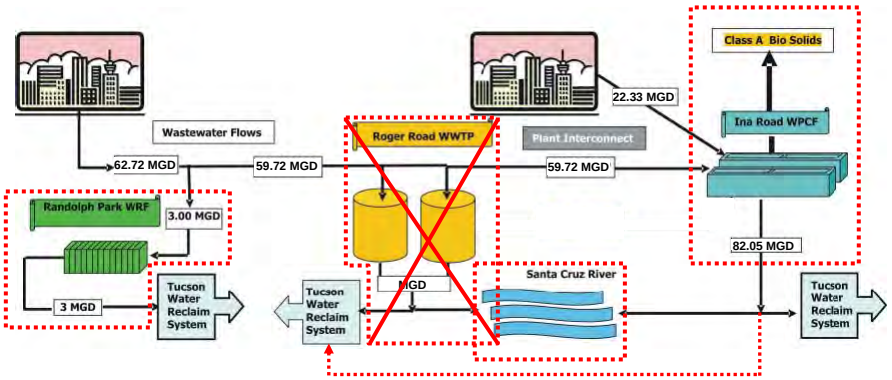
Transfer Some Schematic



Transfer Some (2030)



Transfer All Schematic



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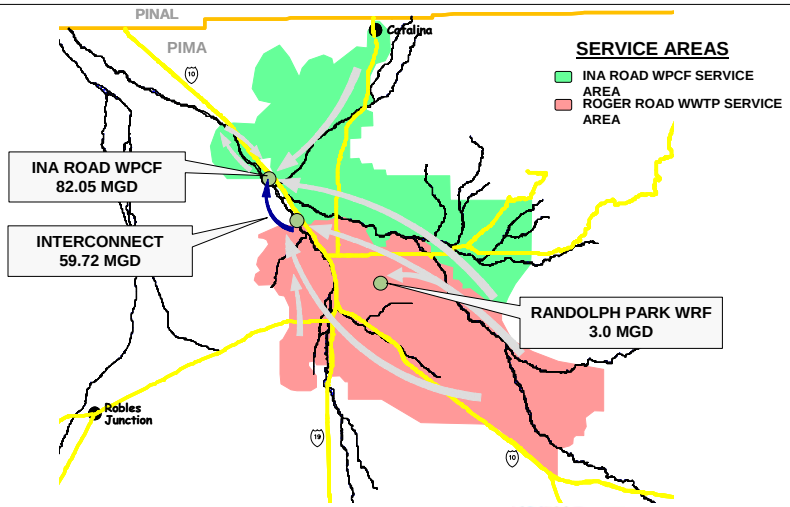
Transfer All (2030)



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Process Evaluations/ Sensitivity Testing

- Process evaluations
  - Bardenpho
- Sensitivity testing
  - MLE + deN Filters
  - IF/AS
  - BT/NAS (20 MGD @ RR)

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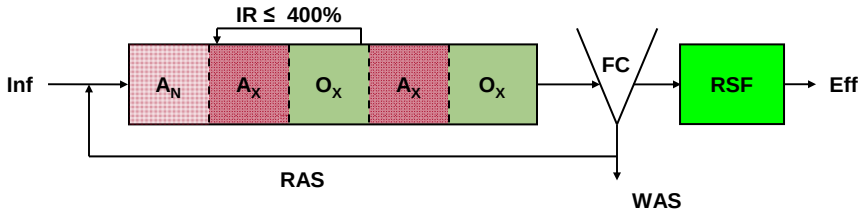
5-Stage Bardenpho

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

Bardenpho Nitrification-Denitrification (NdeN)



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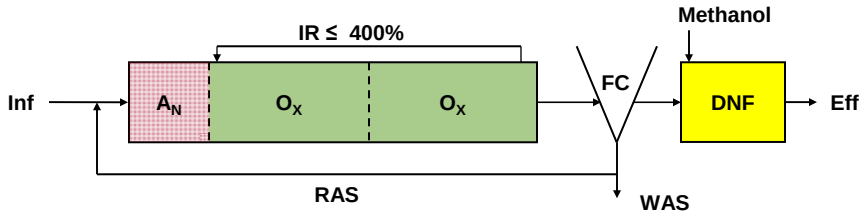
MLE + deN Filters

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

MLE Nitrification + Denitrification Filters



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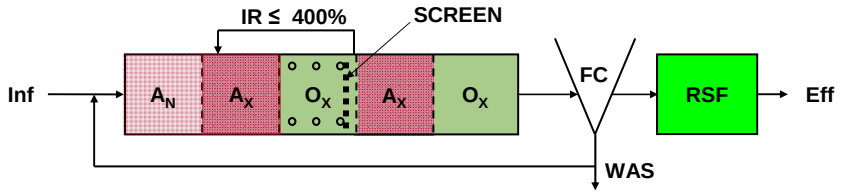
IFAS

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

IFAS Nitrification-Denitrification - NdeN



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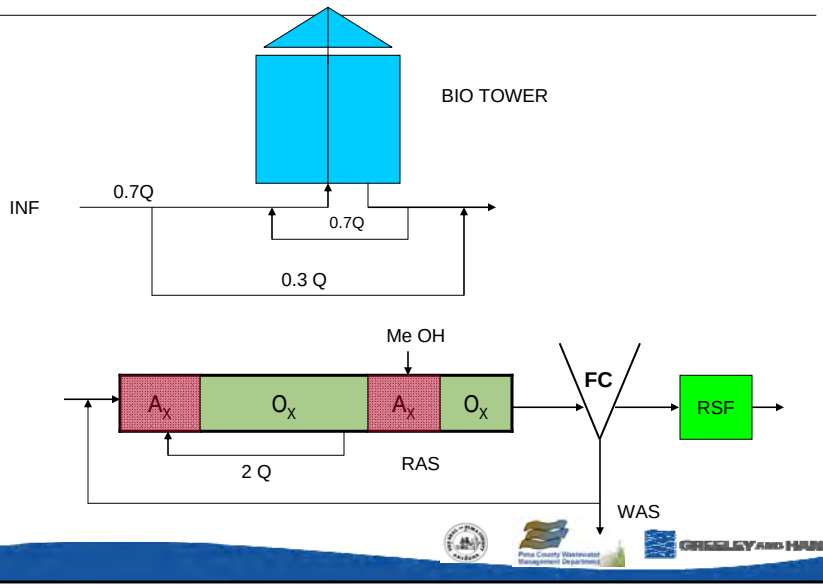
BT/NAS

AN = A
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter



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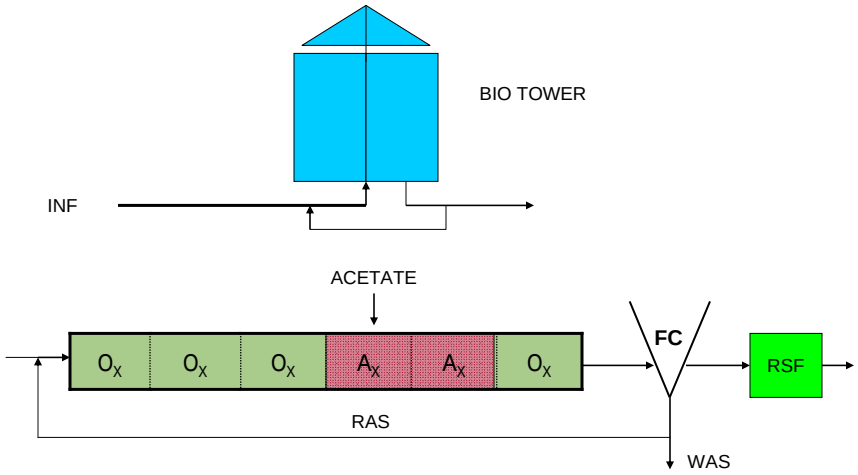
BT/NAS

AN = A
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter



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Biosolids and Bio Gas

- For all process alternative evaluations:
  - For each System Configuration Alternative, it was assumed that sludge would be thickened at the respective WWTP
  - All biosolids were assumed to be digested and dewatered at Ina Road
  - Thermo/Meso Anaerobic Digestion was assumed

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Biosolids and Bio Gas

- Bio Gas utilization studies currently underway:
  - Current sludge gas utilization is the base line condition
  - Investigating
    - Evaluation of Bio-Gas (BG) usage potential and power supply facilities

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Biosolids and Bio Gas

- Evaluation of Bio-Gas (BG) usage potential and power supply facilities
  1. Introduction
  2. Summary
  3. Bio-gas Quantities, Quality and Energy Potential
  4. End Uses of Energy
  5. Bio-gas Conversion Alternatives
  6. Alternatives Selection and Economic Analysis
  7. Alternatives Evaluation and Ranking
  8. Conclusions and Recommendations

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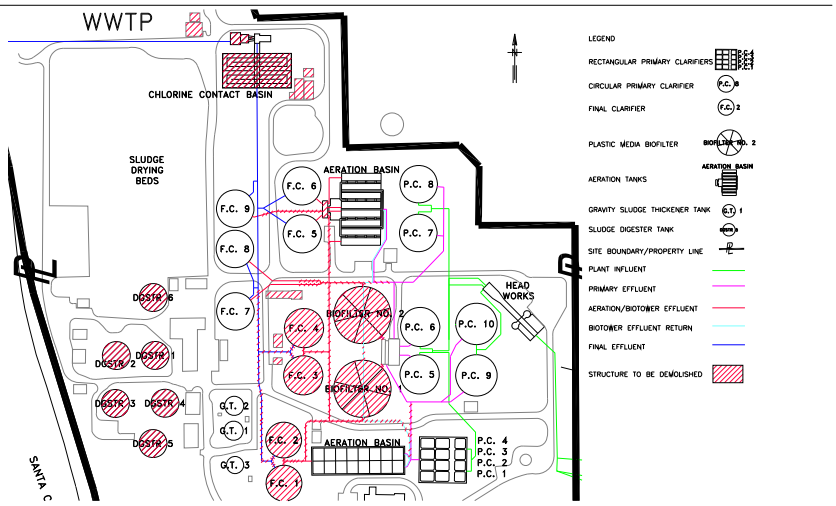
Pima County Wastewater Management Department

GREELEY AND HANSEN

Site Layouts and Costs

Joe Popeck

Roger Road
Site Layout 32 MGD- Demo



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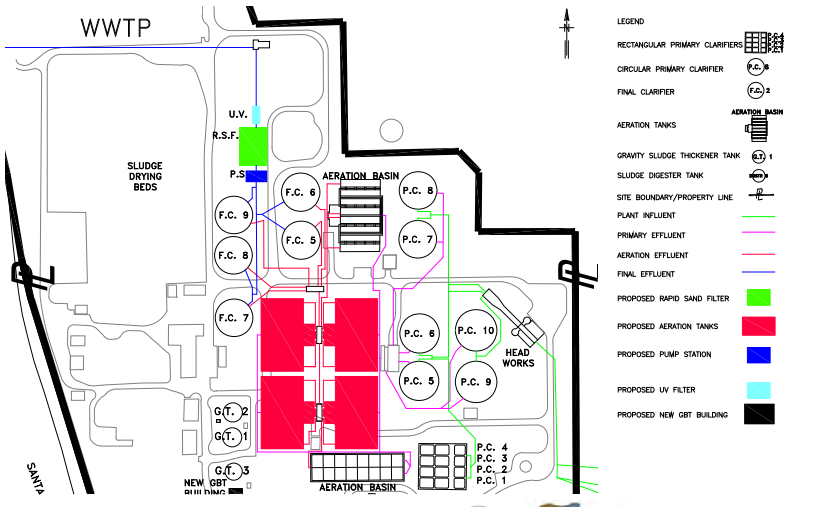
Roger Road
Site Layout – Bardenpho 32 MGD



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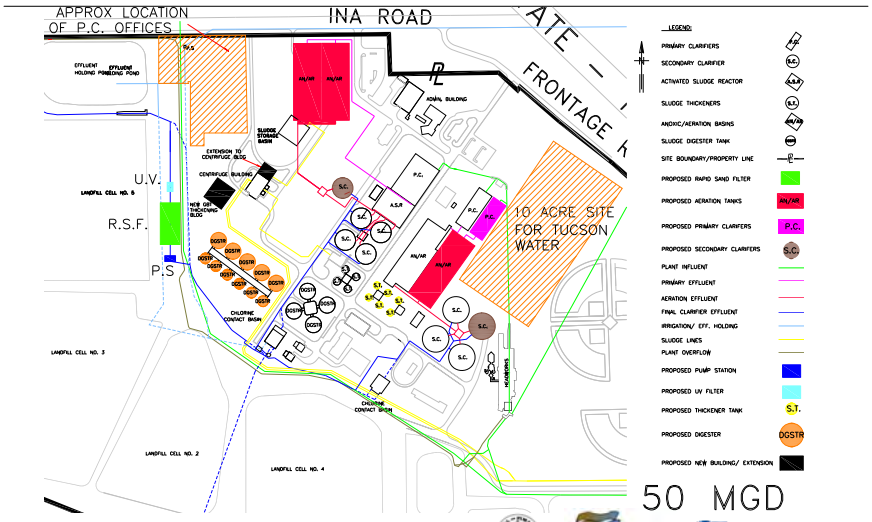
Ina Road
Site Layout – Bardenpho 50 MGD



Capital Costs – $1000's

5 Stage Bardenpho	32-MGD Existing RR WWTP	50-MGD IR WPCF
Demolition and Removal Costs	$4,000	$0
New Influent Screening Facility	$0	$0
New Influent Grit Facility	$0	$0
Odor Control	$16,000	$17,300
Primary Clarifiers	$5,500	$7,800
Aeration Tanks	$27,900	$43,500
Final Clarifiers	$8,500	$10,000
Pump Station to Filters/UV Disinfection	$1,920	$3,000
Filters	$17,200	$26,800
UV Disinfection	$1,920	$3,000
Chemical Feed Systems	$0	$0
Sludge Thickening & Dewatering Facilities	$2,600	$20,700
Sludge Digestion Facilities	$0	$35,400
Total Treatment Plant Capital Costs	$85,540	$167,500

Capital Costs – $1000's

Capital Costs	*32-MGD Existing RR WWTP and 50-MGD IR WPCF*
Total RR and IR Plant Capital Costs	$253,040
Plant Interconnect	$22,000
TW Reservoir	$11,000
Reclaimed Water Return Line & PS to RR	$270
TW Booster PS	$810
Total Other Capital Costs	$287,100

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Annual Costs – 1000's

Annual O&M Cost	*32-MGD Existing RR WWTP*	*50-MGD IR WPCF*
Labor	$3,500	$4,000
Methanol	$0	$0
Polymer-sludge thicken/dewater	$30	$700
Alum for P removal	$0	$0
Power-Treatment	$2,313	$3,738
Power-Rec. water+ booster PS	$0	$395
Interconnect pipeline maintenance	$10	$0
Total Annual Cost	$5,853	$8,833
Combined Total Annual Cost	$14,685	-
Present Worth of Annual Costs	$144,200,000	-

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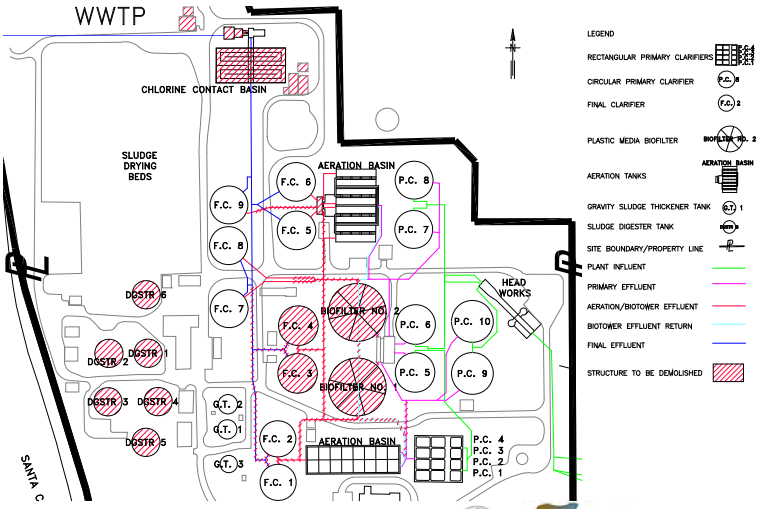
Total Present Worth of Existing RR 32 MGD and IR 50 MGD – $1000's

Item	*Cost*
Capital Cost	$287,100
Present Worth of Annual Costs	$144,200
Total Present Worth	$431,300

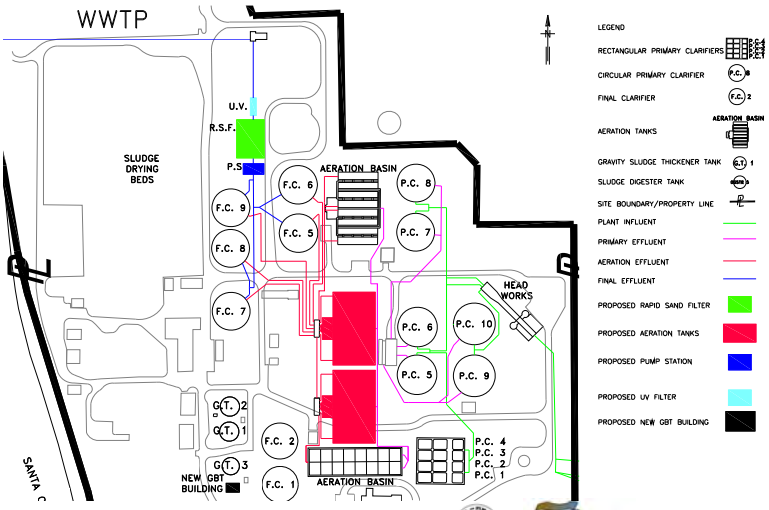
69

Roger Road Site Layout 20 MGD – Demo



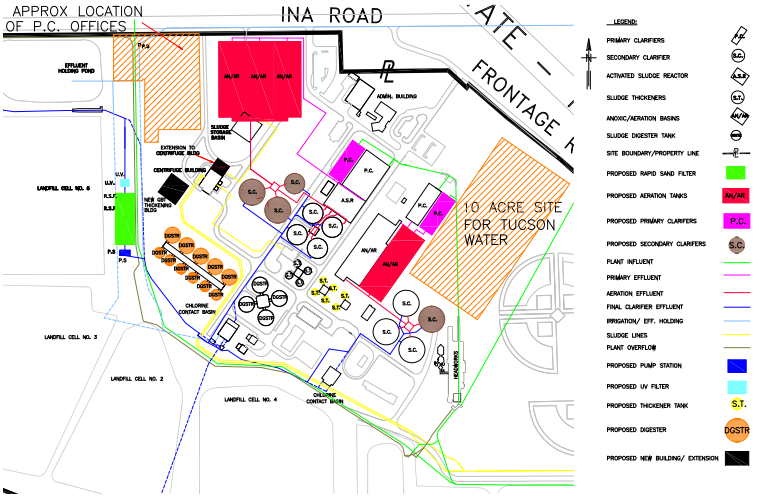
70

Roger Road
Site Layout – Bardenpho 20 MGD



71

Ina Road
Site Layout – Bardenpho 62 MGD



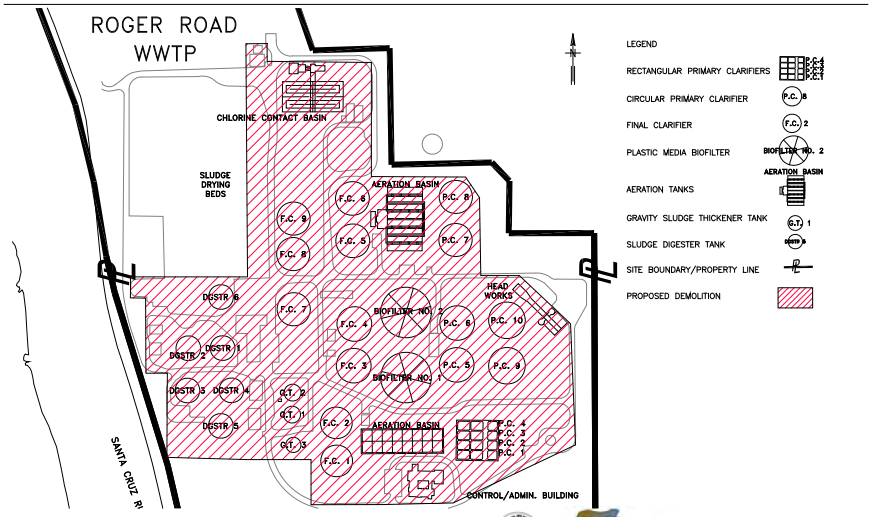
72

Total Present Worth of Existing RR 20 MGD and IR 62 MGD – $1000's

Item	*Cost*
Capital Cost	$318,600
Present Worth of Annual Costs	$145,200
Total Present Worth	$463,800

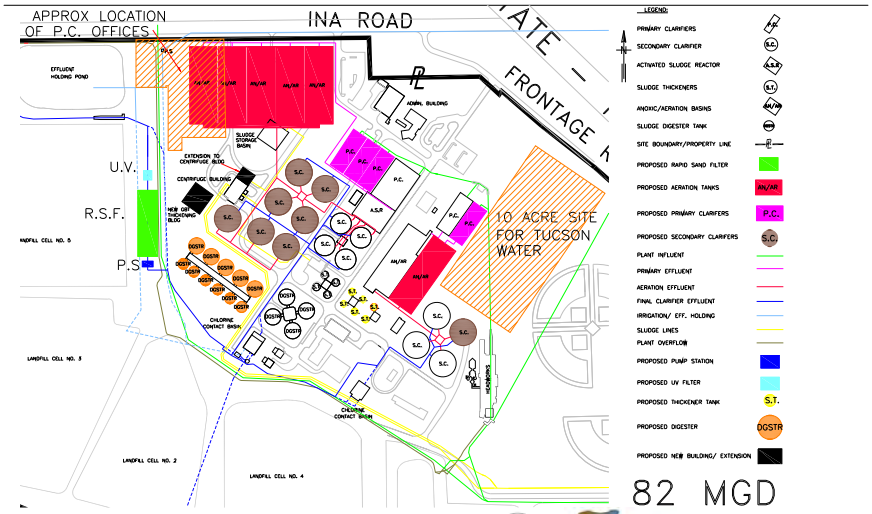
73

Roger Road Plant Demolition – All Flow to IR



74

Ina Road
Site Layout – Bardenpho 82 MGD



75

Total Present Worth of RR 0 MGD and IR 82 MGD – $1000's

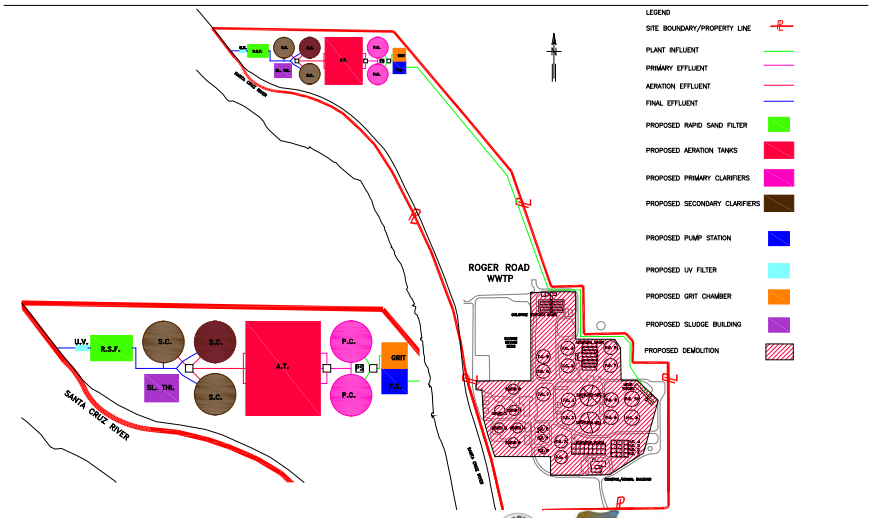
Item	*Cost*
Capital Cost	$374,600
Present Worth of Annual Costs	$139,100
Total Present Worth	$513,700

76

Sports Park Update

Rafael Payan / Andy Richardson

Roger Road – Green Field Site Layout 32 MGD-Option 1



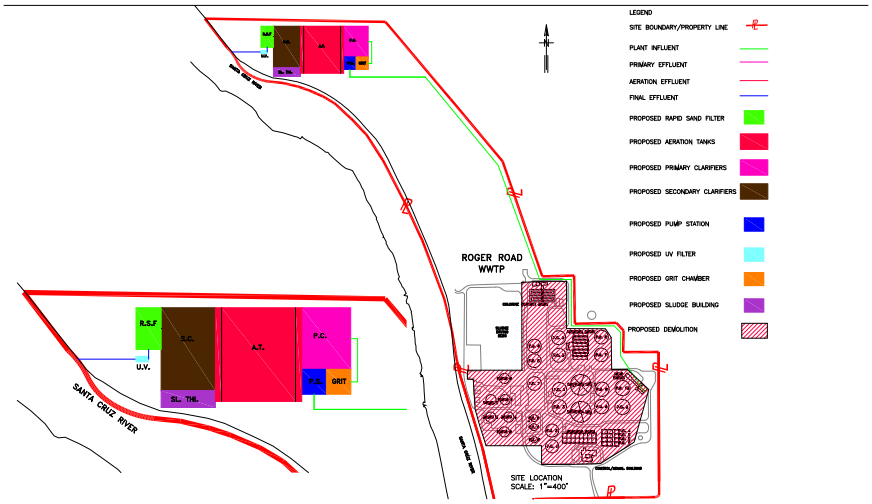
78

Total Present Worth of Green Field RR 32 MGD (Option 1) and IR 50 MGD – $1000's

Item	*Cost*
Capital Cost	$319,800
Present Worth of Annual Costs	$137,300
Total Present Worth	$457,100

79

Roger Road – Green Field Site Layout 32 MGD-Option 2



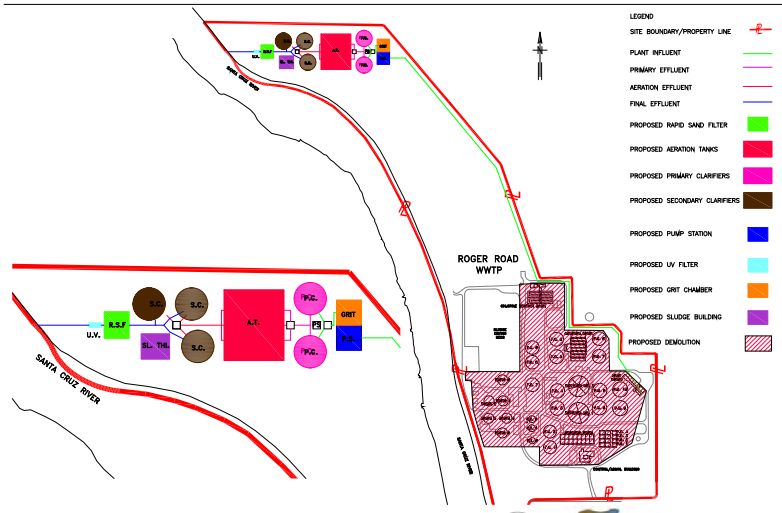
80

Total Present Worth of Green Field RR 32 MGD (Option 2) and IR 50 MGD – $1000's

Item	*Cost*
Capital Cost	$328,800
Present Worth of Annual Costs	$137,300
Total Present Worth	$466,100

81

Roger Road – Green Field Site Layout 20 MGD-Option 1



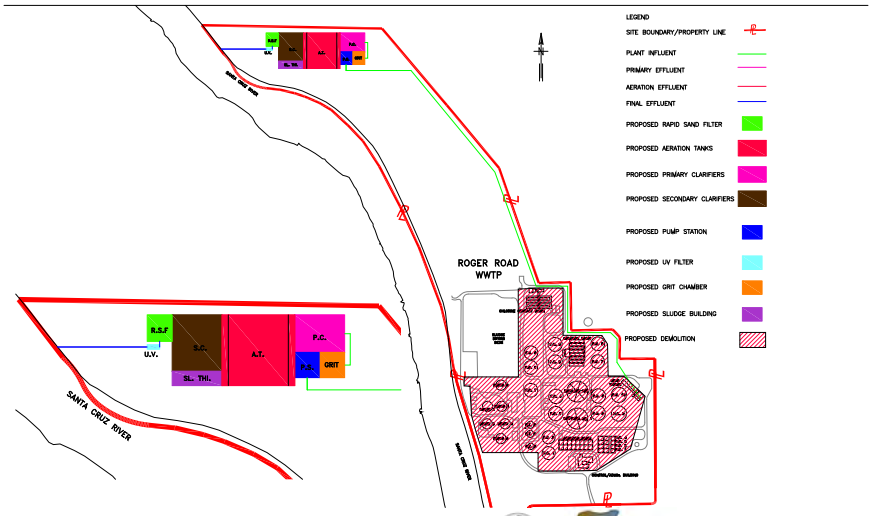
82

Total Present Worth of Green Field RR 20 MGD (Option 1) and IR 62 MGD – $1000's

Item	*Cost*
Capital Cost	$340,000
Present Worth of Annual Costs	$140,300
Total Present Worth	$480,300

83

Roger Road – Green Field Site Layout 20 MGD-Option 2



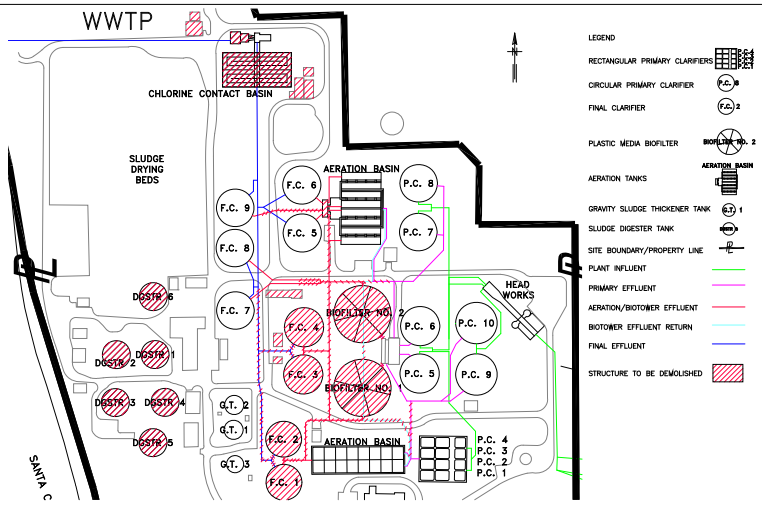
84

Total Present Worth of Green Field RR 20 MGD (Option 2) and IR 62 MGD – $1000's

Item	*Cost*
Capital Cost	$345,600
Present Worth of Annual Costs	$140,300
Total Present Worth	$485,900

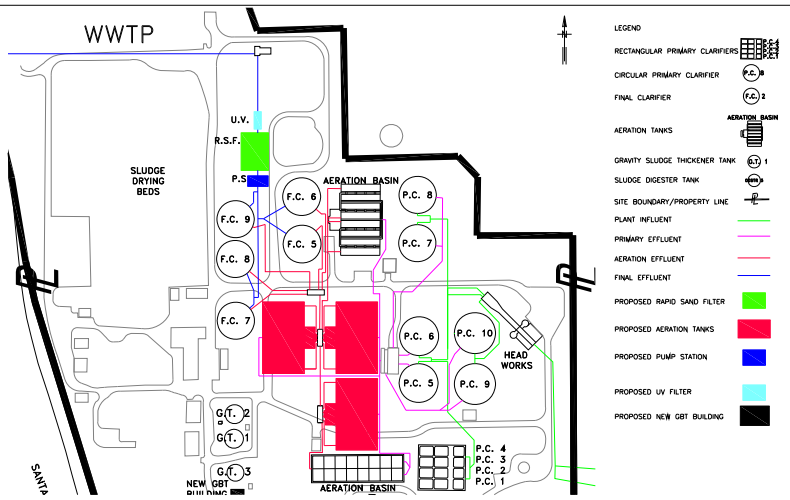
85

Roger Road
Site Layout 32 MGD – Demo



86

Roger Road
Site Layout 32 MGD – IF/AS



87

Total Present Worth of IF/AS RR 32 MGD and IF/AS IR 50 MGD – $1000's

Item	*Cost*
Capital Cost	$294,600
Present Worth of Annual Costs	$144,200
Total Present Worth	$438,800

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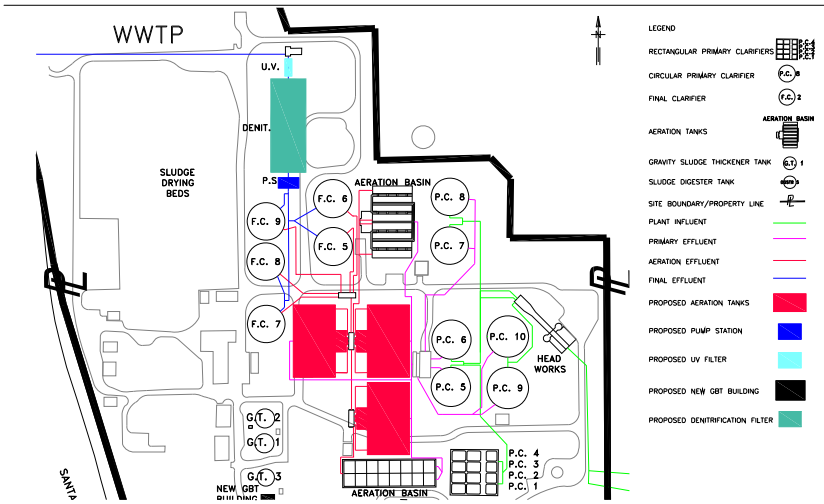
Roger Road
Site Layout 32 MGD – MLE + deN Filters



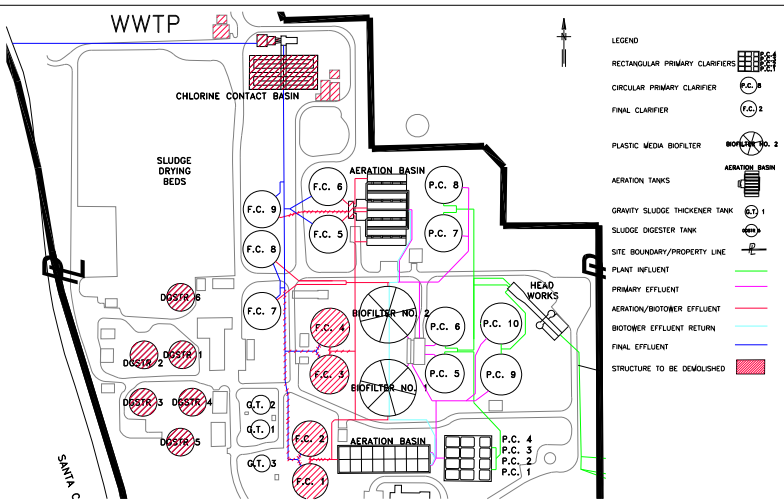
89

Total Present Worth of MLE + deN RR 32 MGD and MLE + deN IR 50 MGD – $1000's

Item	*Cost*
Capital Cost	$299,600
Present Worth of Annual Costs	$139,200
Total Present Worth	$438,800

90

Roger Road
Site Layout 20 MGD-BT/NAS Demo



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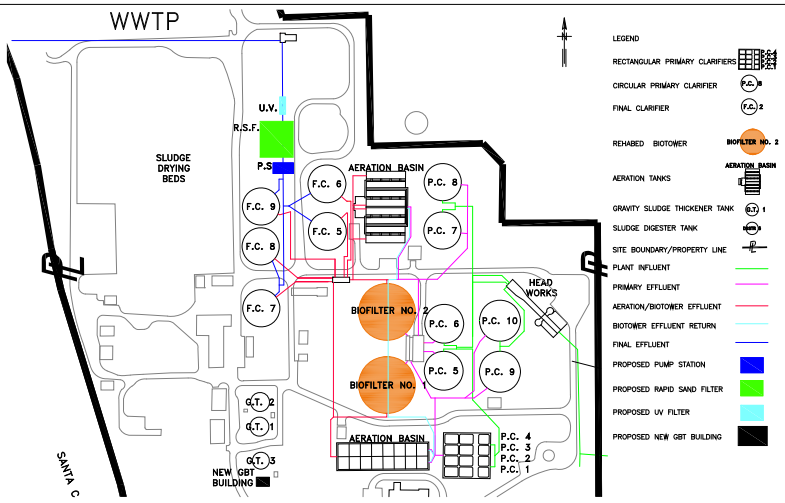
Roger Road
Plant Layout 20 MGD-BT/NAS



92

Total Present Worth of BT/NAS RR 20 MGD and Bardenpho IR 62 MGD – $1000's

Item	*Cost*
Capital Cost	$326,600
Present Worth of Annual Costs	$152,000
Total Present Worth	$478,600

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Evaluation Matrices

Gordon Culp

System Configuration Cost Evaluation

COST MATRIX					
	RR=32 mgd IR=50 mgd	RR=20 mgd IR=62 mgd	RR=0 mgd IR=82 mgd	RRGF=32 mgd IR=50 mgd	RRGF=20 mgd IR=62 mgd
Capital Cost					
Plant interconnect	$22,000,000	$25,100,000	$31,600,000	$22,000,000	$25,100,000
RR Demolition and Removal	$4,000,000	$4,000,000	$16,100,000	$16,100,000	$16,100,000
Roger Road treatment plant	$81,540,000	$56,500,000	$0	$102,160,000	$65,800,000
Ina Road Treatment Plant	$167,500,000	$211,400,000	$284,660,000	$167,500,000	$211,360,000
Reclaimed water return	$270,000	$9,800,000	$19,400,000	$270,000	$9,800,000
Tucson Water Booster PS	$810,000	$810,000	$810,000	$810,000	$810,000
Tucson Water Reservoir	$11,000,000	$11,000,000	$22,000,000	$11,000,000	$11,000,000
Total Capital Cost	**$287,100,000**	**$318,600,000**	**$374,600,000**	**$319,800,000**	**$340,000,000**
Annual O&M Cost					
Labor	$7,500,000	$7,300,000	$6,200,000	$6,800,000	$6,800,000
Methanol	$0	$0	$0	$0	$0
Polymer-sludge thicken/dewater	$730,000	$720,000	$700,000	$730,000	$720,000
Alum for P removal	$0	$0	$0	$0	$0
Power-treatment	$6,050,000	$6,050,000	$6,050,000	$6,050,000	$6,050,000
Power-rec. water return + booster PS	$395,000	$710,000	$1,210,000	$395,000	$710,000
Interconnect line maint.	$10,000	$10,000	$10,000	$10,000	$10,000
Total annual cost	$14,685,000	$14,790,000	$14,170,000	$13,985,000	$14,290,000
Present Worth of Annual Costs	$144,200,000	$145,200,000	$139,100,000	$137,300,000	$140,300,000
Total Present Worth Cost	**$431,300,000**	**$463,800,000**	**$513,700,000**	**$457,100,000**	**$480,300,000**

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Process Evaluation

PROCESS SENSITIVITY COMPARISONS

PROCESS	FLOW RR/IR	PRESENT WORTH	CAPITAL
BARDENPHO	32/50	$431,300,000	$287,100,000
IFAS @ RR & IR	32/50	$438,800,000	$294,600,000
MLE + deN FILTERS @ RR & IR	32/50	$445,800,000	$299,600,000
BARDENPHO/GREENFIELD-RR	32/50	$457,100,000	$319,800,000
BARDENPHO	20/62	$463,800,000	$318,600,000
BT/NAS RR + BARDENPHO IR	20/62	$478,600,000	$326,600,000
BARDENPHO/GREENFIELD-RR	20/62	$480,300,000	$340,000,000

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System Evaluation Matrix

- Uses criterion and weights agreed to in earlier workshop for comparing system alternatives
- This is a tool to have a structured and focused discussion on the relative merits of the alternatives – judgment must be applied to the result

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System Evaluation Matrix

		Unweighted Ranking					Weighted Ranking				
Criteria	Weighting Factor	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5										
Schedule	5										
Constructability	3										
Flexibility	4										
System Reliability	4										
System Operability	4										
Environmental Impacts	4										
Water/Wastewater System Optimization	5										
Public Acceptance	5										
Potential for Cost Sharing	3										
Effects on Financing	3										
TOTAL											

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Cost	**5 $431M**	**4 $464M**	**2 $514M**	**4 $457M**	**3 $480M**
Ratio to lowest cost	1.00	1.08	1.19	1.06	1.11
Incremental cost above lowest cost	$0	$33M	$73M	$26M	$49M

System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Schedule	**4**	**4**	**5**	**5**	**5**

- All can meet schedule
- Alternatives involving rehab of Roger Road have greater schedule risk due to uncertainty associated with construction within existing plant

System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Constructability	**2**	**2**	**4**	**5**	**4**

- Construction within Roger Road plant will be very difficult
- Greenfield Roger Road at 32 MGD involves the least construction within existing plants
- Greenfield Roger Road at 20 MGD and Roger Road at 0 MGD involves more construction within existing Ina Road site than Greenfield at 32 MGD

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Flexibility	**3**	**3**	**5**	**5**	**5**

- May not be possible to create same degree of flexibility in plant design when working within constraints of existing Roger Road plant
- Greenfield Roger Road and Transfer All options offer fewest restrictions on designing plant for flexibility

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
System Reliability	**4**	**4**	**5**	**5**	**5**

- Greenfield Roger Road and Transfer All options offer more new components that can be similar in design
- Rehabilitated Roger Road plant will be less reliable due to the older components that will remain

103

System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
System Operability	**3**	**3**	**5**	**4**	**4**

- Transfer All option – all O&M under one command, all training deals with one system
- Greenfield options will be easier to operate than rehabilitated Roger Road plant but involve operating two plants
- Rehabilitated Roger Road plant more difficult to operate, old components and cumbersome layout

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Environmental Impacts	**3**	**3**	**5**	**4**	**4**

- All options deliver 37 MGD to Roger Road for reuse and riparian habitat maintenance
- Concentrating construction and operation at one location (Ina Road) would have least short and long term environmental impacts
- Greenfield options reduce chance that construction will cause a plant upset and related environmental damage and regulatory non-compliance
- Rehabilitation of Roger Road options increase chance of construction-related plant upsets and regulatory non-compliance

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Water/Wastewater System Optimization	**5**	**4**	**3**	**5**	**4**

- 32-MGD Roger Road options make best use of existing collection system, can use existing 24-inch reclaimed water line to convey needed volume of reclaimed water from Ina Road to Roger Road, and maintains greater volume at higher elevation for potential reuse
- 20-MGD Roger Road options retain less reclaimed water at Roger Road and Transfer All option retains none at Roger Road

106

System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Public Acceptance	**2**	**2**	**2**	**2**	**2**

- A Greenfield option may be viewed as an improvement over the existing plant or a desirable buffer for the proposed sports park
- Others may oppose the new location involved in a Greenfield plant or want the Roger Road plant gone
- Putting all wastewater treatment at Ina Road may be opposed by those near the Ina Road plant
- All likely to have a mix of support and opposition and all are considered equal

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Potential Cost Sharing	**5**	**4**	**3**	**5**	**4**

- 32-MGD Roger Road options involve least cost to provide needed volume of reclaimed water at Roger Road and perhaps greater potential for cost sharing with Tucson Water
- 20-MGD Roger Road options involve more cost to provide needed volume of reclaimed water at Roger Road and could meet more resistance for cost sharing by Tucson Water
- Transfer All option involves most cost to provide needed volume of reclaimed water at Roger Road

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System Evaluation Matrix

	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
Effects on Financing	**4**	**3**	**2**	**3**	**3**

- Differences are based on the relative magnitude of funding required

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System Evaluation Matrix

Criterion	Weight
Cost	5
Schedule	5
Constructability	3
Flexibility	4
System reliability	4
System operability	4
Environmental impacts	4
Water/wastewater system optimization	5
Public acceptance	5
Potential cost sharing	3
Effects on financing	3

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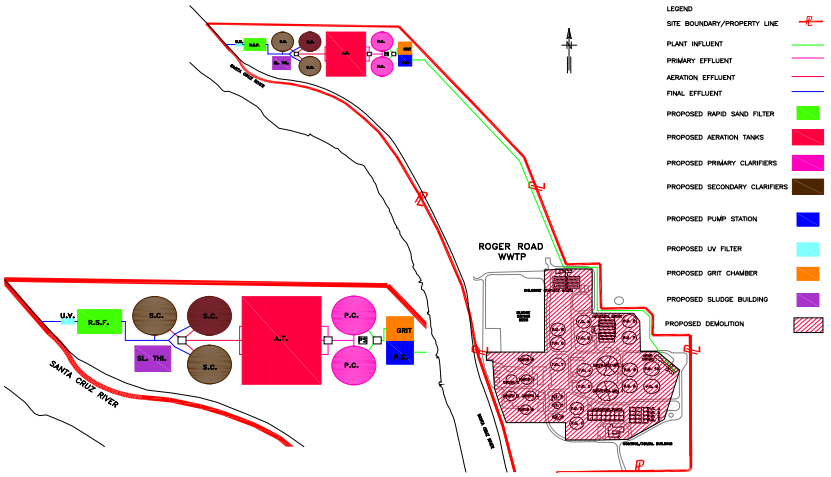
System Evaluation Matrix

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5	5	4	2	4	3	25	20	10	20	15
Schedule	5	4	4	5	5	5	20	20	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	5	4	4	12	12	20	16	16
Environmental Impacts	4	3	3	5	4	4	12	12	20	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	2	2	2	2	2	10	10	10	10	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	4	3	2	3	3	12	9	6	9	9
TOTAL		40	36	41	47	43	165	149	167	191	175

111

Roger Road Recommended 32-MGD Option



112

Greenfield at Roger Road

- Frees up property for economic development
- Eliminates cost/schedule risk associated with rehab
- System more flexible, reliable, operable
- Better integration with reclaimed water
- Least risk for regulatory non-compliance
- Keeps eco-system in Santa Cruz River

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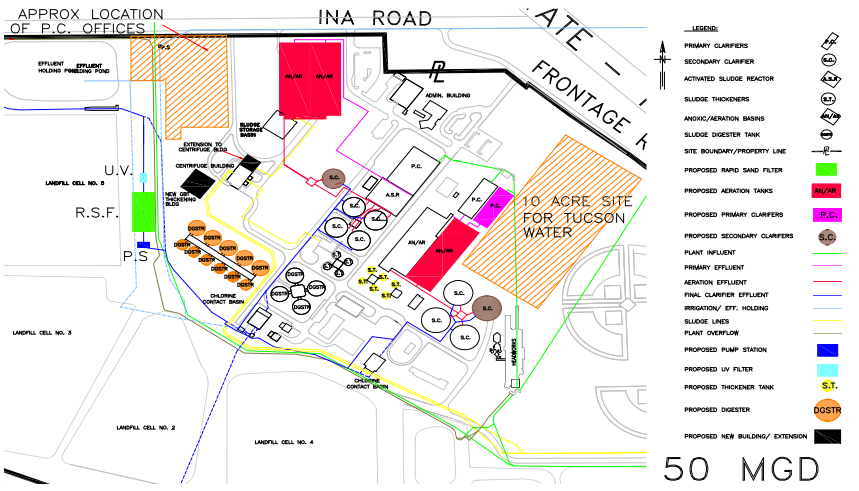
Ina Road Recommended 50-MGD Option



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Pima County Wastewater Management Department

GREELEY AND HANSEN

Next Steps

Andy Richardson

Pima County Wastewater Management Department

GREELEY AND HANSEN

Summary

Andy Richardson

Pima County Wastewater
Management Department

GREELEY AND HANSEN

Workshop #11 Meeting Notes
Evaluation of Treatment Plant

1. The Evaluation of Treatment Plant Workshop for Pima County Regional Optimization Master Plan was held on December 13, 2006. The agenda is attached. The following were in attendance:

PCWMD

Director

Michael Gritzuk

Deputy Directors

Paul Bennett
Mike Bunch
Jackson Jenkins
Jeff Nichols, Finance

PCWMD Staff

David Bartos
Bob Buecher
John Carlson
Ed Curley
Jim Doyle
Laura Fairbanks
Frank Gall
David Garrett
Mary Hamilton
Tim Harmon
Michael Kostrzewski
Mike Lueken
Byron McMillan
John Munden
Steve Munsell
Jeff Prevatt
Karen Ramage
Prakash Rao
Helen Rhudy
Bill Richardson
Ron Riska, Project Manager
Mandley Rust
John Sherlock
John Warner
Ken Weber
Eric Wieduwilt

Legal

Harlan Agnew
Chuck Wesselhoff

WASTEWATER MANAGEMENT ADVISORY COMMITTEE

John Carlson
Brad DeSpain, Town of Marana

PIMA COUNTY PARKS & RECREATION

Rafael Payan,
Director, Natural Resources
Stephen Dean
Linda Mayro

TUCSON WATER

Tucson Water Staff

Melodee Loyer
Tim Thomure
Wally Wilson
Alan Forrest, CH2M Hill
Ken Thompson, CH2M Hill

PEER GROUP

Gary Newman, B&C
Denny Parker, B&C
Joe Husband, MPI

GREELEY AND HANSEN PROJECT TEAM

Jerry Bish
Gordon Culp
Carl Koch
Andy Richardson
Harold Smith

COUNTY ADMINISTRATION

(afternoon for one-hour summary)

Chuck Huckelberry,
County Administrator
John Bernal,
Deputy County Administrator

2. Major topics of the workshop were:

- Workshop #11: Evaluation of Treatment Plant
  - Process Evaluation Review
  - Recommended System Configuration/Layouts
  - Project Sequencing
  - System Costs
  - Project Financing
  - ADEQ Response

A set of handouts were provided to each attendee in advance of the workshop. Additional information was presented during the workshop.

Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be utilized by the project team while conducting the study and are provided at the end of this summary. Some, but not all, of the flip chart notes are incorporated into the following items.

3. Mike Gritzuk welcomed the attendees to the evaluation of the treatment plant workshop. The goal is to advance the preferred plan to the recommended plan by the end of the day by drilling down into the details of the project and examining the construction costs updates. It was noted that the County Administrator, Chuck Huckelberry, and Deputy County Administrator, John Bernal, would be joining the workshop in the afternoon to view the recommended plan, construction costs and financing plan for the project. Until then the group will discuss the details of the recommended plan. The peer group was acknowledged for their continued involvement in the workshop activities. Tucson Water was also acknowledged for their presence and continued participation and contributions to the workshops.

4. Andy Richardson outlined his role as facilitator and encouraged all to participate, but reminded all that he will adjust the program upon arrival of the County Administrator and the Deputy County Administrator in the afternoon to summarize the project elements and review the decisions. After reviewing the agenda and groundrules, the previous workshop decisions and goals to be achieved during the Workshop #11 were outlined.

   Agenda, groundrules, previous decisions and goals were covered on pages 2 through 6 of the handout.

5. Gordon Culp presented the evaluation processes developed and followed in the previous workshops. Evaluations of the system configuration, system configuration costs, non-economic considerations and process from previous workshops were reviewed. Ron Riska asked if the costs were modified. An action from the last workshop was to hire a contractor to review the construction costs. Those results will be provided later in the workshop. Presentation matrices and costs provided from the previous workshop materials were not modified. It was reiterated that costs in the earlier workshops were planning level estimates for project elements not common to all alternatives or options. Therefore, those costs were not total costs, but were developed for comparative purposes.

Jeff Nichols stated that the risk of operating during construction, as-built drawing accuracies (inaccuracies) and unforeseen items need to be addressed with the rehabilitation alternatives. Further, Mike Bunch asked if there are examples of projects where actual costs for rehabilitation costs of old facilities were significantly more than bid construction due to these risk factors. Phoenix 91st Avenue project was offered as an example where there was a 50 percent premium due to risk type issues. Mike Gritzuk asked if there were other examples in the wastewater industry. This will be explored by the project team.

The evaluation process review and previous outcomes were covered on pages 6 through 9 of the handout.

6. Jerry Bish reviewed the assessment of the various system configurations and flows to be treated at each facility. Over the course of the project and in discussions at previous workshops, three system configurations were evaluated and three others considered. Analysis of the results indicates that the least cost alternative is treating 32 mgd of wastewater at Roger Road WWTP and 50 mgd at Ina Road WWTP. Mike Gritzuk asked why this flow arrangement was the least costly to the County. Since the County owns land at each site, there are two principal factors in the cost evaluation considerations. First, there are relatively new headworks at Ina Road WPCF that can accommodate 50 mgd. Secondly, as more flow is transferred to Ina Road WPCF from the Roger Road service area, the larger and more expensive the transfer pipeline becomes. Therefore, the least cost for Pima County is to fully utilize the headworks at Ina Road WPCF and to build the remaining treatment capacity at Roger Road to minimize the additional expense of the transfer pipeline.

   Basis of the plant capacities at each plant site was covered on pages 9 through 11 of the handout.

7. Carl Koch reviewed the treatment plant process and the possible use of side-stream treatment of solids handling recycle flows. Bardenpho was selected as the best treatment technology for the raw wastewater characteristics and effluent quality requirements. This process has a long history of reliable performance and has the benefit of addressing phosphorus removal when and if required. Recommended at Roger Road is a 32-mgd facility without primary sedimentation tanks. With the process model runs, using GPS-X, the system will achieve an effluent of less than 8 mg/L total nitrogen, less than 2 mg/L ammonia and under 1 mg/L phosphorus without the addition of chemical. This performance will meet and exceed the performance criteria required by current and anticipated facility ADEQ permits during the study horizon.

   Denny Parker indicated that the original Bardenpho process was developed and operated in South Africa and was constructed without primary sedimentation tanks, but since then primary sedimentation tanks have been added. Without primary tanks the process units need to be increased in size to accommodate the wastewater load normally removed by primary sedimentation. Therefore, to reduce operating energy costs related to raw wastewater being processed through Bardenpho, it was advised to consider adding primary sedimentation tanks to the process train. Jim Doyle indicated that he saw nothing wrong in adding raw wastewater directly to the Bardenpho process so as to utilize the carbon source associated with the primary wastewater sludge in the wastewater process system. During startup at the Ina Road WPCF, raw wastewater is being conveyed around the primary clarifiers and added directly to the MLE system (BNRAS) with a consistent total nitrogen result of 3.5 mg/L in the effluent. This is being accomplished without appreciable additional air from the blower system. From the operations

perspective, there appears to be benefits of not having primary sedimentation tanks. Joe Husband offered that a careful life-cycle analysis is required to determine the effects of eliminating the primary sedimentation tanks.

At Ina Road WPCF the recommended Bardenpho system is sized to handle the recycle loads with a flow of 50 mgd. From GPS-X modeling, effluent total nitrogen and ammonia concentrations will be less than 8 mg/L and 2 mg/L, respectively. Effluent phosphorus concentration of less than 1 mg/L will not be achieved without the addition of metal salts. However, significant phosphorus can be removed from the wastewater before the addition of chemicals.

Most of the recycle loads will be addressed at the Ina Road WPCF. At the new Roger Road WTTP the waste activated sludge will be thickened to 3 percent before being transferred to Ina Road for digestion. The thickening filtrate will be recycled to the head end of the plant for processing in the main wastewater process stream. At Ina Road the filtrate/centrate from pre-digestion thickening, and post-digestion thickening and dewatering (if required) of sludge will be recycled and processed in the main wastewater process stream. Jim Doyle suggested eliminating thickening at Roger Road and transferring the solids to Ina Road through the plant interconnect.

Carl Koch offered that without primary sedimentation tanks that the headworks at Roger Road would need to be aggressively sized to remove grit and screenings. Ron Riska asked if there were primary sedimentation tanks at Roger Road and those solids were placed into the plant interconnect whether this would create any adverse conveyance system conditions. At this time John Warner did not see any adverse issues from the conveyance perspective. Gary Newman suggested that headworks be provided at Roger Road to address the Roger Road WWTP flow and the plant interconnect.

Denny Parker suggested treatment of recycle side-streams at Ina Road WPCF to make more carbon available in the future for phosphorus removal. It was agreed that it is not necessary to make the decision now because phosphorus removal is not required, but it would be wise to reserve space for consideration of future side-stream treatment. Joe Husband indicated that side-stream treatment studies at Ina Road WPCF proved to save money. John Sherlock expressed that having extra process tankage, or a spare tank, is desirable from an operator's perspective.

For phosphorus removal, Denny Parker believes that from a crystal ball viewpoint that there will someday be regulatory limits imposed on Pima County. Furthermore, when regulated, phosphorus standards of much less than 1 mg/L will be imposed. A phosphorus standard of 0.05 mg/L should be considered in the site allocation in the master plan. A separation or filtration process may be required to achieve low phosphorus removals. Ron Riska has heard that chemical sludges are hard to handle and may have an impact on the end use of the sludge. It was indicated that sludge from phosphorus removal systems are more problematic than conventional wastewater treatment system sludge and should be address in the biosolids handling.

In general, the peer group confirmed that the Bardenpho process is a good program for the master plan. Carl Koch indicated that the system would be designed with flexibility to operate over a range of modes associated with a multi-staged treatment process. Also, based on the unforgiving schedule for implementation, Bardenpho is optimal process for achieving nutrient limits in the effluent.

The wastewater treatment process and recycle treatment at Roger Road WWTP and Ina Road WPCF were covered on pages 12 and 13 of the handout.

8. Carl Koch reviewed the biosolids handling and treatment processes for Roger Road WWTP and Ina Road WPCF. All biosolids stabilization and processing will occur at the Ina Road WPCF. Stabilization will be by mesophilic anaerobic digestion until Class A requirements are imposed. At this time there is uncertainty when Class A biosolids may be required for Pima County biosolids, if ever. The strategy for Pima County is to prepare for achieving Class A biosolids, but not proceed until the marketplace, regulatory agencies or public demand a higher level of biosolids treatment. Plant site layouts are developed around the most land intense system (thermophilic anaerobic digestion, TPAD, followed by dewatering). By accommodating TPAD the plant site could accommodate Cambi or heat drying operations. It was noted that currently the Cambi process has not been granted Class A status by EPA, but it is anticipated that it will be granted in the future.

Jim Doyle asked if thickening of waste activated sludge to 3 percent at Roger Road WWTP was necessary. Thickening assures capacity in the sludge transfer pipeline. Gary Newman indicated that if the proposed operating schedule for the biosolids thickening or dewatering operations was not 24/7, that an equalization tank for the recycle may be necessary to address the cyclic plant loads imposed by recycle flows. Carl Koch pointed out that the TPAD process was developed on a batch feed basis because a continuous feed mode has not been approved by the regulatory agencies.

Dave Garrett asked where biosolids will be placed, if the current disposal site is unavailable. Brad DeSpain offered that there are other nearby agriculture lands available for disposal including land in Pinal County. Jackson Jenkins suggested that the Cambi product may be more desirable to the County. The Cambi product could be used for landfill cover and on park lands. A proposal had been received from Cambi to process up to 16 dry tons per day. Denny Parker indicated that San Francisco had a pilot study of Cambi shutdown because of site constraints and was using other Class A processes.

John Sherlock observed that the current wastewater treatment operations are limited by its biosolids and handling capacity and that the “back end” of the plant may drive the upgrade and expansion program. Currently biosolids processing is at “most risk” at the Roger Road WWTP. Operations are barely keeping up with the handling of sludge. Furthermore, Pima County has one of the few liquid sludge application operations left in the U.S. Mike Gritzuk stated that solids handling at the plants are critical.

It was noted that California does not want biosolids applied to its land. Ed Curley indicated that California communities were disposing of biosolids in Arizona. Because of this, the time for application of Class B biosolids on the land in Arizona may be limited. It was concluded that the provisions for Class A biosolids would be included in the site plan layouts.

Biosolids handling and treatment at Roger Road WWTP and Ina Road WPCF were covered on pages 14 through 18 of the handout along with three additional slides provided at the end of this meeting summary (see attached pages 17 and 18).

9. Jerry Bish covered the projected needs for reclaimed water system for Tucson Water and the possible riparian habitat allocations for the Santa Cruz River between Roger Road and Ina Road. Tucson Water has projected a need for approximately 30 mgd of plant effluent for reclaimed water use at Roger Road, and approximately 20 mgd of plant effluent for reclaimed water use at Ina Road to meet demand. Based on the regulatory requirements for future wastewater treatment, the effluent from the future Roger Road WWTP and Ina Road WPCF will be classified as A+. With this classification Tucson Water would be able to decommission its pressure filter treatment system at Roger Road and feed the distribution system directly after chlorine addition to meet residual requirements. Tucson Water will construct the necessary pump station, reservoir (10 million gallons), pipeline and chlorine residual facilities at Ina Road WPCF to provide for its reclaimed water needs.

The Sweetwater wetlands and recharge basins at Roger Road would be kept operational by Tucson Water. Recharge basins serve to provide for wintertime underground water storage for summertime recovery to meet peak reclaimed water demands. It was noted that Tucson Water provides the pumps for the Silver Bell Golf Course.

The current riparian habitat in the Santa Cruz River between Roger Road and Ina Road is entirely supported by the effluent from the Roger Road WWTP. The Tres Rios Del Notre project looked at that stretch of the river from several perspectives that would provide a benefit to the County. Other County agencies and public groups, such as environmental organizations, have a keen interest in sustaining or enhancing the riparian habitat in the Santa Cruz River.

Water requirements in the Santa Cruz River vary dependent on the results to be achieved. The range is from 1.4 mgd to 16 mgd. The lower value is estimated to sustain the current habitat. The upper range would provide for a major sustainable ecosystem restoration on vacant public and private lands along the Santa Cruz, which would be costly and most likely not be achieved. A probable program would require about 7 mgd, which would serve the existing habitat on public owned properties, keep water in the channel, and allow for some managed recharge. For purposes of the master plan, providing up to 7 mgd of discharge to the Santa Cruz is set as the target. Mike Gritzuk indicated that the reclaimed water needs for the proposed sports park complex need to be determined. It had been estimated earlier that the sports park complex would require approximately 3/4 to 1 mgd of reclaimed water.

With the Roger Road plant rated at 32 mgd, additional effluent water is required to meet both the Tucson Water needs of 30 mgd and the potential Santa Cruz River need of 7 mgd. Effluent water from Ina Road could be pumped to Roger Road to meet the additional demand. With construction of additional pumping capacity at Ina Road, 5 mgd and perhaps as much as 10 mgd, could be conveyed through an existing 24-inch Tucson Water distribution main that passes between the two wastewater treatment plants.

Effluent water discharged from the wastewater treatment facilities is fully allocated by agreements of several parties. Pima County does not have an allocated share of the discharge from the Roger Road facility. Harlan Agnew stated that it was necessary to define whose water goes to the sports park complex and to the Santa Cruz River.

The existing and future reclaimed water needs and riparian habitat water issues in the Santa Cruz River were covered on pages 18 through 20 of the handout.

10. Jerry Bish reviewed the plant interconnect between Roger Road WWTP and Ina Road WPCF needs, sizing and routing. The plant interconnect was previously discussed in Workshops #7 and #12 (note Workshop #12 preceded Workshop #11). Since the last workshop, the historic record of high flows to the Roger Road WWTP were examined to determine the maximum pipeline capacity needed to transfer flow to the Ina Road WPCF from the Roger Road service area. From an analysis of the flow records, the peak flow requirement, including wastewater diurnal flow variations, is 72 mgd. Therefore, for an average flow transfer of 28 mgd, the peak hydraulic capacity of the plant interconnect would need to be approximately 75 mgd (72 mgd). Bob Buecher asked if the headworks capacity at the Ina Road WPCF was capable of handling the interconnect peak flow as well as the wet weather peaks in the Ina Road service area. The headworks capacity at Ina Road WPCF will need to be evaluated. Denny Parker suggested that the secondary clarifiers at both plants be oversized to cushion the impact of higher flows.

    John Carlson asked if building a new plant in the southern end of the conveyance system would reduce wet weather flow to Roger Road WWTP. Paul Bennett offered that the economics were not good to build a facility in the southern end. Jackson Jenkins stated that it had been decided not to build a facility at the southern end.

    Three route alternatives were further evaluated with a pipeline capacity of 75 mgd. Alternative Route 3 was eliminated from consideration in Workshop #12. Each of the remaining three routes (1, 2 and 4) can transfer flow by gravity. The probable construction costs were evaluated for each route. Route 1, along the existing sludge transfer line, is the least costly by a significant amount. Barring right-of-way issues or other unknown factors, Route 1 is the recommended route alternative. It was noted that from recent survey information that the existing sludge line weaves across the existing right-of-way and may need to be relocated in some areas to allow for construction of the plant interconnect. This would add cost to the alternative Route 1 pipeline construction, but since that route is approximately $6 million less expensive, it would most likely remain the less costly approach. John Warner asked whether costs for alternative Route 4, which includes augmentation of a section of existing sewer as part of the route, was taken into account in the costing of the alternatives. This was evaluated earlier and was found that the total costs were less to keep them as separate projects. Laura Fairbanks stated that neighborhood issues work against Route 4.

    The plant interconnect was covered on pages 20 through 24 of the handout.

11. Gordon Culp reviewed the system costs and input from a contractor, JR Filanc Construction Company Inc. (Filanc), who provided construction costs for the Roger Road and Ina Road facilities. Filanc specializes in water and wastewater utility construction in California and Arizona. Previous project cost developments were for comparative wastewater process purposes and did not include common costs for the various alternatives, such as site work, landscaping, security fencing, paving, and so forth. Further, costs were based on 2006 construction cost dollars, which were not escalated to the time of actual construction. The construction costs prepared by the contractor were for 2006 construction and included common elements for the

facilities. Construction costs were not escalated to the time of actual construction. The contractor's costs revealed what is commonly known in the construction industry that there has been a volatile commodities market in recent times, especially for steel and concrete.

Construction costs were prepared for two facilities at Roger Road: 1) upgrade and rehabilitation of existing facilities, and 2) a new "Greenfield" plant. The rehabilitation costs did not include contingencies for latent defects, unforeseen conditions and other construction costs related to the age and condition of the existing facilities. Jackson Jenkins cited that a recent drain failed at the Roger Road WWTP and needed to be repair, and the location was not where the "as-built" plans indicated. It was found under a concrete slab, which required additional cost to fix. Mike Bunch indicated that the existing yard piping arrangement is less than ideal. Costs of making a better arrangement to suit future needs was not included in the rehabilitation costs. It was further offered that the costs of keeping the facility in service, while the rehabilitation is underway, could not be overstated. This cost was not included in the rehabilitation costs. Therefore, costs for the rehabilitation alternative are unrealistic. Denny Parker offered that for master planning, rehabilitation costs are difficult to quantify. To refine the costs of rehabilitation would require a 10 to 15 percent level of design to uncover where the unknown costs are and to apply a price to those elements. Mike Bunch indicated that more of the subjective rehabilitation issues need to be addressed as tangible items and added to the rehabilitation costs. This requires the assignment of costs to the risk factors that are known to exist at the Roger Road WWTP. John Sherlock offered that currently contractors that are working at the Roger Road WWTP are placing a 40 percent premium on construction projects to address the unknowns. John Carlson, retired professional engineer, indicated that from his experience as an ex-contractor that a range of probable costs would be appropriate for the rehabilitation of the existing facilities. From a contractor's viewpoint, working with structures 30 to 40 years old are scary to build onto.

System costs were covered on pages 29 through 31 of the handout.

12. Gordon Culp reviewed a probable sequence of events regarding the upgrades and expansions of the Roger Road WWTP and Ina Road WPCF facilities to meet the ADEQ requirements. Mike Gritzuk asked if the project sequence considered the possibility of delaying components of the project other than those required for treatment and the laboratory. The sequence includes constructing a 24-mgd "Greenfield" facility at Roger Road WWTP by January 2015 and a 50 mgd expansion and upgrade of the Ina Road WPCF by January 2014. An additional 8 mgd of capacity will be constructed at Roger Road after 2015 along with associated sludge facilities at Ina Road WPCF. The class A sludge facilities were not included in the first phase of construction and was assumed to be constructed after the expansions and upgrades at Roger Road WWTP and Ina Road WPCF were complete. The project sequencing analysis indicated that advancing the plant interconnect construction was important to meet the continued increase in wastewater flows at the plants. Mike Bunch reinforced that the plant interconnect was needed to serve population growth in the community. This may have financing implications. It was noted that Interstate 10 is scheduled for widening in the near future, which may impact the construction of the upgrades and expansions at the wastewater plants.

Project sequencing was covered on pages 32 through 34 of the handout.

13. Harold Smith reviewed the capital financing issues to construct the projects outlined in the project sequence provided above, including a "first cut" at annual costs for the County. Key variables include project timing and sequencing, growth of wastewater flows, inflation and interest on bonds. Laura Fairbanks stated that current plant flows are 62 to 66 mgd, including flows to Randolph Park WRF. Therefore, system development fees could be used for parts of the project. Wastewater flows are projected to reach 85 mgd by the year 2030 based on 85 gallons per capita per day. Future water conservation efforts may impact plant flows. Denny Parker stated that flow projections are a surrogate for loads to the plant. Future flows may decrease, but loadings will increase based on population growth, and the plants need to be sized to treat the increased loads. The program to design, construct and startup facilities outlined to meet the ADEQ letter requirements is based on nine years for Roger Road WWTP and eight years for Ina Road WPCF.

    Preliminary annual costs were developed based on 20-year bonds with sales in 2008, 2010 and 2012 to finance the projects. Capital costs were not inflated and were shown in 2006 dollars. O&M costs were escalated at the historic rate of about 3 percent. For sake of the annual costs development, O&M staffing was assumed to be constant between the operation of the existing facilities and the operation of the new facilities. Harold Smith reiterated that the numbers are very, very preliminary. Upon review of the numbers, Mike Kostrzewski indicated that the debt for the County will increase by a factor of 6. Mike Gritzuk indicated that the use of a 2010 bond will probably not be possible and the use of 30-year bonds needs to be looked at to soften rate impacts.

    Capital plan financing issues were covered on pages 35 through 38 of the handout along with four additional slides provided at the end of this meeting summary (see attached pages 19 and 20).

14. Jerry Bish presented site layouts of the year 2030 recommended plan with a 32-mgd Roger Road WWTP and 50-mgd Ina Road WPCF. The recommended plan for future "Greenfield" facilities at Roger Road WWTP are shown along Sweetwater Drive on the south side of the existing wastewater facilities and the Tucson Water reclaimed water filtration plant, reservoir and pumping station operations. The location along Sweetwater Drive meets the regulatory requirements for setbacks using City of Tucson owned land, maximizes the availability of public land for alternative uses (including a new sports complex), enables upstream discharge to the Santa Cruz River to sustain riparian habitat and locates operations adjacent to the existing and future reclaimed water operation. The recommended plan at Roger Road WWTP is for a facility without primary sedimentation tanks. The existing facilities will continue operations until the new facilities are commissioned, after which the existing facilities would be demolished. The site plan includes space for future expansion of facilities capacity by 50 percent beyond the year 2030.

    Gary Newman suggested that the existing headworks and primary sedimentation tanks at Roger Road WWTP could be utilized in front of the new facilities located along Sweetwater Drive. Denny Parker thought the new secondary system could be placed where the new primary sedimentation tanks were shown to get the effluent closer to the Tucson Water facilities. The issue of continued use of the existing headworks and primary sedimentation tanks is both an issue of location of the units relative to the new facilities and suitability of the existing units to function for the intended service. Because of these issues, the existing systems are planned to be retired.

Jack Van Riper asked about backup power supply and where the stormwater collection point for the new facilities was located. These will need to be determined in a more detailed plan of the site. Jackson Jenkins wanted assurance that flexibility would be built into the system; for example, route flow from any aeration tank to any clarifier. Also, how will extra flow at Roger Road be handled if part of the plant is out of service? Extra flows will be transferred to Ina Road WPCF for treatment, or storage in the overflow basins then treatment. For this reason, consideration will be given to add a fourth overflow basin at Ina Road to accommodate future overflow conditions.

At Ina Road WPCF the future facilities will treat 50 mgd of wastewater and will become the centralized location for handling and treatment of Class A biosolids. The site includes space beyond the year 2030 for expansion of both the wastewater and biosolids capacity by 50 percent. That future space would utilize some of the County-owned property at the sports park south of the existing plant. Melodee Loyer wanted to know the location of the future Tucson Water reclaimed water site and to confirm that 10 acres were set aside in the planning for Tucson Water use. The Tucson Water site is located on a 2-acre parcel along the effluent conduit of the treatment works. Additional land can be made available to provide a total of 10 acres.

Jackson Jenkins was interested in having two sludge storage bladders in the future and retiring the existing unit because of its age. Also, where will be the primary and secondary electrical power sources for the Ina Road plant? Gary Newman suggested that onsite generation with gas may be preferable to a second power feed.

Site plans for the future Roger Road WWTP and Ina Road WPCF facilities were covered on pages 24 through 29 of the handout.

15. Andy Richardson reviewed with the workshop group the specific recommendations for the expansions and upgrades of the Roger Road WWTP and Ina Road WPCF. The bases of the recommendations are the decisions from previous workshops and decisions on the materials presented in Workshop #11. The plan is to construct a new 24-mgd water campus like facility at Roger Road along Sweetwater Drive, and construct an additional 8-mgd module before the year 2030 to serve the population growth. Bardenpho is the selected wastewater treatment process.

For Ina Road WPCF the plan is to expand the existing facilities to 50 mgd. Bardenpho is the selected wastewater process. A gravity sewer pipeline with a capacity of 28 mgd (at least 72 mgd peak) will interconnect the service areas of the wastewater facilities.

Sludge facilities will be centralized at the Ina Road WPCF. Mesophilic digestion will be provided until Class A biosolids are required. At that time a batch TPAD process, or some less land intensive alternative such as Cambi or heat drying, will be provided.

Effluent water will be made available to Tucson Water for reclaimed water service at the future Roger Road WWTP and the Ina Road WPCF. The plan allows for approximately 30 mgd at Roger Road WWTP and approximately 20 mgd at Ina Road based on allocated effluent water shares. Up to 7 mgd would be made available for discharge into the Santa Cruz River at the Roger Road WWTP site.

System recommendations were covered on pages 38 and 39 of the handout.

16. Andy Richardson reviewed the general requirements of the ADEQ letters as prescribed in the current operating permits for the Roger Road WWTP and Ina Road WPCF, and outlined the basic probable response based on current planning activities by the Wastewater Management Department. Mike Gritzuk indicated that the plan would need to be updated with the input of this workshop, and meetings will be scheduled with the local ADEQ office and ADEQ headquarters in Phoenix before the letters would be filed with the State. In addition, meetings to review the plan will be held with County Administrator, Chuck Huckelberry and Deputy Administrator, John Bernal before the Board of Supervisors meeting on January 16, 2007.

    General requirements for the ADEQ permit response were covered on pages 39 through 42 of the handout.

17. County Administrator, Chuck Huckelberry, and Deputy County Administrator, John Bernal, joined the workshop in mid-afternoon. A brief review of the recommended plan was provided. Site plan layouts, projected construction costs in 2006 dollars and preliminary annual costs for the recommended 2030 wastewater facilities were included in the review.

18. While there is general agreement among the workshop group with the recommended plan, Andy Richardson led a wrap-up session of the workshop by inviting each participate to express his or her considerations or concerns on the recommended plan. Many were concerned over the costs of the upgrades and expansions at Roger Road WWTP and Ina Road WPCF, and raising the money to finance the new facilities. Some view that the facilities costs as understated at $500 million shown in 2006 dollars, while costs will be closer to $800 million in real dollars when inflation is taken into account.

    For various reasons many expressed support to build a new “Greenfield” facility, and not rehabilitate the existing Roger Road WWTP. Recent experience with rehabilitation of facilities at Roger Road has been bad and costly, and some thought rehabilitation of the existing Roger Road WWTP would be a disaster. A better case for new versus rehabilitation is required that includes real probable costs of rehabilitation.

    There were expressions that the plant interconnect needs to constructed very soon, while others were concerned over low flows in the plant interconnect at startup that might lead to odors being released from the plant interconnect into the community. Some consideration should be given to two interconnect pipelines for reliability. The plant interconnect project may want to be sped up with the widening of Interstate 10 project scheduled to begin in the near future.

    There was a thought that costs of these facilities could be shown as an environmental fee on the customer bills to highlight facility costs, and ratepayers would be informed that those costs would be eventually dropped off the bill. Byron McMillan cautioned that the planning activity needs to be flexible to address future regulations on air quality standards, effluent discharges, and aquifer protection permits. ADEQ and EPA may add more regulations and the sooner they are known the better.

John Munden wants the blower building to be shown on the Roger Road WWTP layouts, energy generation and consumption to be addressed at both sites and adequate restrooms to be provided for employees in the future facilities.

Ed Curley believes that Class A biosolids will be required in Arizona sooner rather than later and provisions will be needed to include the appropriate processing. The Class A biosolids requirements may be imposed by the State suddenly, like the ban on ocean dumping. Disposing of Class B biosolids in a landfill may be required until Class A facilities are placed into operation.

There was support for providing a riparian habitat in the Santa Cruz River, but the big question is who was going to place the water into the river.

Denny Parker thought that getting construction costs from a contractor at the planning stage was great, but more details would be needed to fully develop the risk factors associated with rehabilitation of existing facilities. Several thought that costs for rehabilitation of facilities at the existing Roger Road WWTP were too low.

On the phosphorus issue, make provisions but do not build facilities now; add in the future when required by ADEQ. Further, add room on the site plan development for 2-stage filtration in the future to address more stringent phosphorus removal standards, if required. It was encouraged that provisions for flexibility be included in the design development of the wastewater and biosolids systems.

It was expressed that timing is important and that there are several presentations needed to sell the plan to the Board of Supervisors and others. Mike Gritzuk provided an outline of next steps: complete the risk assessment by assigning appropriate costs to rehabilitation of facilities at Roger Road, look at stretching the costs over the construction period provided by the permits and beyond (are there items beside 8 mgd at Roger Road WWTP that can be deferred?), develop a roll-out plan for the regulators and finance director (need more detail on rate impact analysis), and provide more detail to strengthen the biosolids plan development. Several meetings will be required with the regulatory agency, public officials and stakeholders over the next month or so to present the plan. Other stakeholders include the Chamber of Commerce and the League of Women Voters.

19. Mike Gritzuk closed the meeting by thanking all for their participation with a special thanks to the peer group for their valuable input. He further indicated that much work was needed to advance the program from this point.

Agenda
Workshop #11 – Evaluation of Treatment Plant
December 13, 2006

Time	Topic	Presenter
8:00 am	*Continental Breakfast – Rio Nuevo, Upstairs Conference Room, 52 W. Congress*	
8:30 am	Opening Session • Welcoming Remarks • Review Agenda • Previous Decisions • Workshop Goals	 Mike Gritzuk Andy Richardson
9:00 am	Evaluation Process Review	Gordon Culp
9:15 am	System Configuration • Bardenpho ► Wastewater Treatment ► Recycle Flows • Biosolids Treatment • Reclaimed Water • Plant Interconnect	Carl Koch/Jerry Bish
10:30 am	Break	
10:45 am	Site Layouts • Roger Road WWTP (32 mgd) • Basis of Proposed Plant Capacity ► Wastewater ► Reclaimed Water • Ina Road WPCF (50 mgd) • Basis of Proposed Plant Capacity ► Wastewater ► Biosolids ► Reclaimed Water	Jerry Bish
12:00 pm	Lunch	
1:00 pm	System Costs • Roger Road WWTP (32 mgd) • Ina Road WPCF (50 mgd) • Biosolids Treatment • Reclaimed Water • Plant Interconnect	Gordon Culp
1:30 pm	Project Sequencing • Plant Interconnect • Roger Road WWTP (32 mgd) • Ina Road WPCF (50 mgd) • Biosolids Treatment • Reclaimed Water	Gordon Culp
2:00 pm	Capital Plan Financing Issues	Harold Smith
2:30 pm	Break	
2:45 pm	System Recommendation	Andy Richardson
3:15 pm	ADEQ Presentation/ADEQ Permit Response	Andy Richardson
3:30 pm	Summary Wrap-Up • Comments by Group • Closing Remarks	Andy Richardson Mike Gritzuk
4:00 pm	Adjourn	

Flip Chart Notes – December 13, 2006

EVALUATION REVIEW

- Need to explain planning costs versus final cost.
- Need case studies/real examples of "Cost" risk associated with rehabilitation of existing facilities in water/wastewater industry.
- What is the reason for 50 MGD at Ina Road? Cost of plant interconnect?
- What is the impact on the plant interconnect sizing with flow already at Roger Road?

WASTEWATER TREATMENT

- Question of "No" Primary Sedimentation at Roger Road "Greenfield" Plant.
  - Look at total annual cost with and without primaries –particularly at additional energy without primaries.
  - Should not have primaries at Roger Road – bypassing the primaries at Ina Road WPCF BNRAS has made the process easy to operate.
- Concerns with discharging solids into plant interconnect – will there be an impact?
- Ina Road WPCF: 40% BOD removal in the primary clarifiers.
- Side stream treatment vs. addition of metal salts?
- Why design Bio "P" into process if there will be a need to add metal salts?
- Bio P sludge is more difficult to handle than regular sludge. Has this been taken into consideration?
- P removal will be more stringent than 1 mg/L; could be 0.05 mg/L; something to think about?

BIOSOLIDS

- Why thicken WAS at Roger Road WWTP to 3%? Just put in sludge line to Ina Road WPCF?
- Dewatering schedule – Plan is not to run 24/7. Need to consider loading on plant based on operating schedule
- Need to look at a schedule of achieving class A biosolids in a quick time frame, make sure class B facility work toward that schedule.
- Where is the timeframe and schedule for biosolids – where are we going to place it?
- Current and future biosolids treatment could be on the critical path.
- Biosolids is used elsewhere as landfill cover.
- Current limited solids handling capacity is an operational risk.

RECLAIMED WATER

- Will 30 mgd at Roger Road WWTP be required upon startup of new facilities in 2015? No, this is a future number.
- Is the flow 24/7? The answer is "No."
- Randolph Park WRF provides reclaimed water to the County and Tucson Water.
- How much water does Parks & Recreation want in the Santa Cruz River? about 7 mgd?
- Need to understand whose water discharges from Roger Road WWTP (County does not have water rights to Roger Road WWTP effluent) and how much goes to Santa Cruz? 7 mgd has been allocated for planning.
- Whoever wants the effluent water in the Santa Cruz River should make application for the water.

PLANT INTERCONNECT

- How much flow is at Ina Road service area now and the future? How does this flow have an impact on the flow transfer from Roger Road?
- Is there room at both Ina Road WPCF and Roger Road WWTP for future expansion based on how the plant interconnect is sized?
- Future flows need to be planned for that in sizing of WWTP Facilities.
- For the selected route try to avoid public areas
- Route 4 is really an interceptor route that alleviates other conveyance system issues as well as transfers flow.

COSTS

- Need to address with real examples of the △ between rehabilitation and Greenfield. What does an additional $60 million provide Pima County?
- Need net present value of useful life on rehabilitation vs. Greenfield.
- Convert some of the evaluation criteria on evaluation matrix to $.
- Need to consider another level of detail.
- Need to look at $/gallon numbers on a benchmark basis.
- Add costs associated with keeping the rehabilitation operation in service.
- Need to take into consideration impact of interstate I-10 construction on the implementation of the program.

FINANCING ISSUES

- Need to look at how to make a case for growth to use as a funding source.
  - Already system is at 78.5 % of capacity of the future flows.
  - Plant interconnect could be considered a growth issue.
  - Look at construction time frame and how it relates to cash flow and potential savings?

SITE LAYOUTS

- What are the total acres and pump costs forTucson Water?
- Need to include support facilities on future site plans.
- Where is the area for stormwater collection, need to be located.
- Look at using existing primaries at Roger Road WWTP.
- Will there be an electrical generator building on Roger Road WWTP?
- How will flow split be worked out at in front of Roger Road WWTP to send flow to Ina Road WPCF?
- Tucson Water needs 10 acres per IGA at Ina Road WPCF site.
- Can the existing headworks take the maximum flow from the plant interconnect? Is it sized for the capacity that is needed?
- Provide headworks for all the service area flow at Roger Road WWTP and then send flow to Ina Road WPCF through the plant interconnect.
- Provide 1-day of storage for overflow issues.
- What is the long term standby and primary power plan?
- At Ina Road WPCF look at generation of power with gas.

CONCERNS/CONSIDERATIONS FROM GROUP

- Go to additional level of costing on Roger rehab plan, check facility cost.
- Concerns on interconnect transfer route.
- Concerns on cost to construct facilities.
- Methods to finance – funding sources.
- Low flow on interconnect – Will equalization be required?
- Experience on rehabilitation at Pima County facilities has been bad and costly.
- Riparian area maintenance – who owns water?
- Make sure we have a way to monitor future flows.
- Provide interconnect sooner – consider two lines .
- Benchmark treatment costs at $7/Gal. and go upon cost.
- Construction of interconnect will have some deep excavation cuts.
- Go back to contractor for a guaranteed DB costs number.
- New standards on river discharges; air quality standards; APP standards – need to be taken into consideration.
- Class A biosolids need to be addressed much sooner; concern for public perception of biosolids.
- Construction costs are low.
- Look at bond program – how scheduled to receive funds in time for construction.
- Bottleneck on solids handling.
- Implementation – need funding in place.
- Go to board with inflated inflated construction costs.
- Who is going to water the river?
- Provide for flexibility on site layouts.
- Accommodate cost increases in the funding program.
- Need to figure out scope for designs.
- ADEQ vs. EPA – who's calling the shots?
- How will this project impact costs in region with other projects – timing?
- Manpower costs on plant operations in the future.
- Give thought to strategy on presentation for "Selling Plan."
- $1/2 billion is too low.
- Need cost of risk elements in the construction costs.
- Implementation plan – How far out can remaining elements be stretched?
- Look at all other elements of ROMP and can they be moved out to be constructed at a later time?
- Presentation of plan is important – To finance director.
- Politically is 2010 bond realistic?
- Plan presentations
  - 12/21/06 Recommended Plan to Wastewater Advisory Committee
  - 12/20/06 to County Administration
  - Before 12/31/06 Presentation to local ADEQ office
  - Early January present plan to ADEQ headquarters
  - Presentation to City of Tucson and other stakeholder groups

ADDITIONAL WORKSHOP PRESENTATION SLIDES:

Alternate Class A Options

- Utilize mesophilic digestion for all
- Cambi would add:
  - Pre-digestion thickening to 15%
  - Patented 3 step hydrolysis process prior to digesters
- Heat Drying would add:
  - Driers after digestion and dewatering

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Cambi Process Considerations

- No U.S. installations
- Requires steam and high pressure (safety issues)
- Not currently given Class A status (likely to meet requirements)
- Product too dry for liquid land application
- Potential odors and strong recycle stream

Keep process in picture for future if more development in U.S. and need to pilot test if strong interest in use

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Heat Drying Considerations

- Product too dry for liquid land application
- High energy consumption
- Fire and explosion potential
- High quality product
- Need of known/ready market for the investment

Could be added instead of thermophilic digestion based on future market conditions

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Project Schedule & Costs

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Interconnect	**$22,300,000**															
Design		$1,338,000														
Construct				$20,962,000												
Ina Rd	**$243,900,000**															
Design 50 mgd		$14,634,000														
Construct 50 mgd						$212,193,000										
Construct Thermophilic Digestion														$17,073,000		
Roger Rd	**$234,800,000**															
Design 32 mgd			$12,660,000													
Construct 24 mgd							$148,755,000									
Demo Existing Plant									$23,800,000							
Construct 8 mgd											$49,585,000					

Total ROMP Projects Cost $501,000,000

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Preliminary Financing Plan

1997 Bonds	**$4.1 M**
Other CIP	*$4.1 M*
2004 Bonds	**$132.6 M**
Design Ina 50 MGD	*$14.6 M*
Interconnect	*$22.3 M*
Other CIP	*$95.7 M*
SDF's	**$92.3 M**
Other CIP	*$92.3 M*
2008 Bonds	**$345.0 M**
Construct Ina 50 MGD Ph I	*$127.3 M*
Design Roger 32 MGD	*$12.7 M*
Other CIP	*$205.0 M*
2010 Bonds	**$307.1 M**
Construct Ina 50 MGD Ph II	*$84.9 M*
Construct Roger 24 MGD	*$148.8 M*
Demo Existing Roger	*$23.8 M*
Final 8 MGD Roger	*$49.6 M*
2012 Bonds	**$17.1 M**
Thermophilic Digestion-Ina	*$17.1 M*

1

Preliminary Annual Costs

	2007	2008	2009	2010	2011	2012	2013
Annual Project Costs	**$ 47.8**	**$ 74.3**	**$ 79.2**	**$ 73.4**	**$ 78.3**	**$ 103.5**	**$ 130.5**
Existing Annual Debt Service	$ 15.5	$ 16.2	$ 16.2	$ 16.3	$ 16.4	$ 16.4	$ 15.9
Proposed Annual Debt Service	$ 2.6	$ 7.6	$ 12.2	$ 16.9	$ 24.0	$ 33.4	$ 45.2
Total Debt Service	**$ 18.0**	**$ 23.8**	**$ 28.5**	**$ 33.2**	**$ 40.4**	**$ 49.8**	**$ 61.0**
Annual O&M Costs	$ 70.0	$ 72.6	$ 75.4	$ 78.3	$ 81.3	$ 84.4	$ 87.7
Annual Capital Outlay	$ 5.4	$ 6.1	$ 7.8	$ 10.0	$ 12.2	$ 14.4	$ 15.7
Total O&M and Capital Outlay	**$ 75.4**	**$ 78.8**	**$ 83.2**	**$ 88.3**	**$ 93.5**	**$ 98.9**	**$ 103.3**
Total Annual Costs	**$ 93.4**	**$ 102.6**	**$ 111.7**	**$ 121.5**	**$ 133.9**	**$ 148.7**	**$ 164.4**
% Annual Increse/(Decrease)		10%	9%	9%	10%	11%	11%

	2014	2015	2016	2017	2018	2019	2020
Annual Project Costs	**$ 81.6**	**$ 64.4**	**$ 72.0**	**$ 66.1**	**$ 9.9**	**$ -**	**$ 8.5**
Existing Annual Debt Service	$ 13.8	$ 14.5	$ 15.3	$ 7.1	$ 1.3	$ 1.3	$ 1.3
Proposed Annual Debt Service	$ 52.5	$ 58.2	$ 64.7	$ 70.6	$ 71.5	$ 71.5	$ 72.3
Total Debt Service	**$ 66.3**	**$ 72.7**	**$ 80.0**	**$ 77.7**	**$ 72.8**	**$ 72.8**	**$ 73.6**
Annual O&M Costs	$ 91.9	$ 96.1	$ 99.1	$ 102.3	$ 105.5	$ 108.9	$ 112.4
Annual Capital Outlay	$ 16.9	$ 19.1	$ 20.4	$ 19.6	$ 19.8	$ 20.0	$ 20.3
Total O&M and Capital Outlay	**$ 108.8**	**$ 115.2**	**$ 119.5**	**$ 121.8**	**$ 125.3**	**$ 128.9**	**$ 132.7**
Total Annual Costs	**$ 175.1**	**$ 187.9**	**$ 199.5**	**$ 199.5**	**$ 198.2**	**$ 201.8**	**$ 206.3**
% Annual Increse/(Decrease)	7%	7%	6%	0%	(1%)	2%	2%

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Preliminary Unit Cost

	2007	2008	2009	2010	2011	2012	2013
Annual Unit Cost							
($/CCF)	$2.94	$3.08	$3.19	$3.32	$3.58	$3.89	$4.22
% Increase/(Decrease)		4.4%	3.8%	3.9%	7.9%	8.7%	8.4%

	2014	2015	2016	2017	2018	2019	2020
Annual Unit Cost							
($/CCF)	$4.40	$4.64	$4.83	$4.74	$4.62	$4.62	$4.64
% Increase/(Decrease)	4.4%	5.2%	4.1%	(1.8%)	(2.5%)	(0.0%)	0.4%

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Pima County Regional Optimization Master Plan

Workshop #11
Evaluation of Treatment Plant

December 13, 2006

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator/Previous WS Decisions
Gordon Culp	Evaluation Process Review/System Costs/ Project Sequencing
Jerry Bish/Carl Koch	System Configuration
Jerry Bish	Site Layouts
Harold Smith	Capital Plan Financing Issues
Andy Richardson	System Recommendation/ADEQ Permit Response/Wrap-Up

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Workshop Goals
- Previous Workshop Decisions
- Evaluation Process Review
- System Configuration
- Site Layouts
- Project Sequencing
- System Costs
- Capital Plan Financing
- System Recommendation
- ADEQ Permit Response
- Summary Wrap-up

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

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Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

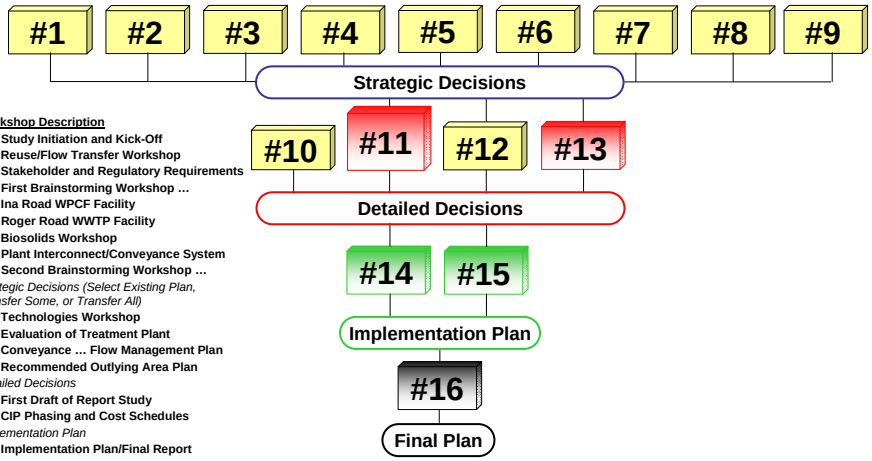
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Previous Workshop Decisions

- Workshop #4 – June 5, 2006
  - Agreed on viable process alternatives
  - Agreed on matrix evaluation criteria
  - Agreed on matrix evaluation criteria weighting
  - Agreed to continue evaluating Bardenpho, MLE and IFAS and MBR
  - Agreed that P removal was a process criteria
  - Agreed to drop AS/NTF, BT/NAS, Step NdeN, Biostyr/Biofor and MBBR from further consideration

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Treatment Process Selection

8 Treatment Processes Considered

↓

5 Treatment Processes Evaluated

↓

Treatment Process to be Used in Comparing System Alternatives

↓

Compare System Alternatives

↓

Preferred System Alternative

↓

Recommended Treatment Process

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Previous Workshop Decisions

- Workshop #5/6 – July 12, 2006
  - Processes with nitrification only were eliminated
  - Agreed to further evaluation Bardenpho for system configuration options
  - Agreed to consider other processes with denitrification for sensitivity testing

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Previous Workshop Decisions

- Workshop #9 – August 8/9, 2006
  - Reaffirm P removal as a process criteria
  - Agreed on system evaluation matrix
  - Agreed no time available for pilot testing
  - Reaffirm Bardenpho for system configuration options

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Previous Workshop Decisions

- Workshop #9 – August 8/9, 2006 *(continued)*
  - Agreed on the flows for the system configuration options
    - Agreed upon 32/50, 20/62 & 0/82
    - Discarded 37.5/44.5,50/32 & 60/22
  - Agreed on WW characteristics for each plant
  - Agreed on MLE + deN filters, IFAS and Biotowers at RR (20 mgd only) for process sensitivity testing

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Previous Workshop Decisions

- Workshop #10 – September 26, 2006
  - Agreed on system configuration
    - Existing plan
  - Within system configuration, agreed upon
    - Greenfield RR WWTP
  - Agreed on process for NdeN
    - Bardenpho

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Workshop Goals

- Go from preferred to recommended plan
- Agree on recycle stream treatment
- Agree on sequence of construction
- Agree on content of ADEQ letter

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Evaluation Process Review

Gordon Culp

System Configuration Evaluation

- Layout and evaluate Bardenpho for each site for three system configuration options including a greenfield option at Roger Road WWTP
- Prepare cost evaluation matrix comparing Bardenpho, IFAS, MLE +deN Filters and BT/NAS
- Prepare non-economic evaluation matrix
- Select system configuration

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System Configuration Cost Evaluation

COST MATRIX					
	RR=32 mgd	RR=20 mgd	RR=0 mgd	RRGF=32 mgd	RRGF=20 mgd
	IR=50 mgd	IR=62 mgd	IR=82 mgd	IR=50 mgd	IR=62 mgd
Capital Cost					
Plant interconnect	$22,000,000	$25,100,000	$31,600,000	$22,000,000	$25,100,000
RR Demolition and Removal	$4,000,000	$4,000,000	$16,100,000	$16,100,000	$16,100,000
Roger Road treatment plant	$81,540,000	$56,500,000	$0	$102,160,000	$65,800,000
Ina Road Treatment Plant	$167,500,000	$211,400,000	$284,660,000	$167,500,000	$211,360,000
Reclaimed water return	$270,000	$9,800,000	$19,400,000	$270,000	$9,800,000
Tucson Water Booster PS	$810,000	$810,000	$810,000	$810,000	$810,000
Tucson Water Reservoir	$11,000,000	$11,000,000	$22,000,000	$11,000,000	$11,000,000
Total Capital Cost	**$287,100,000**	**$318,600,000**	**$374,600,000**	**$319,800,000**	**$340,000,000**
Annual O&M Cost					
Labor	$7,500,000	$7,300,000	$6,200,000	$6,800,000	$6,800,000
Methanol	$0	$0	$0	$0	$0
Polymer-sludge thicken/dewater	$730,000	$720,000	$700,000	$730,000	$720,000
Alum for P removal	$0	$0	$0	$0	$0
Power-treatment	$6,050,000	$6,050,000	$6,050,000	$6,050,000	$6,050,000
Power-rec. water return + booster PS	$395,000	$710,000	$1,210,000	$395,000	$710,000
Interconnect line maint.	$10,000	$10,000	$10,000	$10,000	$10,000
Total annual cost	$14,685,000	$14,790,000	$14,170,000	$13,985,000	$14,290,000
Present Worth of Annual Costs	$144,200,000	$145,200,000	$139,100,000	$137,300,000	$140,300,000
Total Present Worth Cost	**$431,300,000**	**$463,800,000**	**$513,700,000**	**$457,100,000**	**$480,300,000**

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Process Evaluation

- Process Sensitivity Comparisons

Process	Flow RR / IR	Present Worth	Capital
Bardenpho	32 / 50	$431,300,000	$287,100,000
IFAS at RR & IR	32 / 50	$438,800,000	$294,600,000
MLE = deN Filters at RR & IR	32 / 50	$445,800,000	$299,600,000
Bardenpho / Greenfield-RR	32 / 50	$457,100,000	$319,800,000
Bardenpho	20 / 62	$463,800,000	$318,600,000
BT/NAS RR + Bardenpho IR	20 / 62	$478,600,000	$326,600,000
Bardenpho/Greenfield-RR	20 / 62	$480,300,000	$340,000,000

System Evaluation Matrix

- Uses criterion and weights agreed to in earlier workshop for comparing system alternatives
- This is a tool to have a structured and focused discussion on relative merits of alternatives – judgment must be applied to results

System Evaluation Matrix by Consultant Team

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5	5	4	2	4	3	25	20	10	20	15
Schedule	5	4	4	5	5	5	20	20	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	5	4	4	12	12	20	16	16
Environmental Impacts	4	3	3	5	4	4	12	12	20	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	2	2	2	2	2	10	10	10	10	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	4	3	2	3	3	12	9	6	9	9
TOTAL		40	36	41	47	43	165	149	167	191	175

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System Evaluation Matrix by Workshop Attendees

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	5	5	4	2	4	3	25	20	10	20	15
Schedule	5	3	3	5	5	5	15	15	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	4	4	4	12	12	16	16	16
Environmental Impacts	4	3	3	4	4	4	12	12	16	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	1	2	2	3	2	5	10	10	15	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	5	4	2	4	3	15	12	6	12	9
TOTAL		39	36	39	49	43	158	147	159	199	175

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System Evaluation Matrix by Workshop Attendees (Cost Factor = 10)

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	10	5	4	2	4	3	50	40	20	40	30
Schedule	5	3	3	5	5	5	15	15	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	4	4	4	12	12	16	16	16
Environmental Impacts	4	3	3	4	4	4	12	12	16	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	1	2	2	3	2	5	10	10	15	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	5	4	2	4	3	15	12	6	12	9
TOTAL		**39**	**36**	**39**	**49**	**43**	**183**	**167**	**169**	**219**	**190**

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System Configuration and Process Evaluation Summary

- Existing plan system configuration selected
  - 50 mgd at Ina Road WPCF
  - 32 mgd Greenfield at Roger Road WWTP
- Bardenpho process selected

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System Configuration

- Wastewater Treatment and Recycle Flows
- Biosolids Treatment
- Reclaimed Water
- Plant Interconnect

Basis of Proposed Plant Capacity

- History
  - Project required assessment of various system configurations:
    - Existing Plan - 32 mgd @ RR & 50 mgd @ IR
    - Transfer Some – 20 mgd @ RR & 62 mgd @ IR
    - Transfer All – 0 mgd @ RR & 82 mgd @ IR

IR = Ina Road WPCF RR = Roger Road WWTP

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Basis of Proposed Plant Capacity

- Workshop #4 continued use of these flows for system configuration analysis

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Basis of Proposed Plant Capacity

- System configuration flows considered in Workshop #9:

IR (mgd)	RR (mgd)	RR, Greenfield (mgd)
22	60	60
38	44	44
45	37	37
50*	32*	32
62*	20*(1)	20
82*	0*	--

IR = Ina Road WPCF
RR = Roger Road WWTP

* = Flows from Workshop #4
(1) Use of Biotower Option at RR

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Basis of Proposed Plant Capacity

- Workshop #9 considerations:
  - Need 50 mgd at IR for recycle flow treatment
  - Transfer more from RR increases cost of plant interconnect
  - Investment of newer infrastructure @ IR (headworks and secondary facilities)
  - 12.5-mgd modules started with BNRAS plant

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Basis of Proposed Plant Capacity

- Consensus agreement from Workshop #9:
  - Existing Plan – 32 mgd @ RR & 50 mgd @ IR
  - Transfer Some – 20 mgd @ RR & 62 mgd @ IR
  - Transfer All – 0 mgd @ RR & 82 mgd @ IR

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Basis of Proposed Plant Capacity

- Workshop #10 costs evaluation rankings:
  - Least costly - 32 mgd @ RR & 50 mgd @ IR
  - Middle cost - 20 mgd @ RR & 62 mgd @ IR
  - Highest cost - 0 mgd @ RR & 82 mgd @ IR

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Pima County Wastewater Management Department

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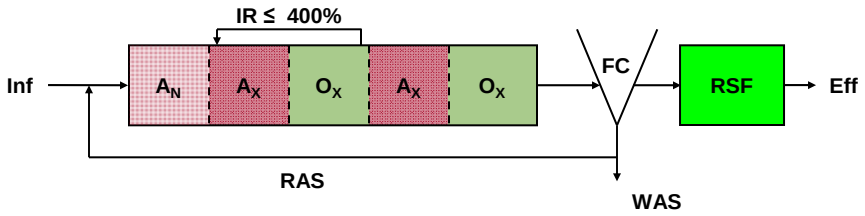
Wastewater Treatment and Recycle Flows

Carl Koch

Wastewater Treatment

AN = Anaerobic
AX = Anoxic
OX = Oxic
FC = Final Clarifier
DNF = Denit Filter
RSF = Rapid Sand Filter

5-Stage Bardenpho



Bardenpho Nitrification-Denitrification (NdeN)

Wastewater Treatment

- Roger Road Greenfield Plant :
  - No primary sedimentation tanks
  - No chemical requirements to achieve:
    - TN ≤ 8 mg/L
    - Ammonia ≤ 2 mg/L
    - P ≤ 1 mg/L

Wastewater Treatment

- Ina Road WPCF:
  - No chemical requirements to achieve:
    - TN ≤ 8 mg/L
    - Ammonia ≤ 2 mg/L
  - Need metal salts to achieve:
    - P ≤ 1 mg/L
    - Add metal salts ahead of primary/final clarifiers

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Major Recycle Flows

- At Roger Road WWTP
  - Only centrate from WAS thickening
  - Can be treated in main WW process stream

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Major Recycle Flows

- At Ina Road WPCF
  - Centrate from primary sludge and WAS thickening
  - Centrate from digested sludge thickening/dewatering
  - Can be treated in Main WW process stream

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Biosolids Treatment

Carl Koch

Workshop No. 7 Conclusions

- All biosolids stabilization at Ina Road WPCF for all Ina and Roger options
- All biosolids alternatives include mesophilic digestion
- Class A Screened Alternatives
  - Temperature Phased Anaerobic Digestion (TPAD)
  - Heat drying
  - Cambi

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Biosolids Treatment Options

- Class B
  - Mesophilic digestion (current process)
- Class A – liquid processes
  - Temperature Phased Anaerobic Digestion (TPAD)
- Class A – cake or dry product processes
  - Temperature Phased Anaerobic Digestion (TPAD) + dewatering
  - Cambi + Mesophilic Digestion (potential future option) + dewatering
  - Heat drying + dewatering

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Alternate Class A Options

- Utilize mesophilic digestion for all
- Cambi would add:
  - Pre-digestion thickening to 15%
  - Patented 3 step hydrolysis process prior to digesters
- Heat Drying would add:
  - Driers after digestion and dewatering

43

Cambi Process Considerations

- No U.S. installations
- Requires steam and high pressure (safety issues)
- Not currently given Class A status (likely to meet requirements)
- Product too dry for liquid land application
- Potential odors and strong recycle stream

Keep process in picture for future if more development in U.S. and need to pilot test if strong interest in use

44

Heat Drying Considerations

- Product too dry for liquid land application
- High energy consumption
- Fire and explosion potential
- High quality product
- Need of known/ready market for the investment

Could be added instead of thermophilic digestion based on future market conditions

45

Planning Decisions

- When to Implement Class A?
  - Digest to Class B until Class A is required
  - Watch for triggers to Class A (NBP public participation)
- Selected Class A approach?
  - For existing market: TPAD
  - For drier product markets: TPAD, Heat Drying, or possibly Cambi
- Location for Class A
  - Ina Road WPCF

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Biosolids Arrangements

- Site layouts for processing biosolids from a total 82-mgd flow
  - Space reserved for processing biosolids from an additional 41-mgd flow
  - Based on 50-mgd Ina Road and 32-mgd Roger Road "Greenfield" Alternative (with no primaries)
  - Primary and WAS thickening, TPAD, post digestion thickening/dewatering

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Biosolids Class B Facilities

- Roger Road WWTP
  - GBT Thickening Facility for WAS to 3% solids
- Ina Road WPCF
  - Gravity thickening/DAF for Primary Sludge to 5% solids
  - GBT Thickening Facility to thicken WAS to 5% solids
  - Nine mesophilic digesters (5 new)
  - Expand Centrifuge Dewatering Facility

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Biosolids Class A Facilities

- Roger Road WWTP
  - GBT Thickening Facility for WAS to 3% solids
- Ina Road WPCF
  - Gravity thickening/DAF for Primary Sludge to 5% solids
  - GBT Thickening Facility to thicken WAS to 5% solids
  - Six mesophilic digesters
  - Nine thermophilic digesters
  - Expand Centrifuge Dewatering Facility

Biosolids and Bio Gas

- For all process alternative evaluations:
  - For each System Configuration Alternative - assumed that sludge is thickened at the respective wastewater plant
  - All biosolids are assumed to be digested and dewatered at Ina Road
  - Thermo/Meso Anaerobic Digestion was assumed

Biosolids and Bio Gas

- Bio Gas utilization studies currently underway:
  - Current sludge gas utilization is base line condition
  - Investigating
    - Evaluation of Bio-Gas usage potential and power supply facilities

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Biosolids and Bio Gas

- Evaluation of Bio-Gas usage potential and power supply facilities
  1. Introduction
  2. Summary
  3. Bio-gas Quantities, Quality and Energy Potential
  4. End Uses of Energy
  5. Bio-gas Conversion Alternatives
  6. Alternatives Selection and Economic Analysis
  7. Alternatives Evaluation and Ranking
  8. Conclusions and Recommendations

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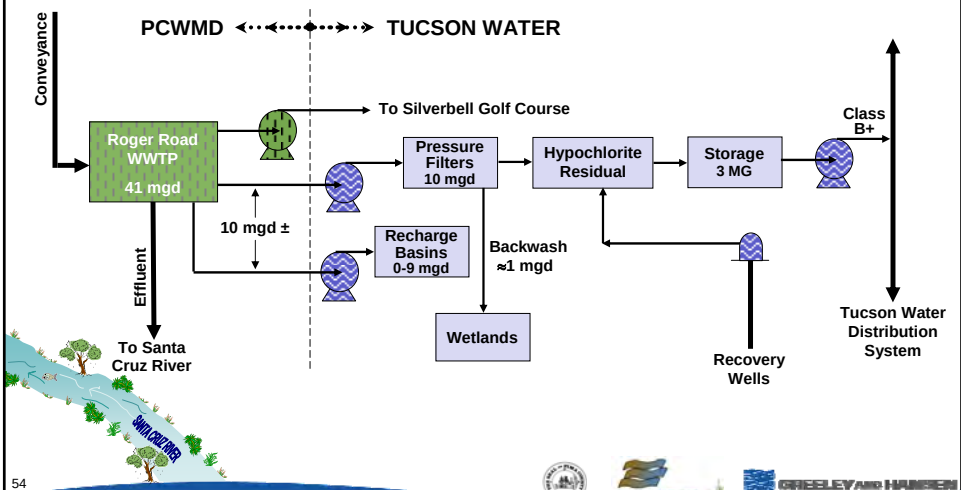
Reclaimed Water

Jerry Bish

Sweetwater Facilities (Existing)



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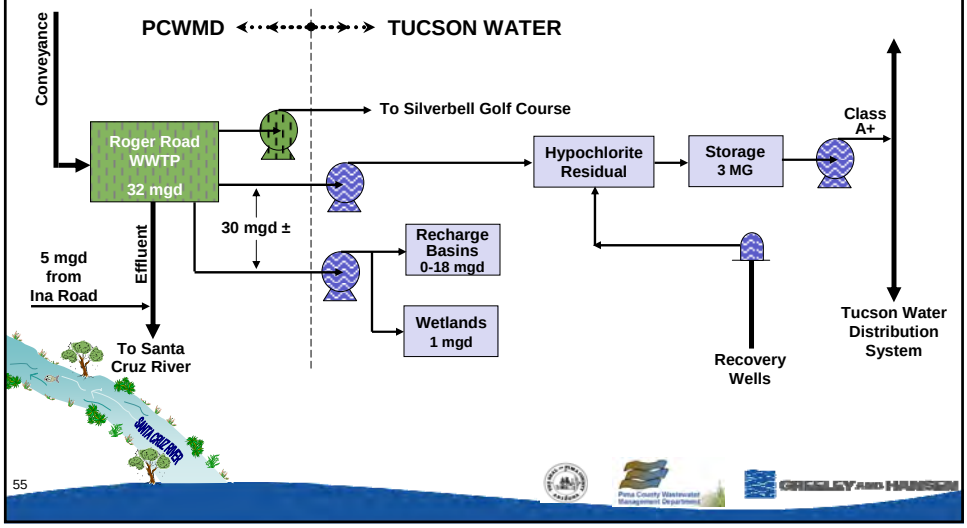
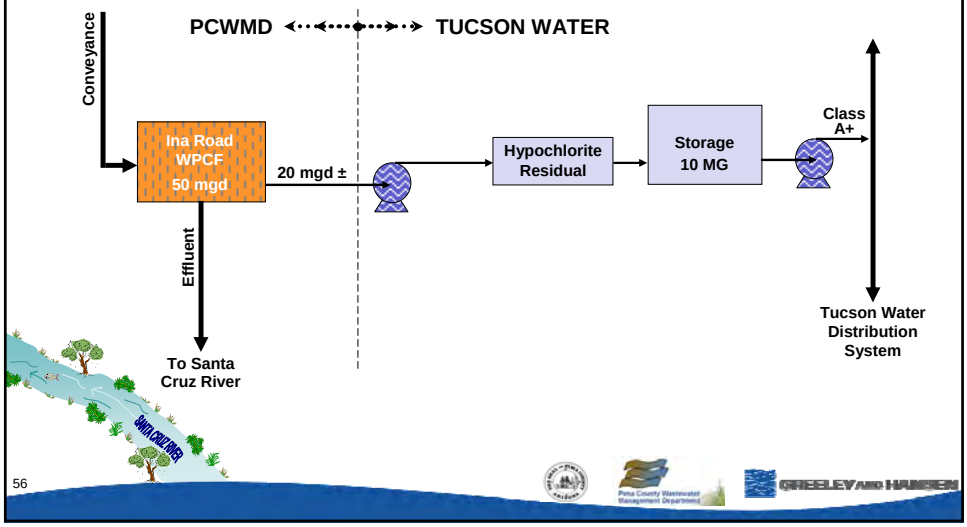
Sweetwater Facilities (Future)



Ina Road Facilities (Future)



Riparian Habitat Allocation – Roger Road to Ina Road

- Tres Rios Del Norte Project
  - Ecosystem restoration
  - Flood damage reduction
  - Groundwater recharge
  - Recreation
  - Cultural resource preservation

- Q ranges: 1.4 to 16 mgd

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Riparian Habitat – Roger Road to Ina Road *(continued)*

- Pima County Parks and Recreation
  - Desires "greenway" for environmental and recreational purposes
- Local environmental groups
  - "Greenbelt" with connection to Sweetwater wetlands

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Santa Cruz River Allocation

- Effluent Q to Santa Cruz River
  - Discharge 2 mgd
    - Serves County-owned properties
    - Preserves of existing riparian habitat
  - Discharge 7 mgd
    - Keeps water in channel
    - Allows for some managed recharge

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Plant Interconnect

Jerry Bish

Plant Interconnect

- Current Transfers
  - Tucson Blvd and Craycroft Road
  - 8-inch sludge line
- Future Transfers
  - 28-mgd Roger Road WWTP to Ina Road WPCF
  - 8-inch sludge line

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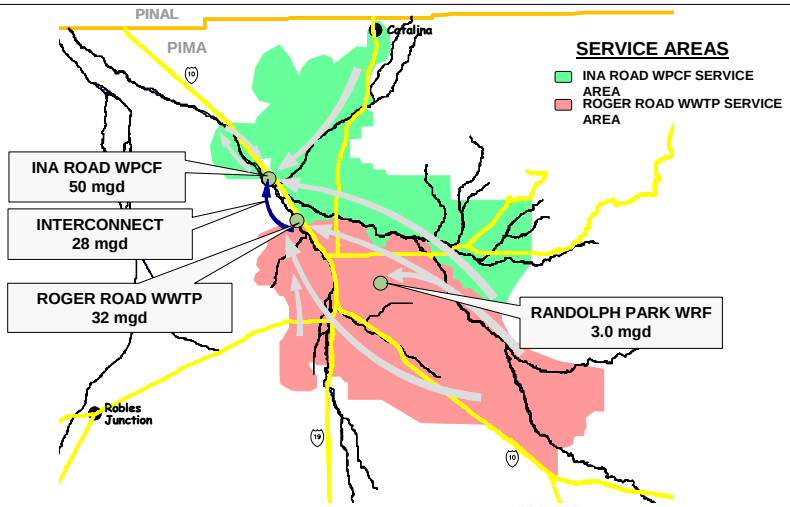
Existing Plan (2030)



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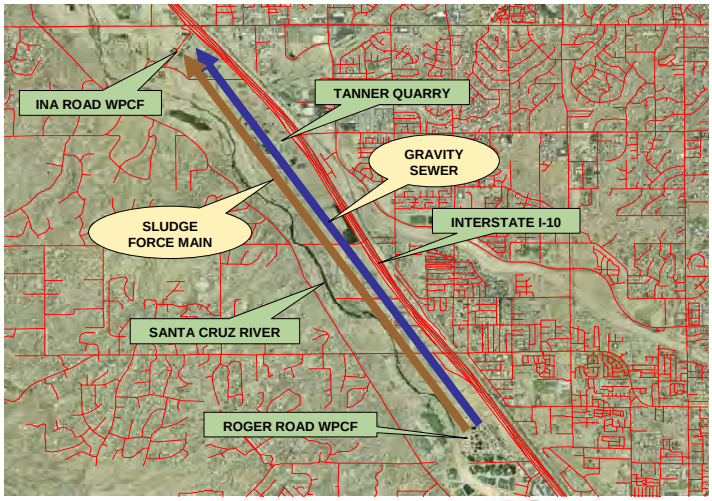
Plant Interconnect



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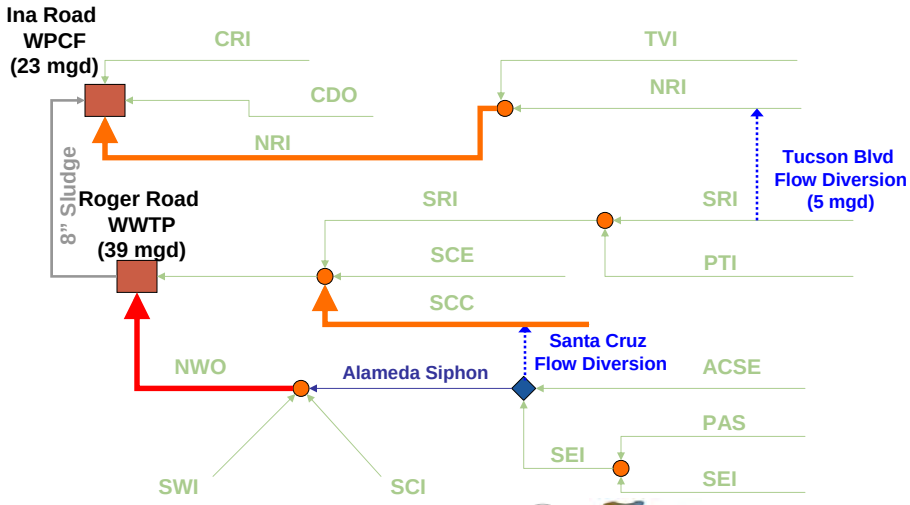
Mass Balance Schematic
(Existing System Configuration and Flows)



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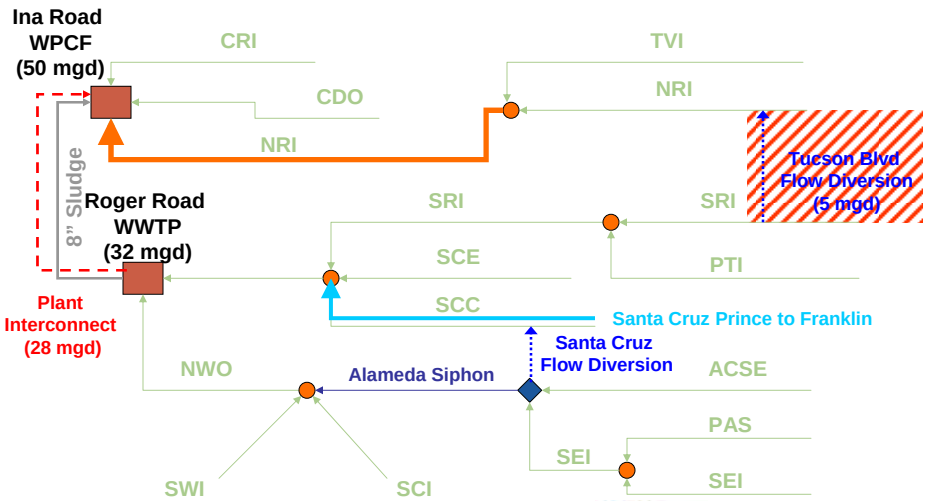
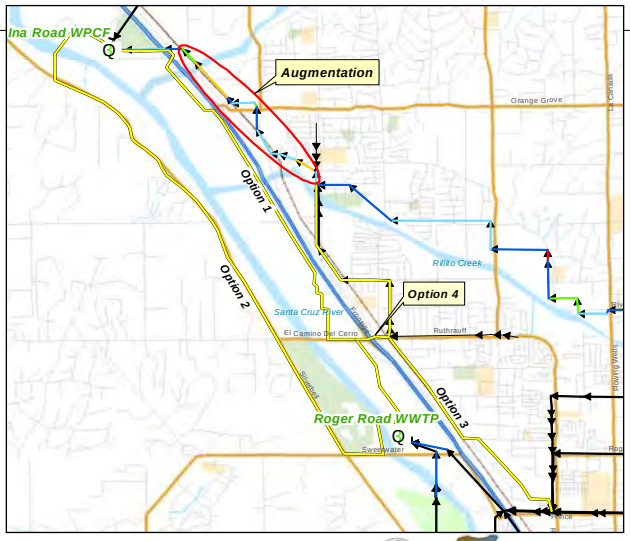
Mass Balance Schematic
(Existing Plan, 2030 Flows)



65

Routing Alternatives



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Steady State/Diurnal Flow

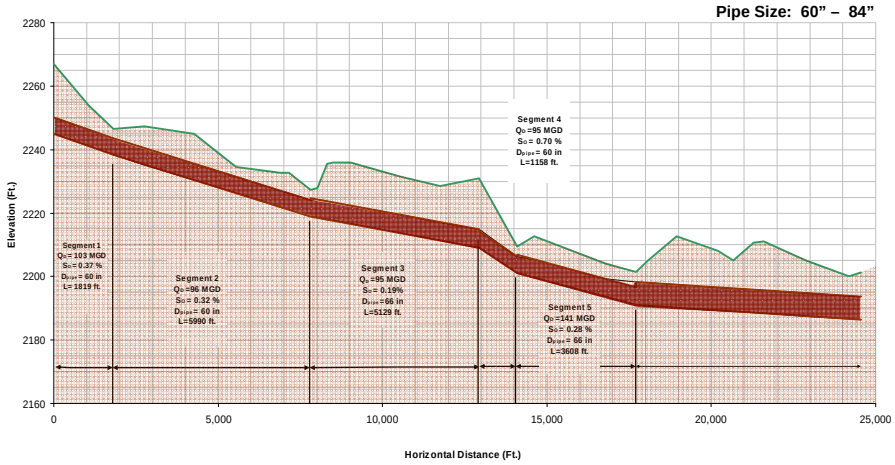
Steady State

	Q_{avg} (mgd)	Q_{min} (mgd)	Q_{max} (mgd)	$Q_{WetWeather}$ (mgd)	Q_{Peak} (mgd)
Roger Road	32	32	32	32	64
Transfer To Ina Road	28	3	50	22	72
Total	60	35	82	54	136

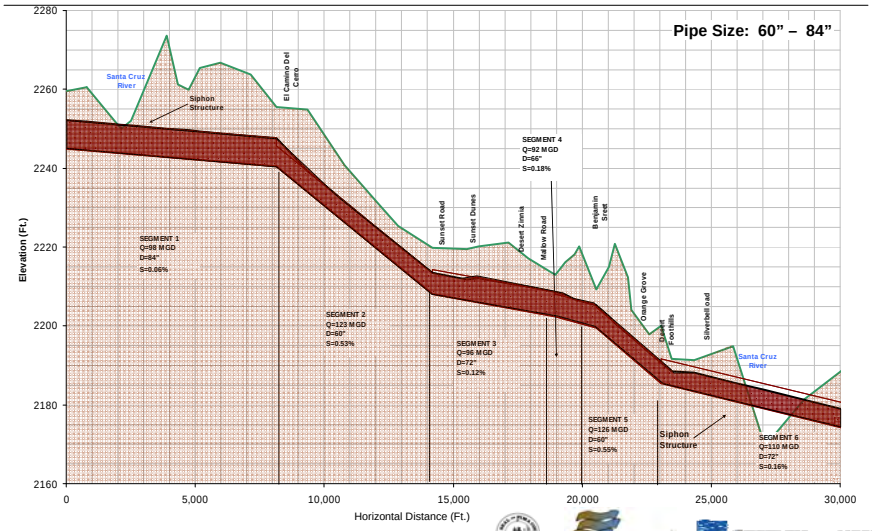
Diurnal Flow

	Q_{avg} (mgd)	Q_{min} (mgd)	Q_{max} (mgd)	$Q_{WetWeather}$ (mgd)	Q_{Peak} (mgd)
Roger Road	32	17.5	41	23	64
Transfer To Ina Road	28	17.5	41	31	72
Total	60	35	82	54	136

Plant Interconnect – Route 1



Plant Interconnect – Route 2



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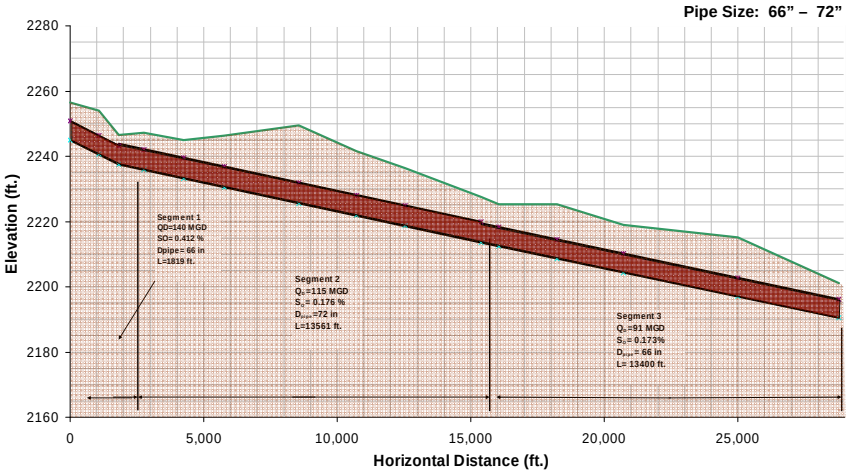
Plant Interconnect – Route 4



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Interconnect Options

Route	Pipe Size	Pipe Length	Cost (millions)	Not Included
Route 1	60" - 84"	24,600 lf	$22.3	R.O.W. Acquistion
Route 2	60" - 84"	30,100 lf	$28.3	
Route 3	Eliminated			
Route 4	66" - 72"	28,800 lf	$29.5	

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Site Layouts

Jerry Bish

Roger Road Proposed Sports Park

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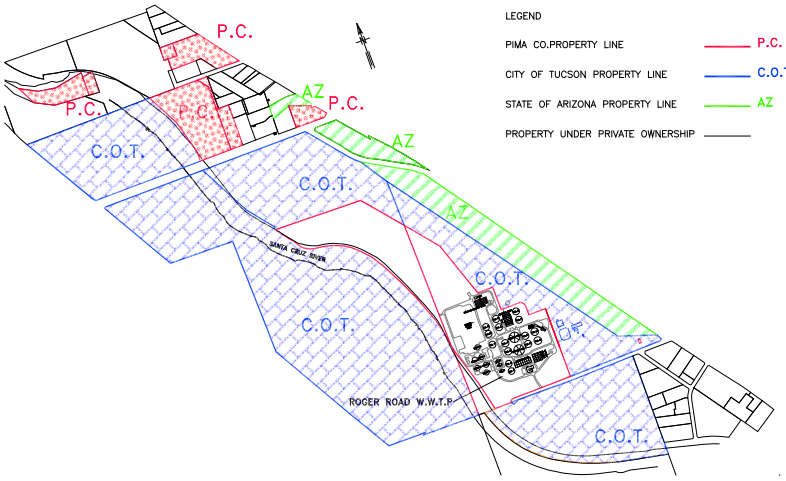
Roger Road Site Ownership



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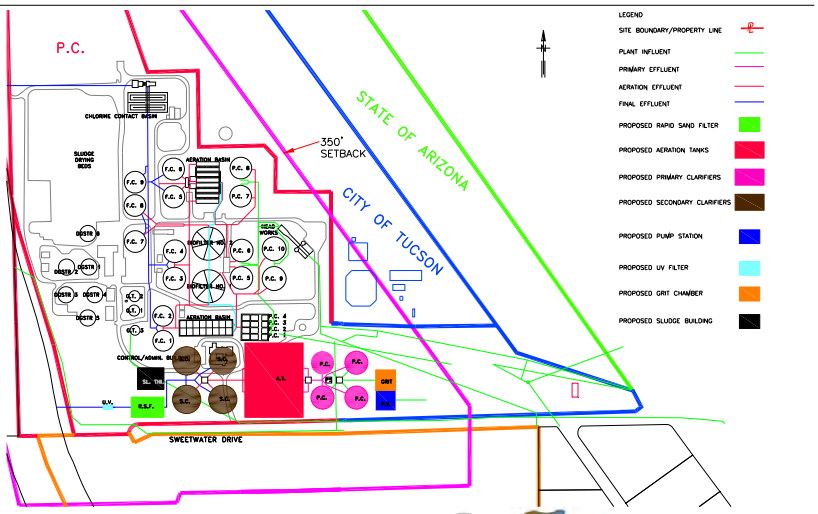
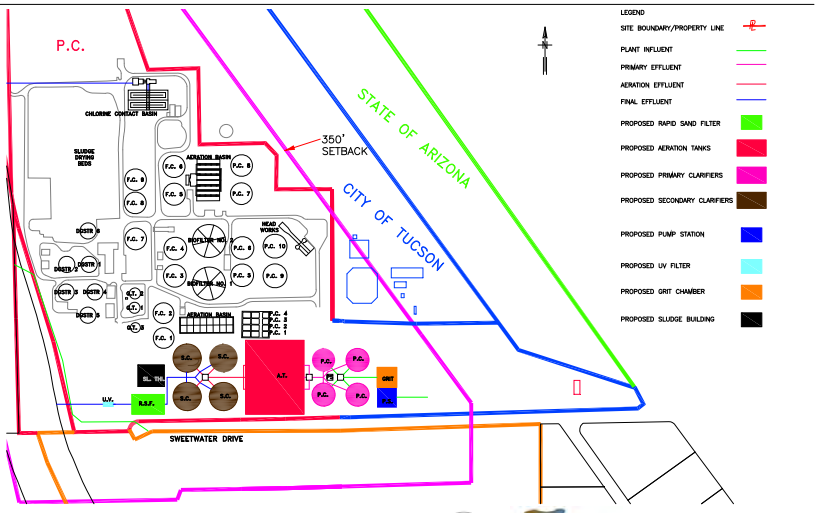
RR – 32-mgd Greenfield with Primary Clarifiers Year 2030 – Location of New Plant



75

RR – 32-mgd Greenfield with Primary Clarifiers Year 2030 – Arrangement for New Plant



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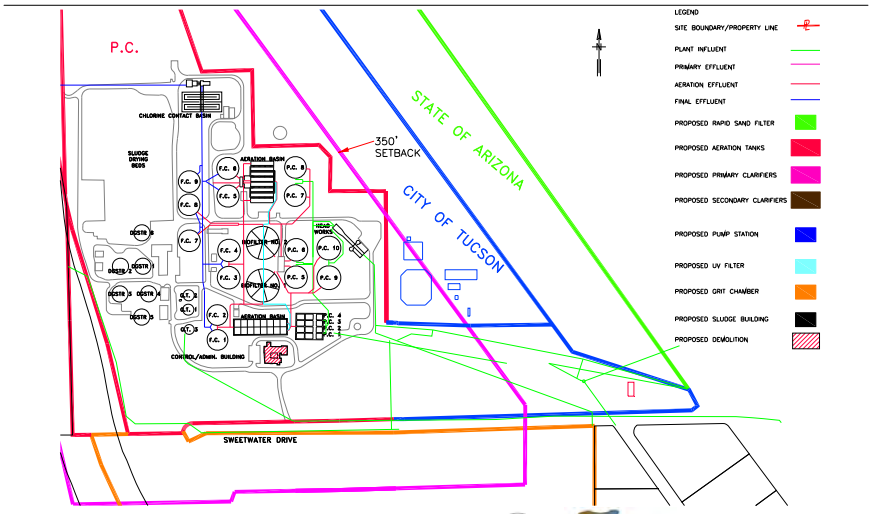
Roger Road – 32-mgd Greenfield with Primary Clarifiers Year 2030 – Required Demolition for New Plant



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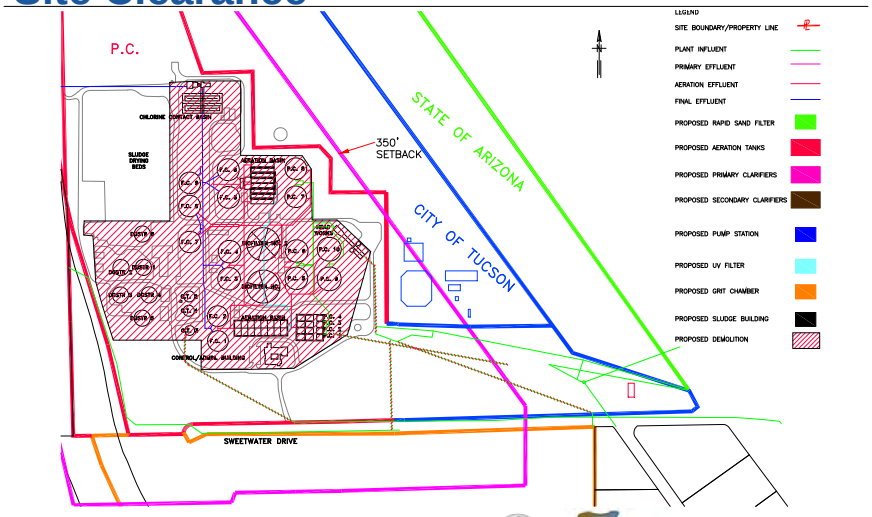
Roger Road – 32-mgd Greenfield with Primary Clarifiers Year 2030 – Required Site Clearance



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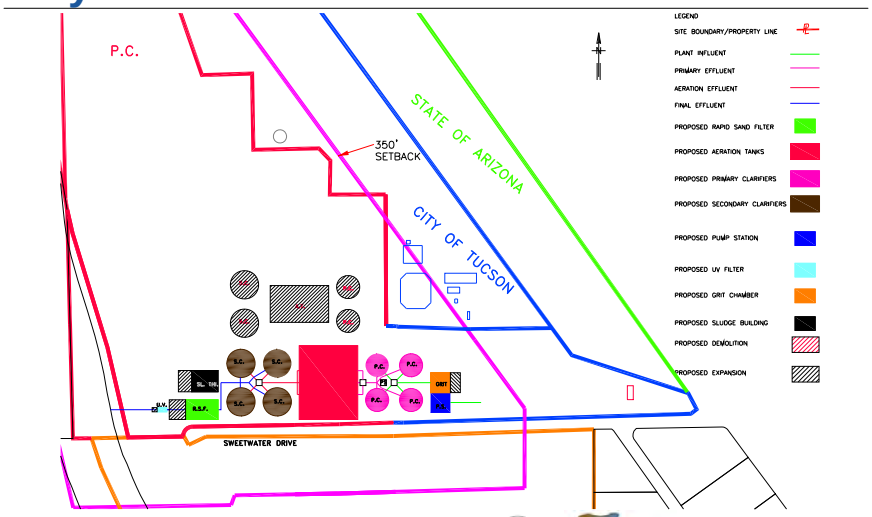
Roger Road – 32-mgd Greenfield with Primary Clarifiers – 16-mgd Expansion Beyond Year 2030



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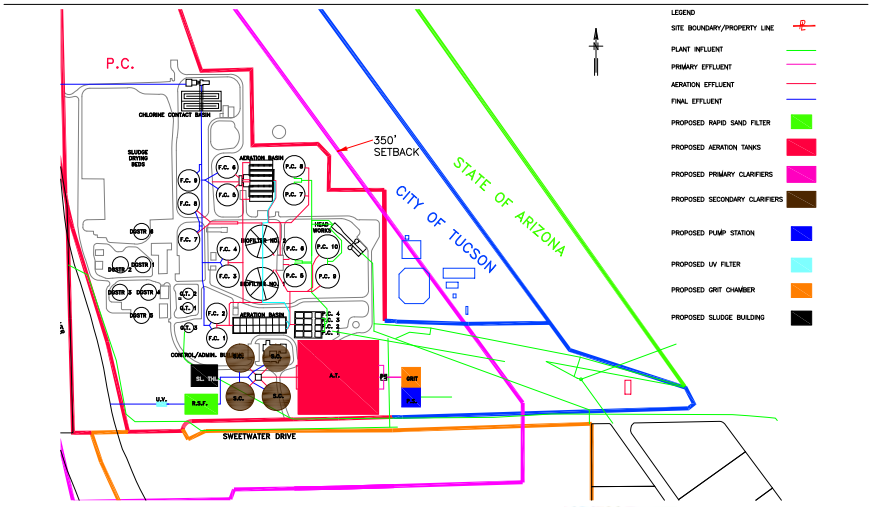
Roger Road – 32-mgd Greenfield without Primary Clarifiers Year 2030 – Proposed Location of New Plant



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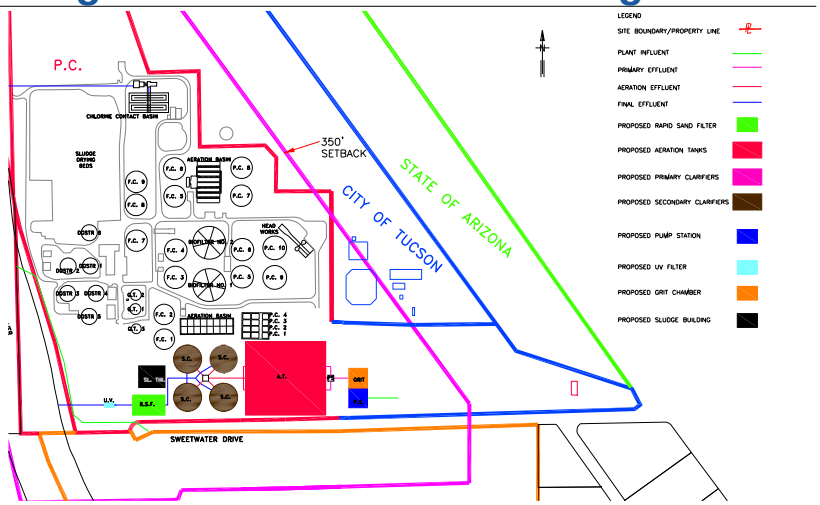
Roger Road – 32-mgd Greenfield without Primary Clarifiers Year 2030 – Arrangement of New and Existing Plants



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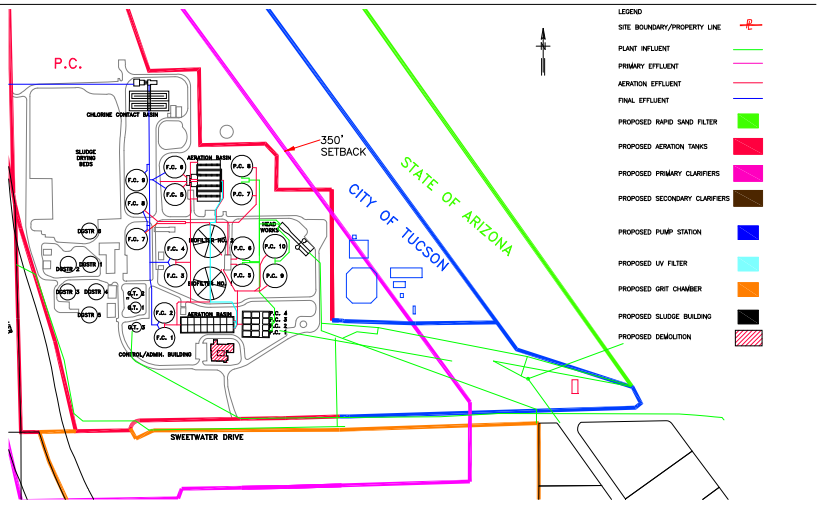
Roger Road – 32-mgd Greenfield without Primary Clarifiers Year 2030 – Demolition for New Plant



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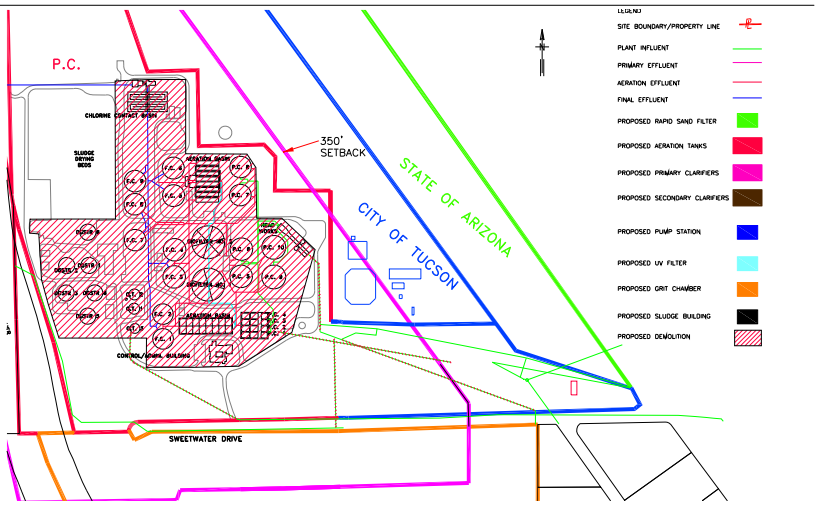
Roger Road – 32-mgd Greenfield without Primary Clarifiers Year 2030 – Site Clearance



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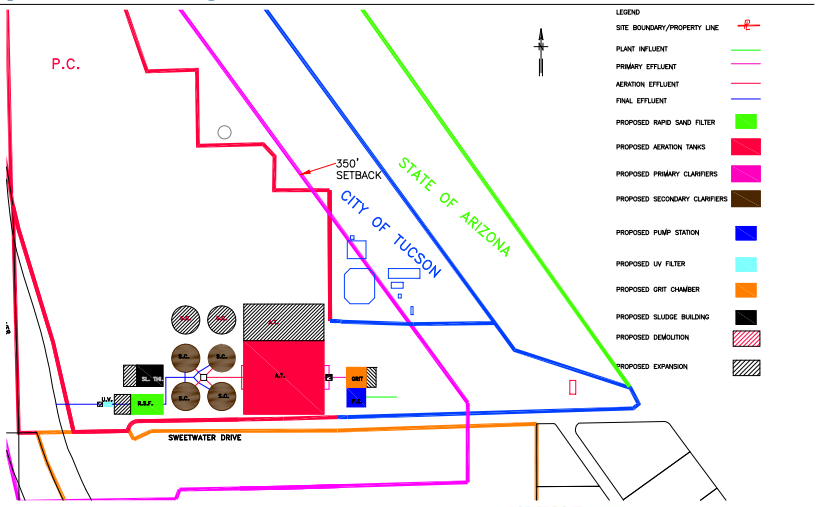
Roger Road – 32-mgd Greenfield without Primary Clarifiers and Possible 16-mgd Expansion Beyond Year 2030



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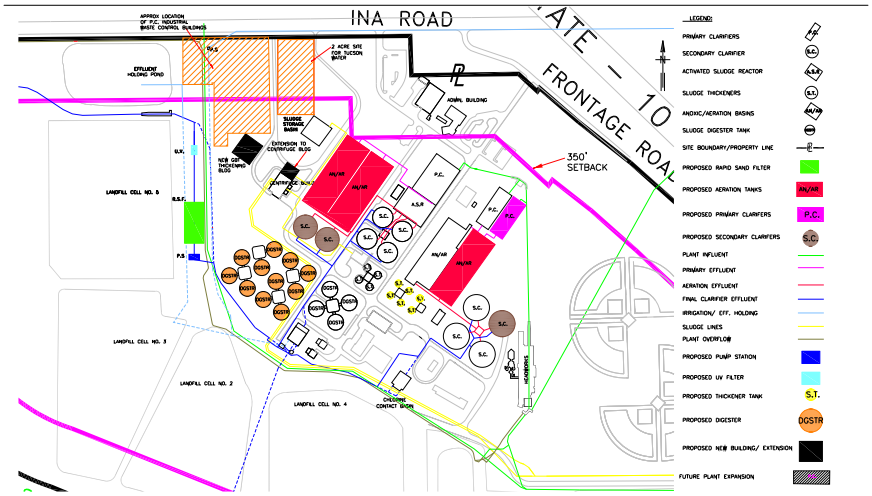
Ina Road – 50 mgd Year 2030



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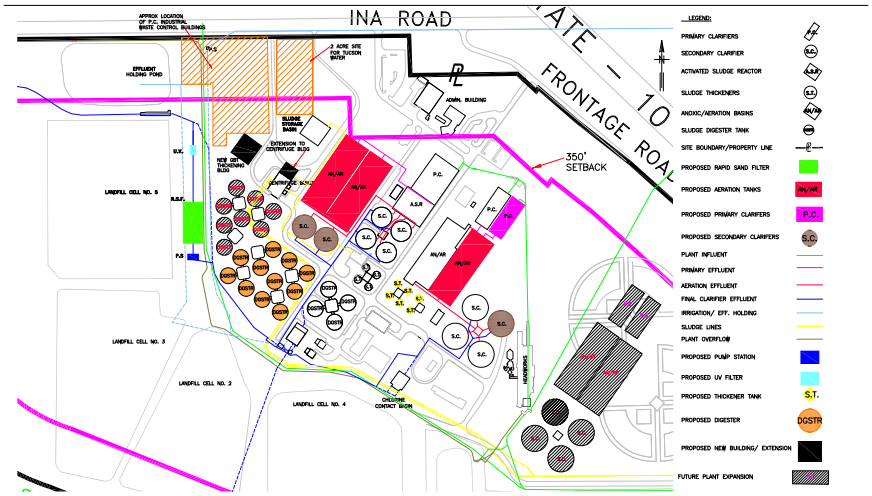
Ina Road – 50-mgd and Possible 25-mgd Expansion Beyond Year 2030



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System Costs

Gordon Culp

Workshop 10 Costs

- Purpose was to compare relative cost of various system alternatives based on planning level cost estimates for the major treatment plant components only

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Workshop 10 Costs

- Costs of these comparative plant elements did not include items such as site work, paving, architecture, fencing, irrigation, administration, laboratory and maintenance buildings, yard piping, contractor's field overhead and profit, and other elements common to all alternatives
- It was noted that total costs would be higher

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Post Workshop 10 Cost Evaluation

- California/Arizona contractor (Filanc) that specializes in the construction of water and wastewater systems developed cost estimate for the total construction cost for complete plants for:
  - Greenfield Roger Road (32 mgd)
  - Rehabilitated Roger Road (32 mgd)
  - Ina Road (50 mgd)

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System Construction Costs Based on Contractor's Estimate of Total Cost of Complete Plants

	RR Rehab 32 mgd Ina Road 50 mgd	RR Greenfield 32 mgd Ina Road 50 mgd
Plant Interconnect	$22,300,000	$22,300,000
RR Demolition	$9,125,000	$23,800,000
RR Treatment Plant	$167,200,000	$211,000,000
Ina Road Treatment Plant	$243,900,000	$243,900,000
Reclaimed Water Return	$270,000	$270,000
Tucson Water Booster PS	$810,000	$810,000
Tucson Water Reservoir	$25,000,000	$25,000,000
Total Construction Cost	$468,605,000	$527,080,000

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System Construction Costs

- Estimated total system construction cost of Greenfield option is 12% higher than rehab option based on contractor's estimate of total cost of complete plants (8% higher on present worth)
- Workshop 10 estimated that the construction cost of the comparative elements of the Greenfield option was 11% higher than the rehab option

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System Evaluation Matrix by Workshop Attendees (Cost Factor = 10)

Criteria	Weighting Factor	Unweighted Ranking					Weighted Ranking				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=60
Cost	10	5	4	2	4	3	50	40	20	40	30
Schedule	5	3	3	5	5	5	15	15	25	25	25
Constructability	3	2	2	4	5	4	6	6	12	15	12
Flexibility	4	3	3	5	5	5	12	12	20	20	20
System Reliability	4	4	4	5	5	5	16	16	20	20	20
System Operability	4	3	3	4	4	4	12	12	16	16	16
Environmental Impacts	4	3	3	4	4	4	12	12	16	16	16
Water/Wastewater System Optimization	5	5	4	3	5	4	25	20	15	25	20
Public Acceptance	5	1	2	2	3	2	5	10	10	15	10
Potential for Cost Sharing	3	5	4	3	5	4	15	12	9	15	12
Effects on Financing	3	5	4	2	4	3	15	12	6	12	9
TOTAL		**39**	**36**	**39**	**49**	**43**	**183**	**167**	**169**	**219**	**190**

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Project Sequencing

Gordon Culp

Potential Sequencing

- Portions of the complete plants can be deferred until after 2015 to reduce initial construction costs
  - One 8-mgd module of the Roger Road Greenfield Plant
  - Demolition of the existing Roger Road Plant
  - Thermophilic digesters at Ina Road
  - Two gravity belt thickeners at Roger Road
  - One mesophilic digester and one centrifuge at Ina Road
- Deferral of these elements may defer construction costs of $70,000,000 – $80,000,000 until after 2015
- Further evaluation may identify other items that could be deferred as a result of phasing Roger Road

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Potential Sequencing-Ina Road

- Design 50 mgd July 2007 - July 2009
- Construct 50 mgd (with mesophilic digestion) Jan. 2010 - July 2013
- Startup/Acceptance Aug. 2013 - Jan. 2014
- Design/Construct thermophilic digestion – when decision to produce Class A sludge is made

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Potential Sequencing-Roger Road

- Design 24 mgd + 8 mgd — Jan. 2008 - Jul. 2010
- Construct 24 mgd — Jan. 2011 - July 2014
- Startup/Acceptance — Aug. 2014 - Jan. 2015
- Demolish existing plant — Feb. 2015 - Nov. 2015
- Construct 8 mgd — Nov. 2015 - June 2018

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Potential Sequencing – Interconnect

- Design — May 2007 - Aug. 2008
- Construct — Jan. 2009 - Dec. 2010

(Based on flow projections there is a need to transfer flow from Roger Road service area to Ina Road plant in 2011 to maintain flow to Roger Road plant at rated capacity of 41 mgd. Current transfer rate is 5.35 mgd.)

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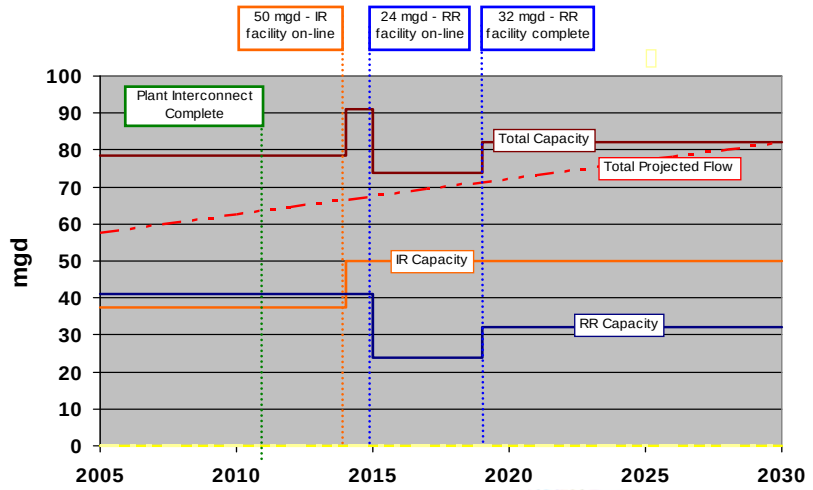
Plant Capacity Analysis



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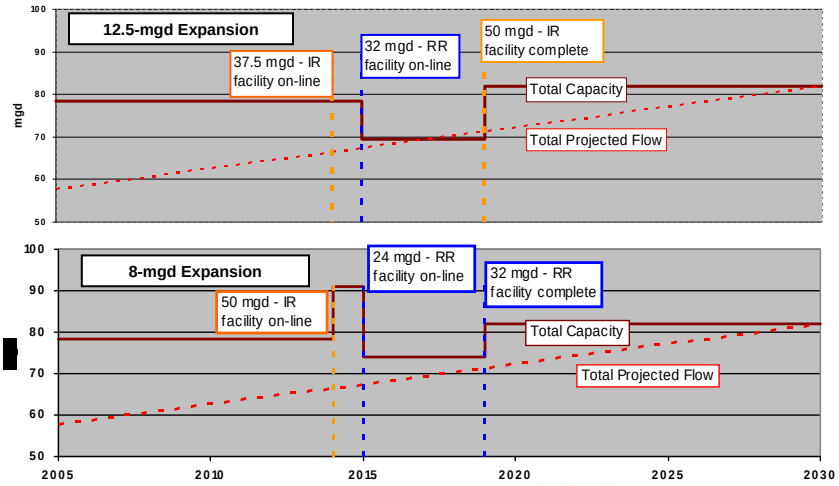
Plant Expansion Analysis



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Potential Sequencing – Reclaimed Water

- Construct additional reclaimed water facilities at Ina Road in parallel with new plant construction
- Coordinate new reclaimed water tie-in connection at Roger Road with new facilities

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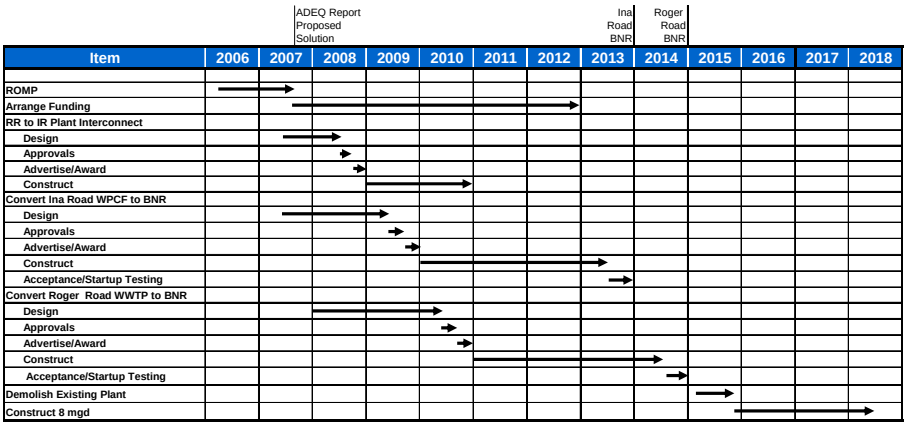
Project Implementation Schedule



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Capital Plan Financing Issues

Harold Smith

Purpose of Funding Options Analysis

- To determine the capital planning alternative that will:
  - Meet Pima County's current and future wastewater treatment needs

    AND

  - Minimize impact on Pima County's wastewater rates

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Status of Analysis

- Working with County staff and engineers to develop optimal phasing and sequencing of projects
- Developed preliminary financing plan
- Developed annual capital and O&M costs associated with preliminary capital plan
- Developed annual unit costs associated with preliminary capital plan

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Key Assumptions

- Plan including Greenfield plant at Roger Road is the preferred capital plan
- Growth related projects are funded with System Development Fees
- Other projects are funded with existing cash reserves, rate revenues and revenue bonds
- Term of revenue bonds is 20 years

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Key Variables

- Project timing and sequencing
- Growth in wastewater flows
- Inflation of O&M costs
- Inflation of construction costs
- Interest rate on bonds
- PV discount rate

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Project Schedule & Costs

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Interconnect	**$22,300,000**															
Design		$1,338,000														
Construct				$20,962,000												
Ina Rd	**$243,900,000**															
Design 50 mgd		$14,634,000														
Construct 50 mgd						$212,193,000										
Construct Thermophilic Digestion														$17,073,000		
Roger Rd	**$234,800,000**															
Design 32 mgd			$12,660,000													
Construct 24 mgd							$148,755,000									
Demo Existing Plant									$23,800,000							
Construct 8 mgd											$49,585,000					

Total ROMP Projects Cost $501,000,000

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Preliminary Financing Plan

1997 Bonds	**$4.1 M**
Other CIP	*$4.1 M*
2004 Bonds	**$132.6 M**
Design Ina 50 MGD	*$14.6 M*
Interconnect	*$22.3 M*
Other CIP	*$95.7 M*
SDF's	**$92.3 M**
Other CIP	*$92.3 M*
2008 Bonds	**$345.0 M**
Construct Ina 50 MGD Ph I	*$127.3 M*
Design Roger 32 MGD	*$12.7 M*
Other CIP	*$205.0 M*
2010 Bonds	**$307.1 M**
Construct Ina 50 MGD Ph II	*$84.9 M*
Construct Roger 24 MGD	*$148.8 M*
Demo Existing Roger	*$23.8 M*
Final 8 MGD Roger	*$49.6 M*
2012 Bonds	**$17.1 M**
Thermophilic Digestion-Ina	*$17.1 M*

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Preliminary Annual Costs

	2007	2008	2009	2010	2011	2012	2013
Annual Project Costs	**$ 47.8**	**$ 74.3**	**$ 79.2**	**$ 73.4**	**$ 78.3**	**$ 103.5**	**$ 130.5**
Existing Annual Debt Service	$ 15.5	$ 16.2	$ 16.2	$ 16.3	$ 16.4	$ 16.4	$ 15.9
Proposed Annual Debt Service	$ 2.6	$ 7.6	$ 12.2	$ 16.9	$ 24.0	$ 33.4	$ 45.2
Total Debt Service	**$ 18.0**	**$ 23.8**	**$ 28.5**	**$ 33.2**	**$ 40.4**	**$ 49.8**	**$ 61.0**
Annual O&M Costs	$ 70.0	$ 72.6	$ 75.4	$ 78.3	$ 81.3	$ 84.4	$ 87.7
Annual Capital Outlay	$ 5.4	$ 6.1	$ 7.8	$ 10.0	$ 12.2	$ 14.4	$ 15.7
Total O&M and Capital Outlay	**$ 75.4**	**$ 78.8**	**$ 83.2**	**$ 88.3**	**$ 93.5**	**$ 98.9**	**$ 103.3**
Total Annual Costs	**$ 93.4**	**$ 102.6**	**$ 111.7**	**$ 121.5**	**$ 133.9**	**$ 148.7**	**$ 164.4**
% Annual Increse/(Decrease)		10%	9%	9%	10%	11%	11%

	2014	2015	2016	2017	2018	2019	2020
Annual Project Costs	**$ 81.6**	**$ 64.4**	**$ 72.0**	**$ 66.1**	**$ 9.9**	**$ -**	**$ 8.5**
Existing Annual Debt Service	$ 13.8	$ 14.5	$ 15.3	$ 7.1	$ 1.3	$ 1.3	$ 1.3
Proposed Annual Debt Service	$ 52.5	$ 58.2	$ 64.7	$ 70.6	$ 71.5	$ 71.5	$ 72.3
Total Debt Service	**$ 66.3**	**$ 72.7**	**$ 80.0**	**$ 77.7**	**$ 72.8**	**$ 72.8**	**$ 73.6**
Annual O&M Costs	$ 91.9	$ 96.1	$ 99.1	$ 102.3	$ 105.5	$ 108.9	$ 112.4
Annual Capital Outlay	$ 16.9	$ 19.1	$ 20.4	$ 19.6	$ 19.8	$ 20.0	$ 20.3
Total O&M and Capital Outlay	**$ 108.8**	**$ 115.2**	**$ 119.5**	**$ 121.8**	**$ 125.3**	**$ 128.9**	**$ 132.7**
Total Annual Costs	**$ 175.1**	**$ 187.9**	**$ 199.5**	**$ 199.5**	**$ 198.2**	**$ 201.8**	**$ 206.3**
% Annual Increse/(Decrease)	7%	7%	6%	0%	(1%)	2%	2%

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Preliminary Unit Cost

	2007	2008	2009	2010	2011	2012	2013
Annual Unit Cost							
($/CCF)	$2.94	$3.08	$3.19	$3.32	$3.58	$3.89	$4.22
% Increase/(Decrease)		4.4%	3.8%	3.9%	7.9%	8.7%	8.4%

	2014	2015	2016	2017	2018	2019	2020
Annual Unit Cost							
($/CCF)	$4.40	$4.64	$4.83	$4.74	$4.62	$4.62	$4.64
% Increase/(Decrease)	4.4%	5.2%	4.1%	(1.8%)	(2.5%)	(0.0%)	0.4%

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Next Steps

- Refine project phasing and sequencing
- Refine the matching of annual capital costs with funding sources
- Explore alternative funding sources
- Generate data necessary to assess actual impact on wastewater rates

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System Recommendation

Andy Richardson

System Recommendation

- Bardenpho process
- 32-mgd Greenfield at Roger Road WWTP
- 50 mgd at Ina Road WPCF
- Plant interconnect 28 mgd average (72-mgd peak)

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System Recommendation *(continued)*

- Biosolids – mesophilic to TPAD
- Reclaimed water – 30 mgd at Roger Road and 20 mgd at Ina Road
- Riparian habitat – discharge allocation of 7 mgd at Roger Road

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Pima County Wastewater Management Department

GREELEY AND HANSEN

ADEQ Presentation and Permit Response

Andy Richardson

Current AZPDES Permit – Roger Road WWTP

- Variances
  - Ammonia toxicity
    Variance until January 30, 2015

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AZPDES Permit – Roger Road WWTP

- Ammonia toxicity terms/conditions
  - By January 30, 2007
    - Complete engineering design review
      - Upgrade or replace
    - Document selected construction option
    - Submit documenting letter to ADEQ
  - By January 30, 2011
    - Award contract for construction
  - By January 30, 2015
    - Treatment of effluent to non-toxic ammonia levels

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Current AZPDES Permit – Ina Road WPCF

- Variances
  - Ammonia toxicity
    Variance until January 30, 2014

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AZPDES Permit – Ina Road WPCF

- Ammonia toxicity terms/conditions
  - By February 1, 2007
    - Complete initial engineering study
    - Recommendation for upgrading Ina Road WPCF
    - Submit documenting letter to ADEQ
  - By December 31, 2010
    - Award contract for construction
  - By January 30, 2014
    - Treatment of effluent to non-toxic ammonia levels

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ADEQ Response – Ina Road

- System Configuration
  - Expand and Modify to accommodate treatment up to 50 mgd
- Process
  - Bardenpho

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ADEQ Response – Ina Road

- Schedule
  - Complete Regional Optimization Master Plan ..... July 2007
  - Arrange Funding for Capital Improvements ..... July 2007 thru Dec 2012
  - Design Plant Interconnect ..... May 2007 thru Aug. 2008
  - Construct Plant Interconnect ..... Jan. 2009 thru Dec. 2010
  - Design Ina Road WPCF Improvements ..... July 2007 thru July 2009
  - Construct Ina Road WPCF Improvements ..... Jan. 2010 thru July 2013
  - Startup/Testing of Ina Road WPCF Improvements ..... Aug. 2013 thru Jan. 2014

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ADEQ Response – Roger Road

- System Configuration
  - Construct New Water Campus to treat up to 32 mgd
  - Demolish Existing WWTP
- Process
  - Bardenpho

123

ADEQ Response – Roger Road

- Schedule
  - Complete Regional Optimization Master Plan ..... July 2007
  - Arrange Funding for Capital Improvements ..... July 2007 thru Dec. 2012
  - Design Plant Interconnect ..... May 2007 thru Aug. 2008
  - Construct Plant Interconnect ..... Jan. 2009 thru Dec. 2010
  - Design New Roger Road Water Campus ..... Jan. 2008 thru July 2010
  - Construct New Roger Road Water Campus ..... Jan. 2011 thru July 2014
  - Startup/Testing of New Roger Road Water Campus ..... Aug. 2014 thru Jan. 2015

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Summary

Andy Richardson

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Workshop #10 vs. Contractor Construction Cost Estimates – Roger Road 32 mgd

	Roger Road Rehab-Comparative Plant Elements	Roger Road Greenfield - Comparative Plant Elements	Incremental Cost of Greenfield Plant Approach as % of Total System Cost
Workshop 10	$85,600,000	$118,260,000	$32,720,000 10.9%
Contractor	$156,600,000	$193,300,000	$36,700,000 8.5%

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Workshop #10 vs. Contractor Cost Estimates – Ina Road 50 mgd

	Comparative Plant Elements – Estimated Cost
Workshop 10	$167,500,000
Contractor	$225,700,000

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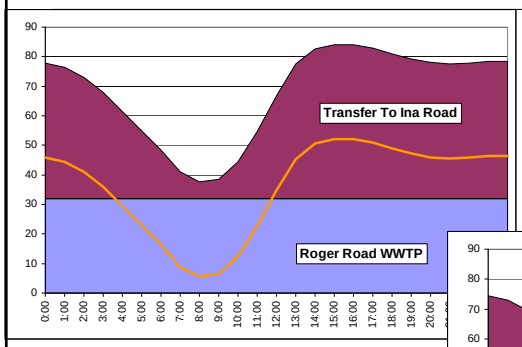
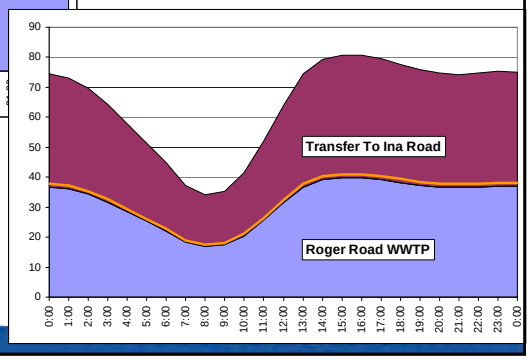
Transfer Options (Dry Weather)





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Preliminary Financing Plan

1997 Bonds	**$4.1 M**
Other CIP	*$4.1 M*
2004 Bonds	**$132.6 M**
Design Ina 50 MGD	*$14.6 M*
Interconnect	*$22.3 M*
Other CIP	*$95.7 M*
SDF's	**$92.3 M**
Other CIP	*$92.3 M*
2008 Bonds	**$345.0 M**
Construct Ina 50 MGD Ph I	*$127.3 M*
Design Roger 32 MGD	*$12.7 M*
Other CIP	*$205.0 M*
2010 Bonds	**$307.1 M**
Construct Ina 50 MGD Ph II	*$84.9 M*
Construct Roger 24 MGD	*$148.8 M*
Demo Existing Roger	*$23.8 M*
Final 8 MGD Roger	*$49.6 M*
2012 Bonds	**$17.1 M**
Thermophilic Digestion-Ina	*$17.1 M*

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Preliminary Annual Costs

	2007	2008	2009	2010	2011	2012	2013
Annual Project Costs	**$ 47.8**	**$ 74.3**	**$ 79.2**	**$ 73.4**	**$ 78.3**	**$ 103.5**	**$ 130.5**
Existing Annual Debt Service	$ 15.5	$ 16.2	$ 16.2	$ 16.3	$ 16.4	$ 16.4	$ 15.9
Proposed Annual Debt Service	$ 2.6	$ 7.6	$ 12.2	$ 16.9	$ 24.0	$ 33.4	$ 45.2
Total Debt Service	**$ 18.0**	**$ 23.8**	**$ 28.5**	**$ 33.2**	**$ 40.4**	**$ 49.8**	**$ 61.0**
Annual O&M Costs	$ 70.0	$ 72.6	$ 75.4	$ 78.3	$ 81.3	$ 84.4	$ 87.7
Annual Capital Outlay	$ 5.4	$ 6.1	$ 7.8	$ 10.0	$ 12.2	$ 14.4	$ 15.7
Total O&M and Capital Outlay	**$ 75.4**	**$ 78.8**	**$ 83.2**	**$ 88.3**	**$ 93.5**	**$ 98.9**	**$ 103.3**
Total Annual Costs	**$ 93.4**	**$ 102.6**	**$ 111.7**	**$ 121.5**	**$ 133.9**	**$ 148.7**	**$ 164.4**
% Annual Increse/(Decrease)		10%	9%	9%	10%	11%	11%

	2014	2015	2016	2017	2018	2019	2020
Annual Project Costs	**$ 81.6**	**$ 64.4**	**$ 72.0**	**$ 66.1**	**$ 9.9**	**$ -**	**$ 8.5**
Existing Annual Debt Service	$ 13.8	$ 14.5	$ 15.3	$ 7.1	$ 1.3	$ 1.3	$ 1.3
Proposed Annual Debt Service	$ 52.5	$ 58.2	$ 64.7	$ 70.6	$ 71.5	$ 71.5	$ 72.3
Total Debt Service	**$ 66.3**	**$ 72.7**	**$ 80.0**	**$ 77.7**	**$ 72.8**	**$ 72.8**	**$ 73.6**
Annual O&M Costs	$ 91.9	$ 96.1	$ 99.1	$ 102.3	$ 105.5	$ 108.9	$ 112.4
Annual Capital Outlay	$ 16.9	$ 19.1	$ 20.4	$ 19.6	$ 19.8	$ 20.0	$ 20.3
Total O&M and Capital Outlay	**$ 108.8**	**$ 115.2**	**$ 119.5**	**$ 121.8**	**$ 125.3**	**$ 128.9**	**$ 132.7**
Total Annual Costs	**$ 175.1**	**$ 187.9**	**$ 199.5**	**$ 199.5**	**$ 198.2**	**$ 201.8**	**$ 206.3**
% Annual Increse/(Decrease)	7%	7%	6%	0%	(1%)	2%	2%

132

Preliminary Unit Cost

	2007	2008	2009	2010	2011	2012	2013
Annual Unit Cost							
($/CCF)	$2.94	$3.08	$3.19	$3.32	$3.58	$3.89	$4.22
% Increase/(Decrease)		4.4%	3.8%	3.9%	7.9%	8.7%	8.4%

	2014	2015	2016	2017	2018	2019	2020
Annual Unit Cost							
($/CCF)	$4.40	$4.64	$4.83	$4.74	$4.62	$4.62	$4.64
% Increase/(Decrease)	4.4%	5.2%	4.1%	(1.8%)	(2.5%)	(0.0%)	0.4%

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Sewer Bill Comparison

	Average Bill (10 ccf)				
Utility	**Current**	**2008**	**2010**	**2015**	**2020**
Austin, TX	**$40.14**	**$41.91**	**$45.68**	**$56.65**	**$70.26**
Santa Barbara, CA	**$26.99**	**$28.18**	**$30.71**	**$38.09**	**$47.24**
Flagstaff, AZ	**$26.90**	**$28.08**	**$30.61**	**$37.96**	**$47.08**
Dallas, TX	**$26.87**	**$28.05**	**$30.58**	**$37.92**	**$47.03**
Fort Worth, TX	**$26.80**	**$27.98**	**$30.50**	**$37.82**	**$46.91**
Santa Monica, CA	**$22.62**	**$23.62**	**$25.74**	**$31.92**	**$39.59**
Los Angeles, CA	**$20.97**	**$21.89**	**$23.86**	**$29.59**	**$36.70**
Boulder, CO	**$19.67**	**$20.54**	**$22.38**	**$27.76**	**$34.43**
Pima County	**$18.98**	**$19.82**	**$21.39**	**$29.87**	**$29.90**
San Antonio, TX	**$18.96**	**$19.79**	**$21.57**	**$26.76**	**$33.19**
Peoria, AZ	**$18.05**	**$18.84**	**$20.54**	**$25.47**	**$31.59**
Albuquerque, NM	**$16.15**	**$16.86**	**$18.38**	**$22.79**	**$28.27**
Phoenix, AZ	**$15.34**	**$16.01**	**$17.46**	**$21.65**	**$26.85**
Denver, CO	**$14.59**	**$15.23**	**$16.60**	**$20.59**	**$25.54**
Scottsdale, AZ	**$14.53**	**$15.17**	**$16.53**	**$20.51**	**$25.43**
Oakland, CA	**$12.45**	**$13.00**	**$14.17**	**$17.57**	**$21.79**
Salt Lake City, UT	**$12.40**	**$12.95**	**$14.11**	**$17.50**	**$21.70**
Mesa, AZ	**$9.20**	**$9.60**	**$10.47**	**$12.98**	**$16.10**
Average	**$20.09**	**$20.97**	**$22.85**	**$28.52**	**$34.98**

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Workshop #12 Meeting Notes
Plant Interconnect/Conveyance System

1. The Plant Interconnect/Conveyance System Workshop for Pima County Regional Optimization Master Plan was held on October 11, 2006. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
PCWMD Staff
Bob Buecher
Ed Curley
Bob Decker
Ben Fyock
Mary Hamilton
Jackson Jenkins
Michael Kostrzewski
Mike Lueken
Byron McMillan
John Munden
Steve Munsell
Karen Ramage
Bill Richardson
Ron Riska, Project Manager
Robert Shay
Jon Simms
John Warner
Mike Willet
Legal
Harlan Agnew

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Tim Thomure
Dean Trammel

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Gordon Culp
Anne Smith
Steve Sticklen

2. Major topics of the workshop were:

- Workshop #12: Plant Interconnect/Conveyance System
  - Wet Weather Approach
  - In-System Storage
  - Tucson Blvd. Capacity Tests
  - Hydraulic Analysis-Existing Conditions
  - Hydraulic Analysis-Y2030
  - Plant Interconnect
  - Evaluation Criteria

A set of handouts were provided to each attendee in advance of the workshop. Additional information was presented during the workshop. The additional information on diurnal flows, in-system storage and 2030 total flows is provided at the end of this summary of meeting notes.

Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be utilized by the project team while conducting the study. The flip chart notes are incorporated into the following items.

3. Mike Gritzuk welcomed the attendees to the conveyance system workshop. The goals of the workshop are to address the capacity issues and the plant interconnect between Roger Road WWTP and Ina Road WPCF for the 2030 facilities.

4. Anne Smith outlined her role as facilitator and encouraged all to participate, but remind all that she will move the workshop along to meet the established schedule. After reviewing the ground rules there are several goals outlined to be achieved during the workshop including agreement on the wet weather approach and route of the plant interconnect. In addition, previous workshop decisions on conveyance were reviewed.

   Agenda, ground rules, previous decisions and goals were covered on pages 2 through 4 of the handout.

5. Steve Sticklen reviewed the 2006 Facility Plan issues and the master plan activities to date. The master plan includes getting flow to the Roger Road WWTP and Ina Road WPCF based on flows of 32 mgd at Roger Road WWTP and 50 mgd to Ina Road WPCF. The previous condition assessment of the interceptor system indicated significant rehabilitation needs throughout the system. PCWMD is active in addressing those needs. Further, the previous sewer hydraulic evaluations indicated that sewer capacity may be limited in certain areas to serve the community for future capacity. The capacity evaluation undertaken by the project team confirms most of those limitations which are discussed later.

   The 2006 Facility Plan issues were covered on pages 5 and 6 of the handout.

6. Steve Sticklen began the wet weather evaluation explaining the probabilistic approach and why it was chosen for analysis including why a 10-year storm event chosen. The 10-year storm was chosen because it is specified in CMOM regulations. Although CMOM not mandatory at this time it will most likely be adopted by all wastewater agencies at some future date.

   Mike Bunch suggested that graphs be color-coded by season, because there is a seasonal effect from "snow birds." Bob Buecher indicated that statistically the chosen method was not a good method of analysis because there are so few days within the one year data set which include rain, (maybe 12 of the 365 points on the graph are days with rain), therefore extrapolating one year to ten years is not a good approach. It is recognized that there are limitations to the method, and rainfall vs. flow is the preferred approach, which is included in a pending study now under negotiation by Pima County with a consultant. Results of that study are two years away. The effort described in the workshop was to provide a bridge between assuming a 15% allowance for

wet weather flow and the pending study. Bob Buecher believes that it is not logical in Tucson to see little difference between a 1 year and 10 year peak flow as suggested by the analysis of the probabilistic approach. Data analyzed was from June 2005 to June 2006, a relatively dry period which did not include the significant wet weather events in July and August, 2006. By example, John Warner reported that the NWO overflowed in the big storm in July. There were no overflows in the data set used in the hydraulic analysis. Further, CMOM requires the use in the analysis of a 24 hour storm and not localized, high intensity and short duration storms.

A question was raised why not include additional years of wet weather data in the analysis? Mike Gritzuk suggested that a separate meeting was necessary to come to agreement on the issues of wet weather. In the meantime, additional flow data will be provided to the project team for analysis.

The wet weather analysis and design standards were covered on pages 7 through 12 of the handout.

7. Since the pending conveyance system hydrologic study will not be done in time to provide peak flow data for treatment plant design work that needs to start in early 2007, historic flow data from plant influent meters can be analyzed to refine the peaking factors. Future infiltration and inflow (I/I) improvements could lower peaking factors but historic data should provide a conservative basis. There is no assurance that future peaking factors will be reduced. The project team will be provided with the flow data from the treatment plants for analysis of peaking factors. Further Ron Riska indicated that the data developed in the hydraulic evaluation be used in the negotiations of the pending hydrology based hydraulic study.

8. Steve Sticklen reviewed the opportunities for in-system storage. These areas are in the reaches nearest the treatment plant. There would be a need for 6 million gallons of storage at Roger Road WWTP to store diurnal variations in the year 2030. From the hydraulic analysis there may be 3.3 million gallons available within 2 miles of Roger Road WWTP. Of that 3.3 million gallons, 2.9 million gallons is available in new Santa Cruz Interceptor. Upon further examination of the need and availability of in-system capacity it is not recommended, but will reviewed further relative to costs. Bob Buecher suggested over sizing the plant interconnect and use it for storage.

9. For the hydraulic model it was conservatively assumed that all septic tanks would be removed from service and be served by the conveyance system. However, this was viewed as too conservative and it was agreed that septic tanks will be assumed to stay off the system, but that all growth would assumed to be connected to the conveyance system. The hydraulic model assumed that Randolph Park could be off line for short times due to emergencies and that conveyance capacity for Randolph Park flows should be provided. This was agreed as an appropriate assumption.

10. Steve Sticklen reported on the hydraulic model evaluation of the capacity testing at Tucson Blvd. The hydraulic testing and modeling confirm that the system can transfer 12 to14 mgd, although close to surcharging at these flows. Typically the flows are in the range of 5 to 8 mgd. At higher flows the system becomes surcharged. Mike Kostrzewski asked that the locations of surchaging be shown on the hydraulic profiles.

11. The hydraulic modeling analysis under existing conditions does not exhibit surcharging conditions, contrary to findings of the 2006 Facility Plan. The hydraulic model findings were confirmed with the flow monitoring stations within the conveyance system. Bob Decker stated that video work in the NWO interceptor showed that d/D greater than 85% before the line was rehabilitated. After rehabilitation, which removed significant quantities of debris, the d/D was running about 60%. Therefore, after rehabilitation field observations agree with model results. In general, the location of capacity issues is in good agreement with facility plan.

12. For the hydraulic analysis for the year 2030 the following flow assumptions need to be modified. 1) Don't assume that existing septic tanks will be sewered. 2) Assume that Randolph Park WRF will be in service except for emergencies, but need to provide conveyance capacity for those emergencies. And 3) 85 gpcd assumption is conservative but okay to use. Before these assumptions are incorporated into the model the hydraulic results are similar to the 2006 Facility Plan. In general there are seven (7) reaches that will need improvement. Some additional evaluation will be conducted on the timing of those needs.

    Bob Decker offered that the SEI system was originally designed with two pipelines in mind so extra easements are already available to increase capacity. On costs table for the areas of future improvements there appears to be incorrect or missing cost information. The project team is to review and correct accordingly.

    The hydraulic model was covered on pages 12 through 20 of the handout.

13. Steve Sticklen presented the four plant interconnect route options: 1) sludge line route, 2) Silver Bell Avenue route, 3) east of interstate I-10 route, and 4) combination of sludge line and east of interstate I-10 route. From the group discussion it was determined that there would be few sewer connects along Route 2, because of the low density and the current use of septic tanks in the area. There was discussion by John Warner on the original intent of route 3. The intent was to have two lines – one line down route #1 and one line along the east side of the interstate I-10. The goal was to provide greater reliability by having two lines. This is different than the option 3 evaluated to date. After further discussion, both versions of option 3 were eliminated.

    For Route 1 the survey is not complete, but current information is that the sludge line wanders around quite a bit through and maybe even outside of the existing easement. Other projects have found that the sludge line is not always in the location shown on the plans. It has been off by 20 feet in some cases. It was further noted that none of the interconnect profiles showed river (wash) crossings nor did they include costs for the crossings. These will be added to the profiles and costs tables.

    The plant interconnect was covered on pages 20 through 25 of the handout.

14. Gordon Culp presented the evaluation criteria to be considered for the plant interconnect route options. This led to discussion of the negatives associated with each route related to these criteria. Comments included:

- #1 – Constructability, size and location of sludge line, archaeology, right of way (survey under way), does not address augmentation capacity of NRI.
- #2 – Utility conflicts, traffic control, right of way, archaeology, public acceptance (closer to housing), environmental impacts, constructability, odor control.
- #4 – Right-of-way, business disruption, public acceptance, traffic control, odor control, railroad and highway crossings, permits, utility conflicts.

Additional comments included checking with ADOT regarding routes #2 and #4, to see if coordination with any DOT projects may be possible.

After discussion by the group, it was concluded that Option #1 is the preferred route with the least cost and least impacts, if the right-of-way and archaeological concerns can be addressed successfully. However, evaluation of Options 2 and 4 will be developed for comparison.

The evaluation criteria and costs comparisons for the route options were covered on pages 25 through 27 of the handout.

15. In the general discussion at the end of the workshop several comments were offered and included. Rehabilitation of sludge line manholes and valves is under contract. The line has been inspected by video and found to be in good shape. Concern about how long the County can live without having the interconnect being in service. Design and construction will take several years. Flow is being pushed from the Roger Road WWTP service area to Ina Road WPCF because the Roger Road WWTP is reaching capacity. Current rate of capacity increase is 3/4 to 1 mgd per year. Depending on timing, some interim way of getting flow to IR – involving temporary pumping station and plastic line next to the sludge line or fix the bottlenecks that are limiting flow transfer in the existing system maybe required. Subsequent analysis in this study will evaluate the timing of the need for added conveyance capacity to Ina Road WPCF.

    Concern was expressed that the flow line is lowering in the rivers (washes) s some degrading of the river bottoms at the river crossings that needs to be considered.

16. There needs to be a meeting of the minds on the wet weather approach. A meeting between the project team and PCWMD is to be held in early November to work out the details. In addition, the plant flow data needs to be analyzed to determine peaking factors. The project team will review the plant influent flow records to determine an appropriate peaking factor.

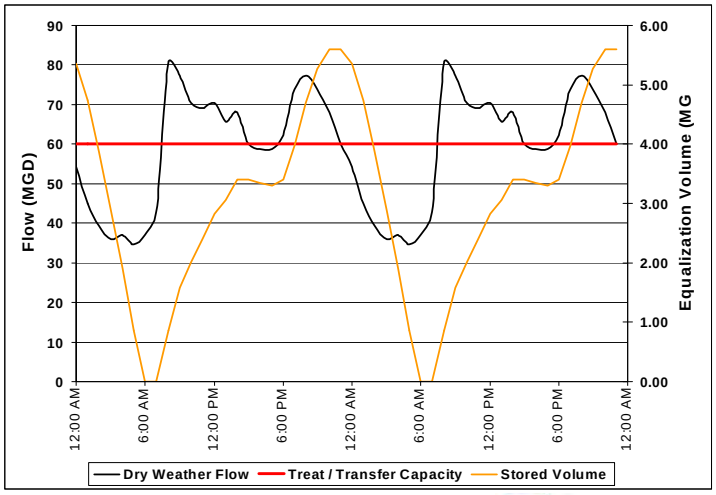
17. Workshop 11 will include a review of the plant interconnect and will include an analysis of whether Roger Road WWTP is operated at a fixed rate of 32 mgd with peaks sent to Ina Road WPCF, or whether Roger Road WWTP will treat diurnal flow variations. Sending peaks to Ina Road WPCF will substantially increase the peak flows at Ina Road WPCF but will simplify operation at Roger Road WWTP.

18. Mike Gritzuk closed the meeting and looked forward to the wet weather flow and plant interconnect issues being settled by Workshop # 11.

Agenda
Workshop #12 – Conveyance System Alternatives/
Recommended Flow Management Plan
October 11, 2006

Time	*Topic*	*Presenter*
12:30 pm	Public Works Building at 201 North Stone, Conference Room C (Basement)	
12:45 pm	Opening Session	
	• Welcoming Remarks	Mike Gritzuk
	• Review Agenda	Anne Smith
	• Workshop Goals	
1:00 pm	Summary of Key 2006 Facility Plan Issues	Steve Sticklen
1:10 pm	Peak Wet Weather Flow Analysis	Steve Sticklen
2:00 pm	Design Parameters	Steve Sticklen
	• Regulatory	
	• Peaking Factors	
	• Wet Weather Flow Allowance	
2:15 pm	Hydraulic Model Development / Calibration	Steve Sticklen
2:30 pm	Tucson Boulevard Capacity Test	Steve Sticklen
2:40 pm	Planned System Upgrades – Santa Cruz Central Interceptor	Steve Sticklen
2:50 pm	Break	
3:00 pm	Hydraulic Analysis – Existing Conditions	Steve Sticklen
3:20 pm	Hydraulic Analysis – 2030 Conditions	Steve Sticklen
3:40 pm	Plant Interconnect	Steve Sticklen
	• Routing Alternatives	
	• Transfer Alternatives	
4:30 pm	Evaluation Criteria/Cost Comparisons	Gordon Culp/Steve Sticklen
4:50 pm	Summary Wrap-Up	Anne Smith
	• Comments by Group	
	• Closing Remarks	Mike Gritzuk
5:00 pm	Adjourn	

Diurnal Flow



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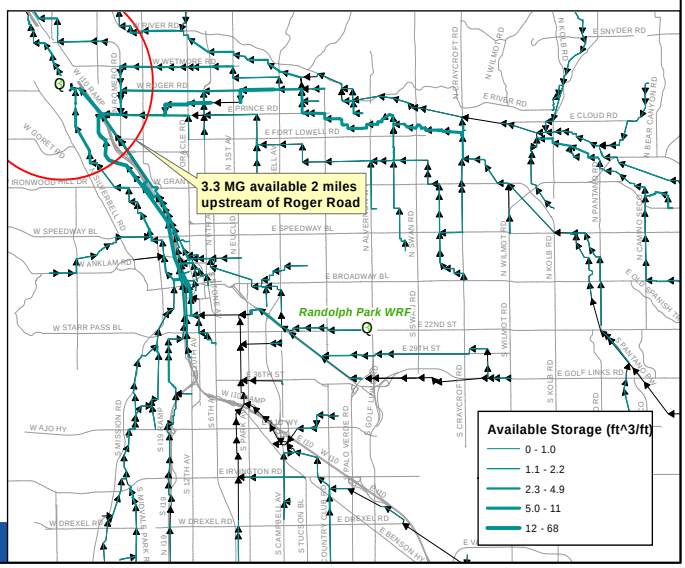
In-System Storage

- 3.3 MG available within 2 miles of Roger Road WWTP
- 2.9 MG available in new Santa Cruz Central
- Requires complex system of gates to utilize



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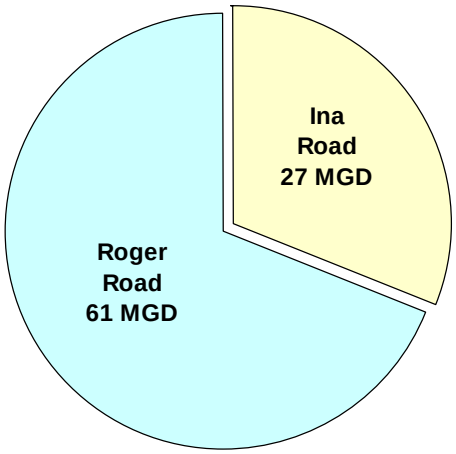
2030 Total Flows



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Pima County
Regional Optimization
Master Plan

Workshop #12
Plant Interconnect / Conveyance System

October 11, 2006

Workshop Presenters

- Mike Gritzuk — Welcome/Closing
- Anne Smith — Facilitator
- Steve Sticklen — Conveyance
- Gordon Culp — Evaluation

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Welcoming Remarks

Mike Gritzuk

Overview

Anne Smith

Agenda

- Key Issues
- Peak Wet Weather Flow Analysis
- Design Parameters
- Hydraulic Model Development / Calibration
- Tucson Blvd Capacity Test
- Planned System Upgrades
- Hydraulic Analysis – Existing Conditions
- Hydraulic Analysis – 2030 Conditions
- Plant Interconnect

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Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

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Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

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Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

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Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

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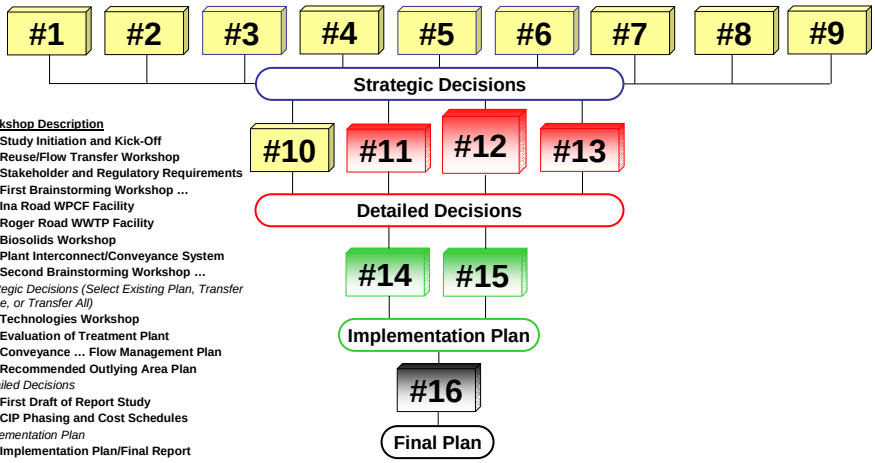
Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

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Previous Workshop Decisions

- Use Model-Lite" for analysis
- Conduct sensitivity on Peaking Factor
- Investigate four plant interconnect options
- Look for opportunities for in-system storage

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Workshop Goals

- Agree on wet weather approach
- Present findings / recommendations
- Agree on interconnect route
- Discuss other considerations

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Summary of 2006 Facility Plan Issues

Steve Sticklen

2006 Facility Plan Summary

- Condition assessment
- Hydraulic evaluation
- Plant interconnect

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Condition Assessment Summary

- $4.5M to rehab manholes
- Siphons and pump stations
- $13.5M to rehab pipes in poor condition
- $162M to rehab pipes in fair condition

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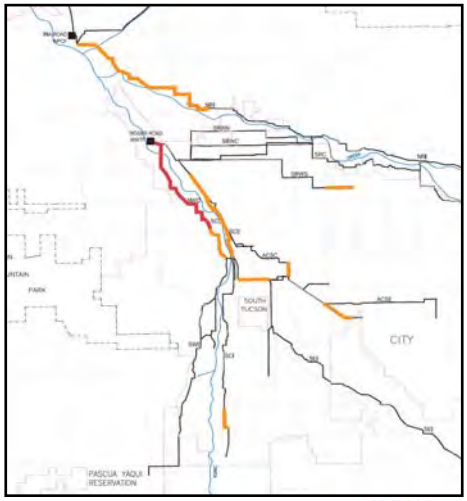
Existing Capacity Issues



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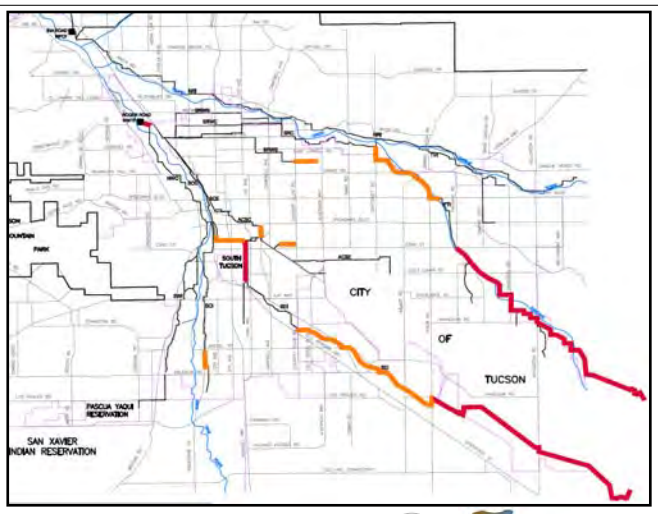
2030 Capacity Issues



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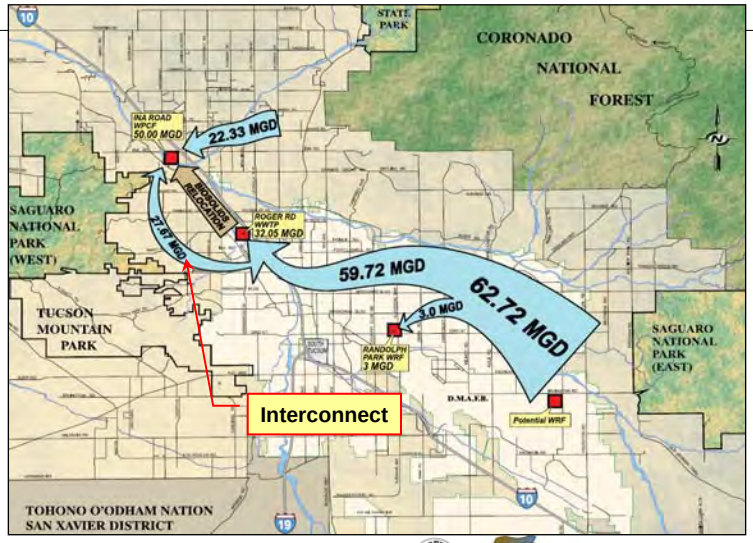
Plant Interconnect



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Wet Weather Flow Analysis

Steve Sticklen

Objectives

- Identify system elements impacted by wet weather
- Estimate peak flows and water levels to 10-year rainfall event
- Develop strategy for accounting for wet weather flows during hydraulic analyses

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Probabalistic Method

- 12 months flow data from 27 sites
- 15-minute average values
- Frequency distribution of peak daily flows and water levels
- Regression analysis
- 10-year flows and water levels

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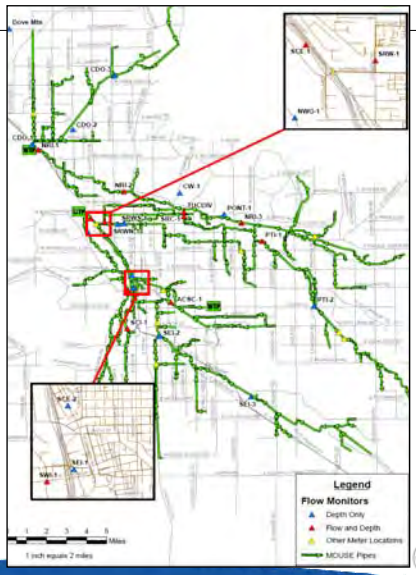
Flow Monitoring Sites



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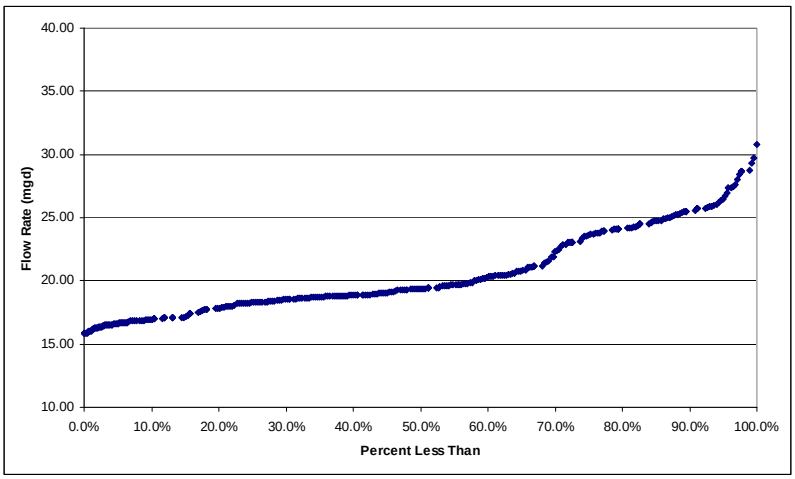
Flow Frequency Distribution



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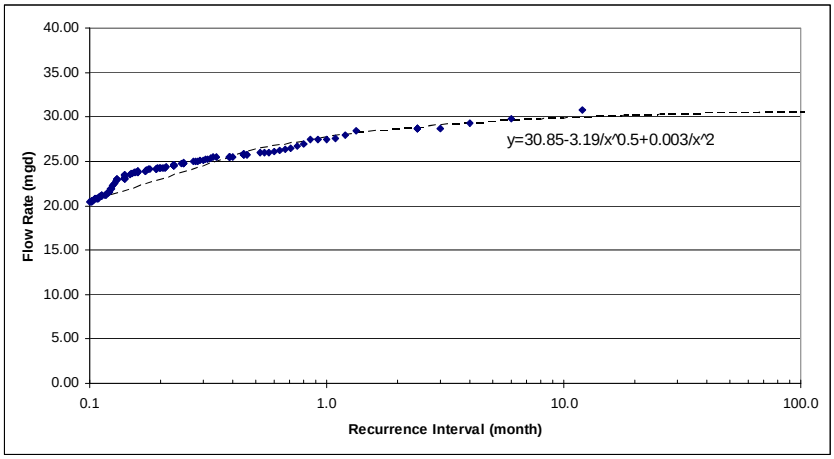
Regression Analysis



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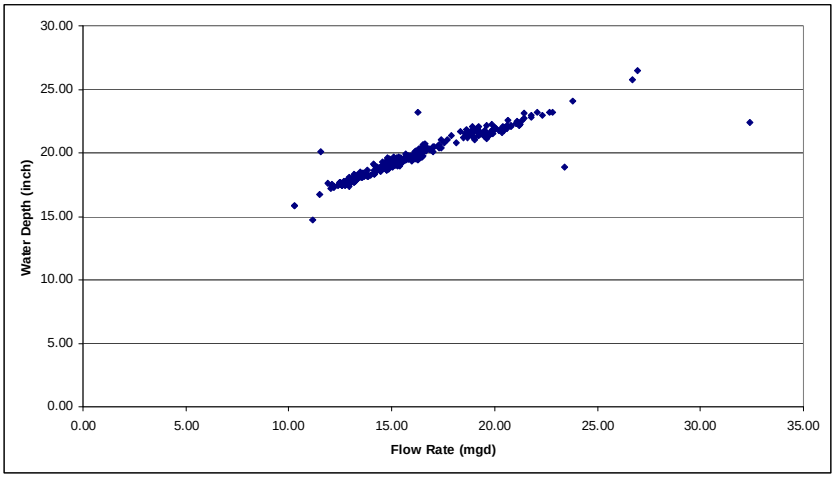
Depth vs. Flow



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Summary of Results

Site	Flow Rate, mgd					Design Capacity(2), mgd	Wet Weather Flow(3)	PF(4)	Water Depth/Pipe Diameter					Pipe Diameter, inch
	Historical(1)				Calculated				Historical(1)				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
ACSC-1	2.69	3.56	4.60	8.77	10.19	19.2	6.63	4.00	0.22	0.26	0.29	0.42	0.51	42
AV-1	1.10	1.45	1.87	3.28	3.93	9.1	2.48	3.80	0.30	0.34	0.38	0.53	0.57	24
CDO-1	-	-	-	-	-	94.8	-	-	0.29	0.32	0.36	0.39	0.43	48
CDO-2	-	-	-	-	-	31.1	-	-	0.24	0.25	0.28	0.33	0.38	36
CDO-3	-	-	-	-	-	-	-	-	0.27	0.31	0.33	0.48	0.49	24
CW-1	-	-	-	-	-	-	-	-	0.19	0.20	0.21	0.31	0.25	12
Dove Mtn	-	-	-	-	-	-	-	-	0.16	0.17	0.20	0.21	0.22	15
GV-1	1.26	1.69	2.34	2.82	3.21	-	1.52	2.66	0.34	0.39	0.46	0.51	0.50	21
NRI-1	16.96	19.40	25.54	30.82	30.56	38.3	11.16	2.21	0.54	0.56	0.66	0.74	0.76	42
NRI-2	12.82	15.32	20.04	32.40	33.29	-	17.97	3.04	0.45	0.50	0.56	0.68	0.73	39
NRI-3	8.19	9.49	10.10	11.93	11.78	20.1	2.29	1.74	0.33	0.36	0.37	0.41	0.46	33
NWO-1	-	-	-	-	-	28.7	-	-	0.48	0.52	0.55	0.60	0.63	48
PONT-1	-	-	-	-	-	16.18	-	-	0.27	0.31	0.33	0.44	0.35	12
PTI-1	9.37	10.57	11.66	14.44	12.87	29.8	2.30	1.71	0.36	0.38	0.40	0.44	0.46	36

(1) Based on data recorded from July 1, 2005 to June 30, 2006
(2) From previous study: 2006 Metropolitan Area Facility Plan Update. Included here for reference only
(3) Wet weather flow, estimated as the difference between the calculated 10-year flow and historical 50-percentile flow
(4) PF: Peaking factor, estimated as 1.4 x (calculated 10-year flow/ historical 50-percentile flow)

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Summary of Results *(continued)*

Site	Flow Rate, mgd					Design Capacity(2), mgd	Wet Weather Flow(3)	PF(4)	Water Depth/Pipe Diameter					Pipe Diameter, inch
	Historical(1)				Calculated				Historical(1)				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
PTI-2	-	-	-	-	-	13.5	-	-	0.35	0.38	0.41	0.45	0.48	30
SCE-1	25.23	28.33	34.05	44.32	49.52	148.1	21.19	2.45	0.28	0.30	0.31	0.37	0.36	78
SCE-2	-	-	-	-	-	7.8	-	-	0.30	0.38	0.42	0.62	0.58	30
SCI-1	4.19	4.51	4.97	8.34	7.29	12.1	2.78	2.26	0.38	0.40	0.42	0.62	0.57	30
SEI-1	-	-	-	-	-	92.8	-	-	0.36	0.37	0.38	0.46	0.47	60
SEI-2	-	-	-	-	-	-	-	-	0.30	0.31	0.33	0.98	0.52	36
SEI-3	-	-	-	-	-	21.4	-	-	0.33	0.36	0.39	0.57	0.53	30
SRC-1	14.93	16.17	18.03	26.26	28.53	11.8	12.36	2.47	0.35	0.37	0.38	0.45	0.48	54
SRW-1	2.22	2.42	2.69	3.90	4.23	7.8	1.81	2.45	0.30	0.32	0.33	0.51	0.51	30
SRWN-1	-	-	-	-	-	127.9	-	-	0.20	0.24	0.25	0.28	0.28	66
SRWS-1	-	-	-	-	-	9.7	-	-	0.48	0.50	0.53	0.71	0.77	27
SWI-1	5.48	6.39	7.10	9.46	8.52	43.9	2.13	1.87	0.28	0.31	0.33	0.89	0.35	33
TUCDIV	1.37	3.13	7.61	11.98	14.92	30.2	11.79	6.67	0.20	0.30	0.40	0.96	0.70	33

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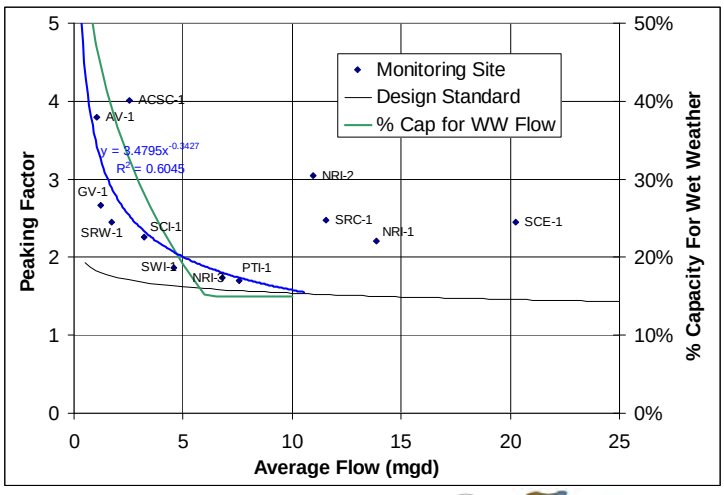
Modified Peaking Factor



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Per Acre Wet Weather Flows

Meter Site	Service Area (acres)	10-Year Wet Weather Flow (MGD)	GPD/acre
NRI-1	110,190	11.16	101
NRI-2	101,249	17.97	177
SRC-1	41,880	12.36	295
Weighted Average			**164**

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Summary and Conclusions

- Flows increase during wet weather
- System has adequate excess capacity to accommodate 10-year flows
- Probabilistic method does not correlate rainfall and flow
- Only predicts flow rates, <u>not</u> volumes
- Recommend comprehensive wet weather study including hydrologic modeling

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Design Standards

Steve Sticklen

Regulatory Standards – CMOM

- 2008 – Standardized Rule
- Convey peak dry and wet weather flows
- Convey 10-year-24-hour event
- Upgrade deficient system elements within 10 years
- Prevent SSOs
- Capital Improvement Plan

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Regulatory Standards - Other

- Max Dry Weather d/D = 0.75
- Appropriate peaking factor
- Wet weather allowance based on:
  - Percentage of peak dry weather flow
  - Gallons per acre
- Minimum depth of cover = 3 feet
- V_d = 2 – 10 feet/second

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Standard Peaking Factor

Upstream Population	Dry Weather Peaking Factor
1,001 – 10,000	$PF = (6.330 * p^{-0.231}) + 1.094$
10,001 – 100,000	$PF = (6.177 * p^{-0.233}) + 1.128$
More than 100,000	$PF = (4.500 * p^{-0.174}) + 0.945$

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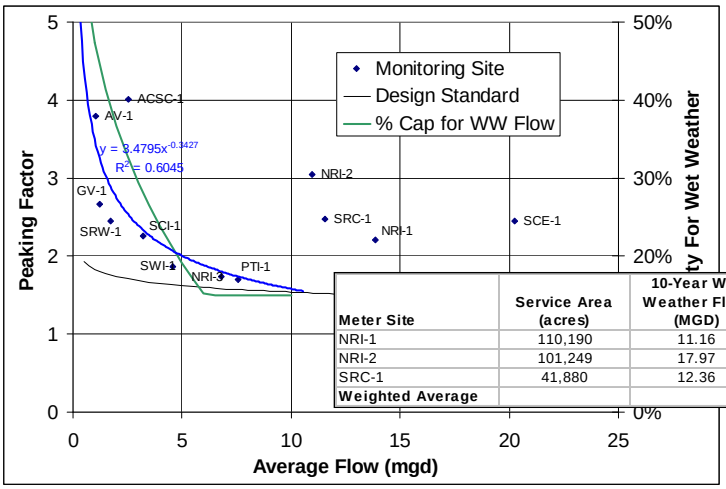
Wet Weather Allowance



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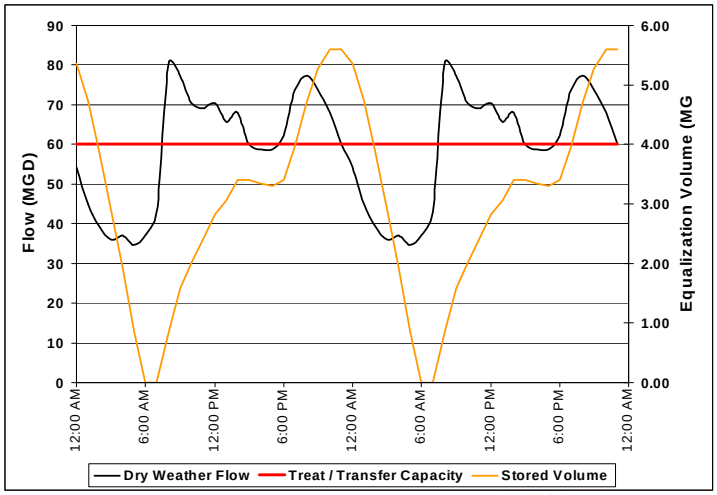
Diurnal Flow



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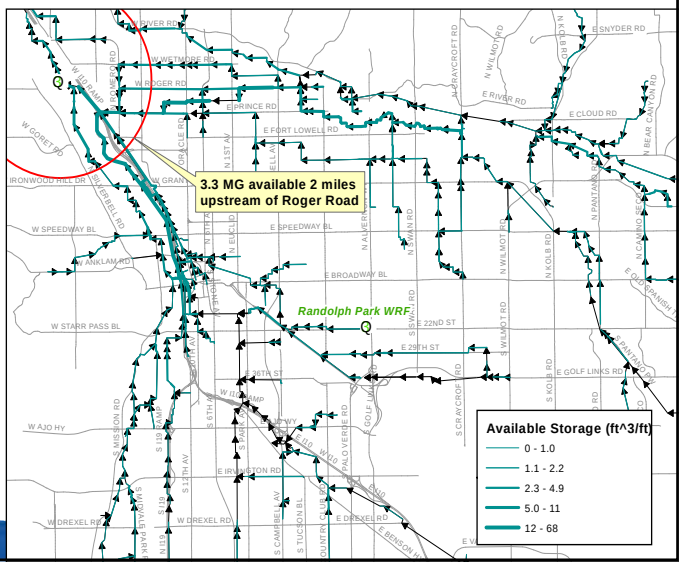
In-System Storage

- 3.3 MG available within 2 miles of Roger Road WWTP
- 2.9 MG available in new Santa Cruz Central
- Requires complex system of gates to utilize



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Pima County Wastewater Management Department

GREELEY AND HANSEN

Hydraulic Model

Steve Sticklen

MOUSE Hydraulic Model

- Pipes ≥ 15 inches
- Diversion Structures
  - Craycroft
  - Tucson Boulevard
  - Aviation Corridor
  - Alameda Siphon
  - 18th & Vine
  - 18th & I-10

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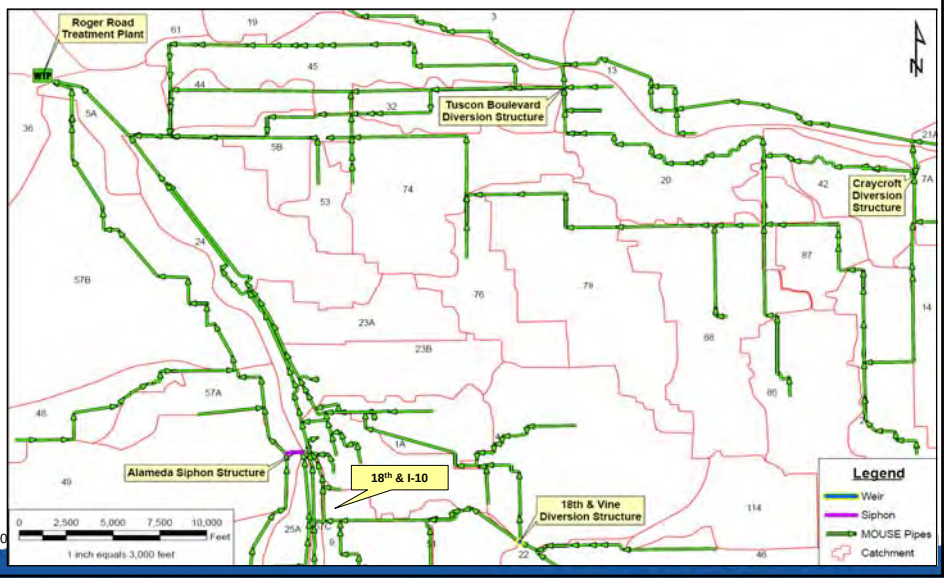
Diversion Structure Locations



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Model Capabilities

- Open channel flow
- Pressurized / surcharged flow
- Backwater conditions
- Diversion structures (gates / weirs)
- Pump stations

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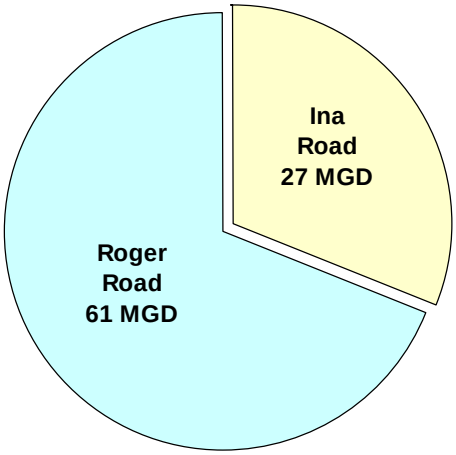
2030 Total Flows



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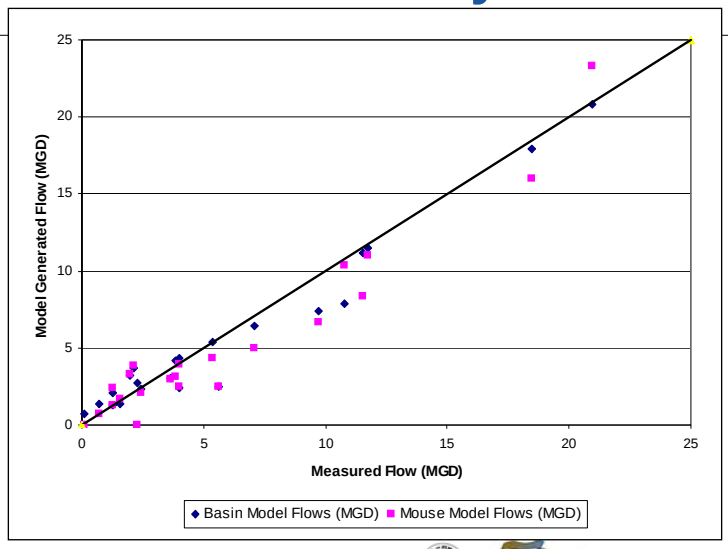
Calibration Summary



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Tucson Blvd Capacity Test

- July 28, 2005
- Diverted <u>all</u> flow to NRI
- Diverted flow rate = 12 MGD
- Flow data confirmed diversion rate
- Simulated same conditions

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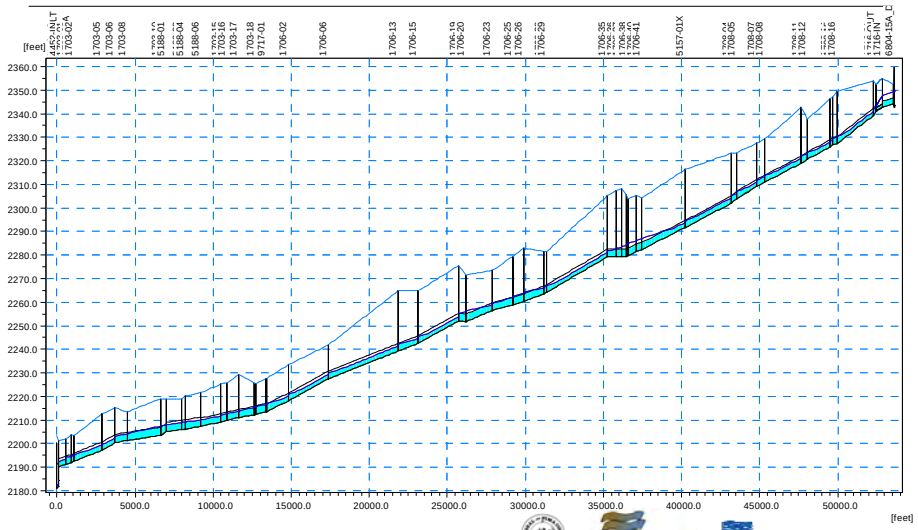
NRI Profile – Tucson Blvd Test



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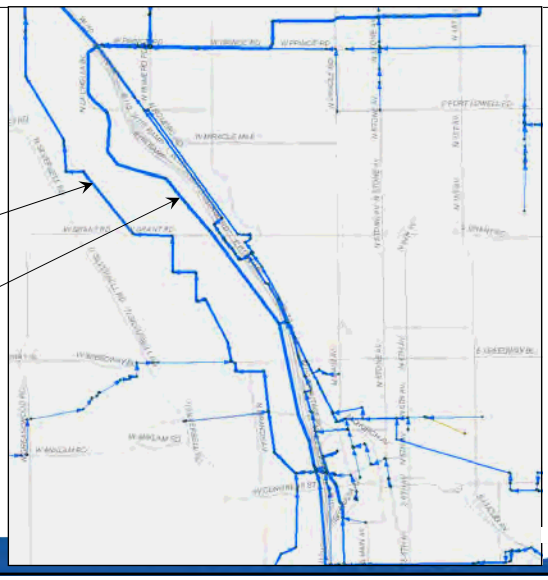
Planned Upgrade – Santa Cruz



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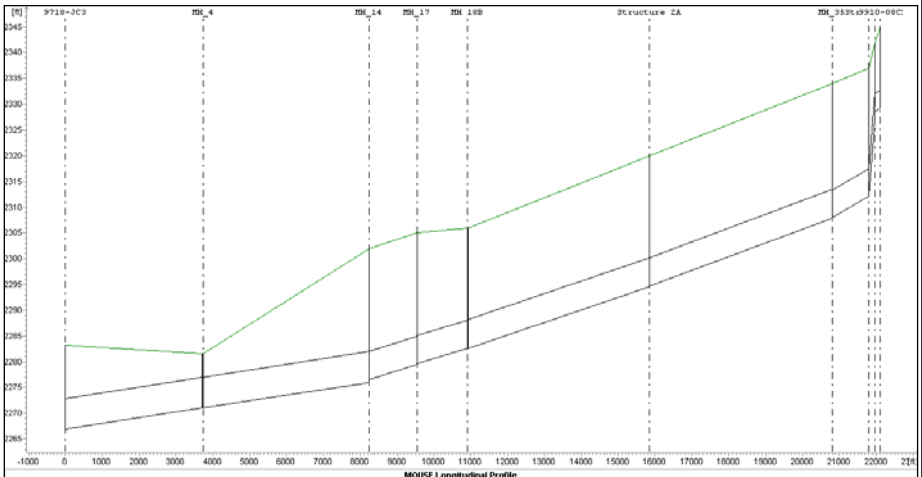
New Santa Cruz Profile



Link ID	Link_15	Link_5	Link_3	Link_13	Link_12	Link_11	Link_10
Link Diameter	6.0000		5.5000				5.3330
Shaft ID	9718-JC3	MH_4	MH_14	MH_17	MH 18B	Structure 2A	MH_35	36A
Shaft Diameter	4.0000						
Ground Level	2283.20	2281.50	2302.00	2305.00	2306.00	2320.00	2334.00
Invert Level	2266.40	2271.02	2275.99	2279.50	2282.54	2294.62	2307.92

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Hydraulic Analysis – Existing Conditions

- Flow data and model indicate no system surcharging
- NWO has adequate capacity
  - Measured median peak d/D = 0.52
  - Modeled peak d/D = 0.56 (8% diff.)
  - Peak 10-year d/D = 0.63
- Portions of NRI near capacity
- Portions of SCC near capacity

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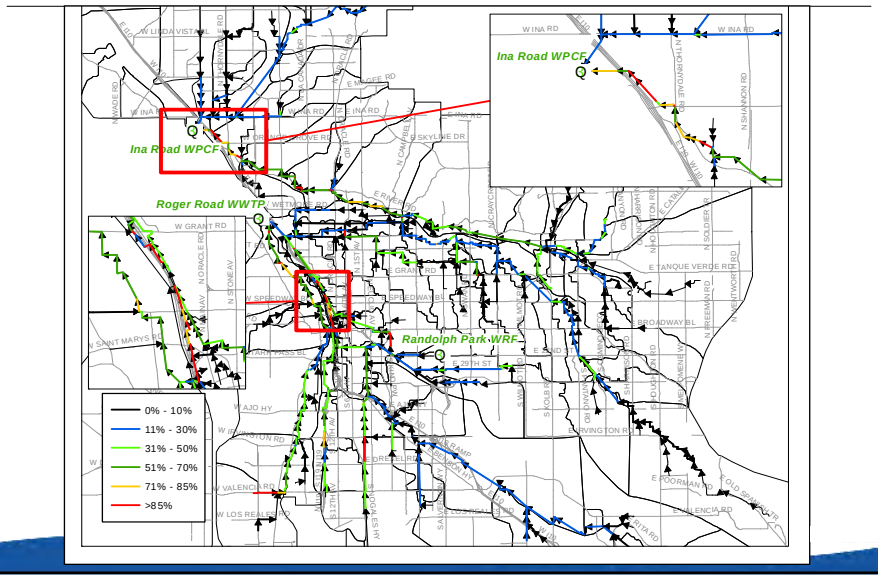
Existing Hydraulic Deficiencies



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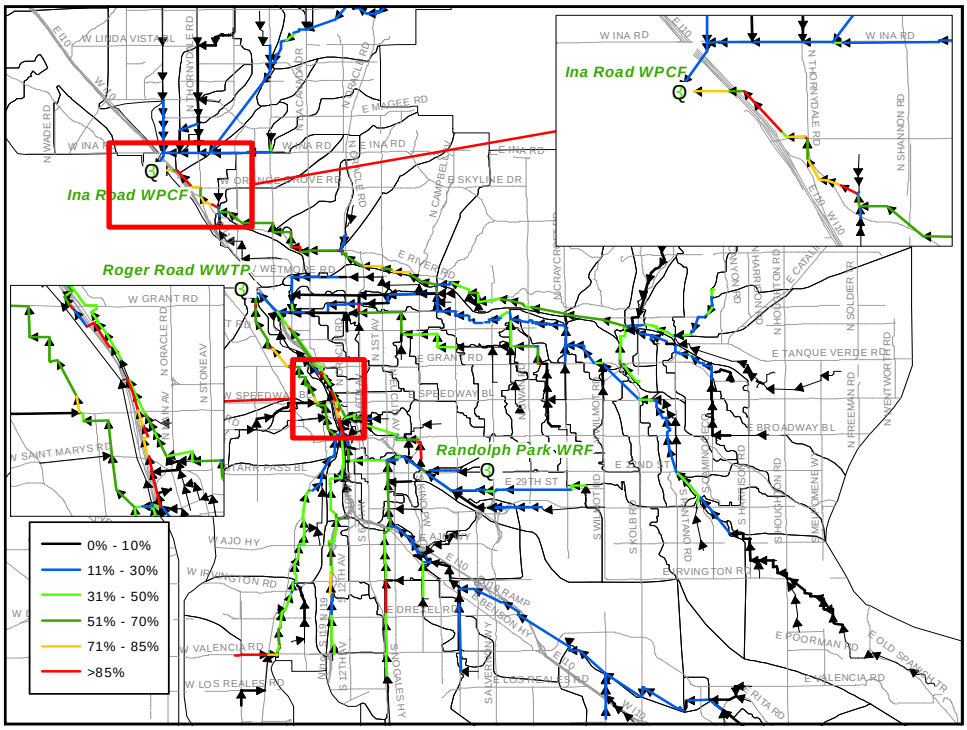
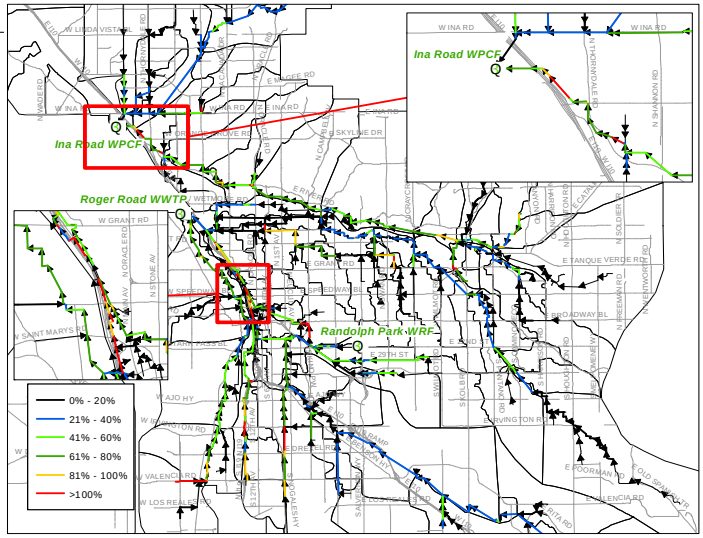


Wet Weather Flow Allowance



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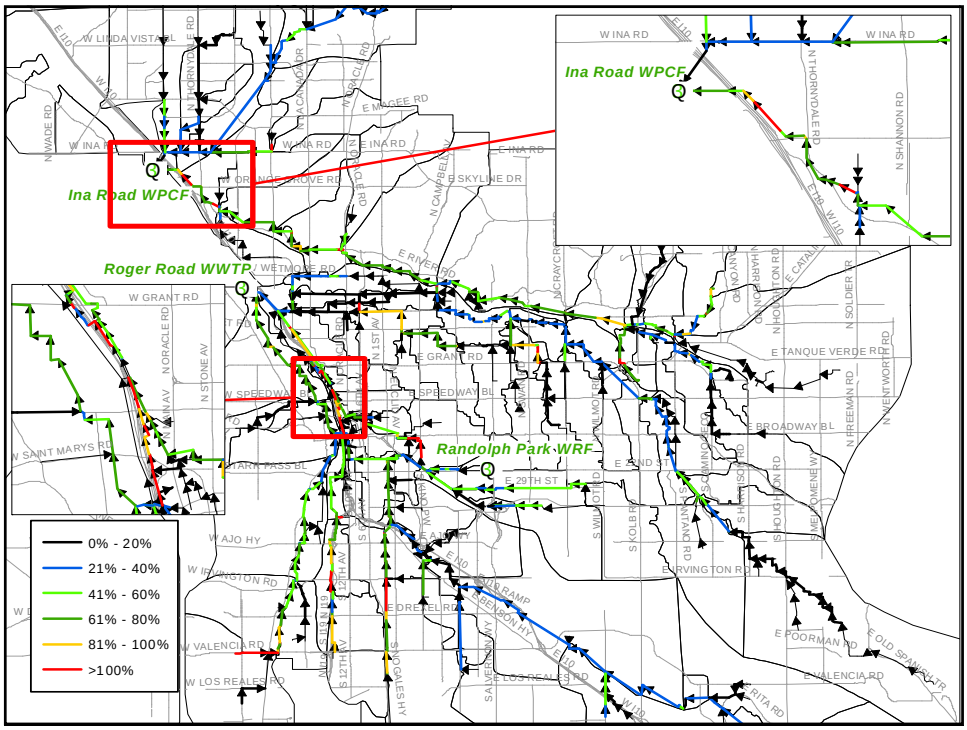
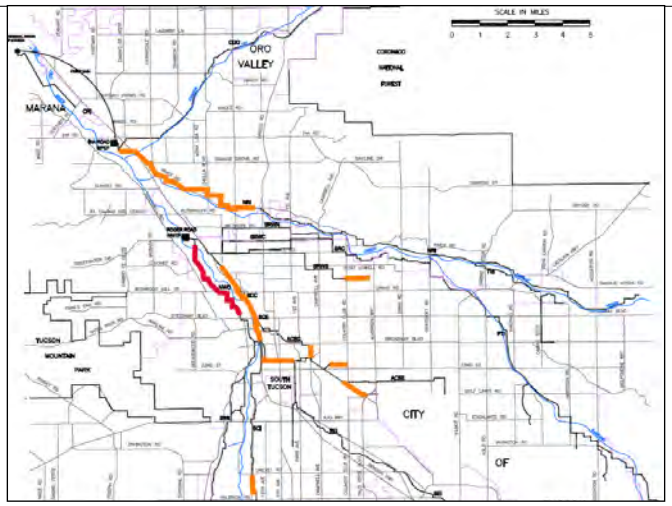


2005 Capacity Issues - Facility Plan



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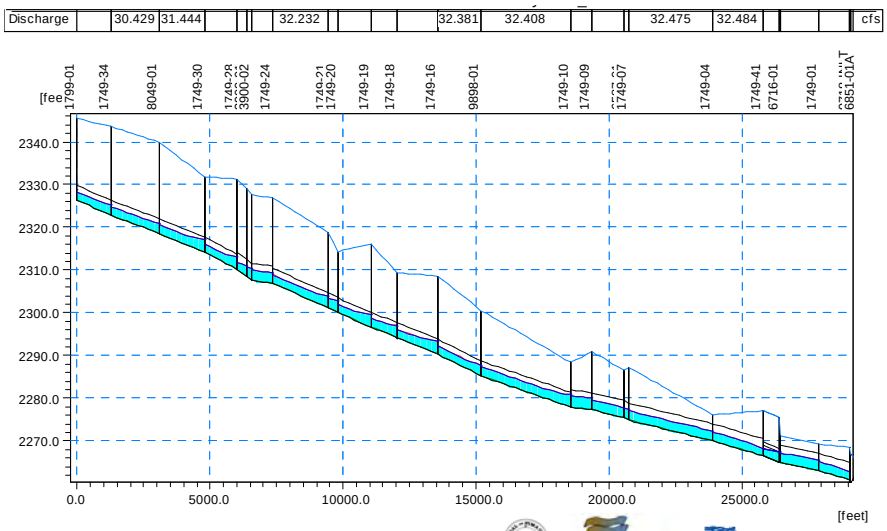
NWO Profile



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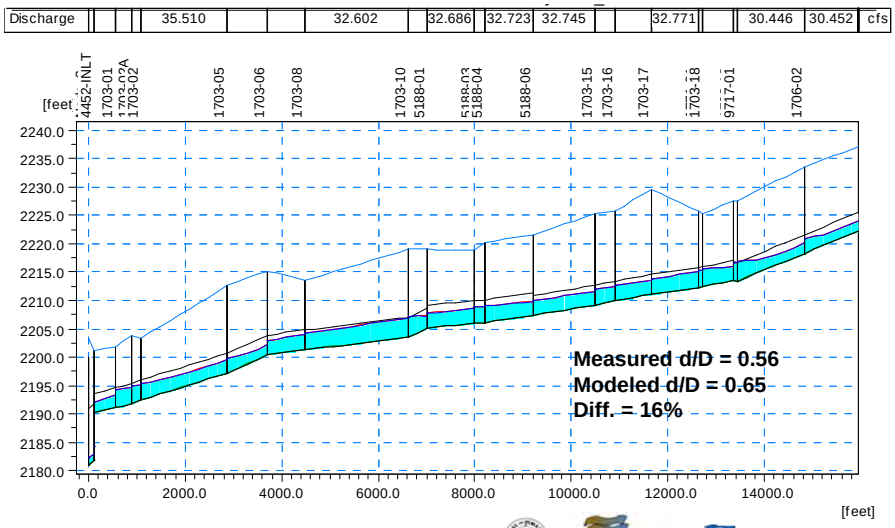
NRI Profile



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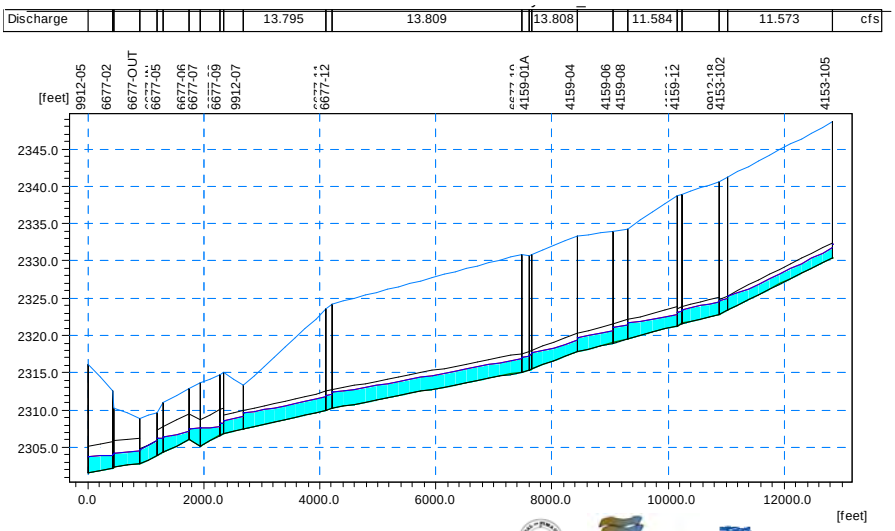
SCC Profile



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2030 Hydraulic Analysis

- All septic customers served
- 85 GPCD used for all sewersheds
- Randolph Park assumed to be offline

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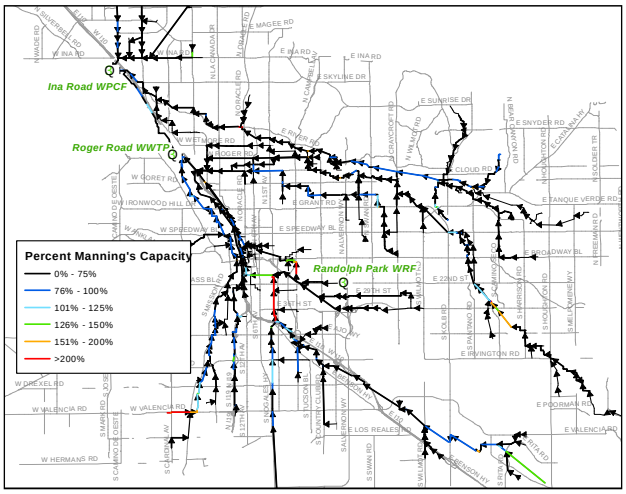
2030 Hydraulic Analysis



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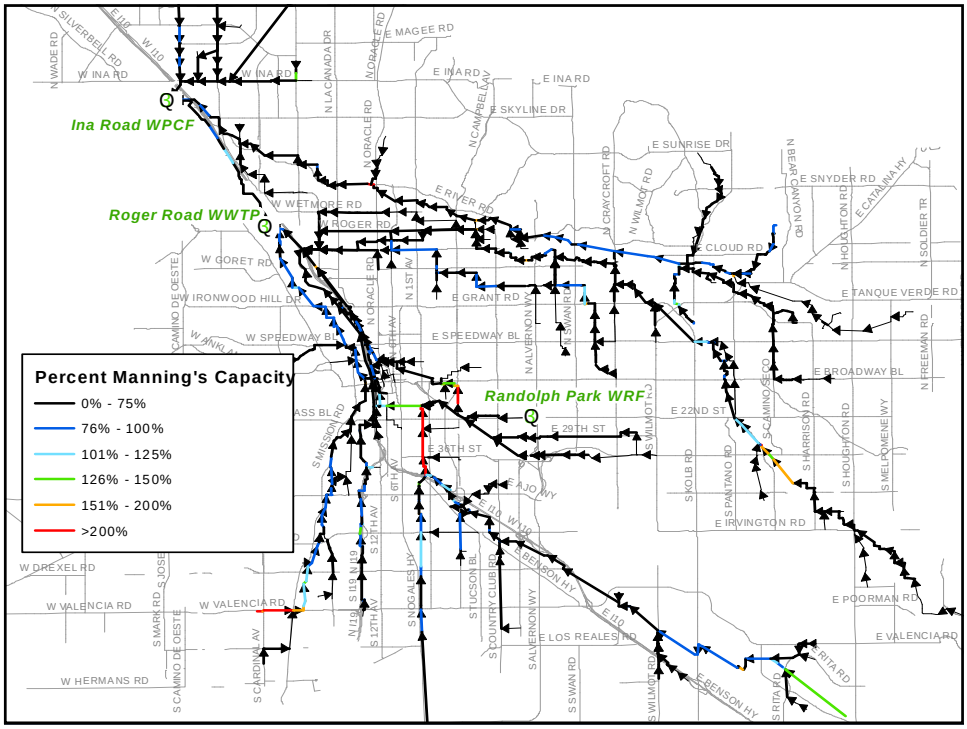
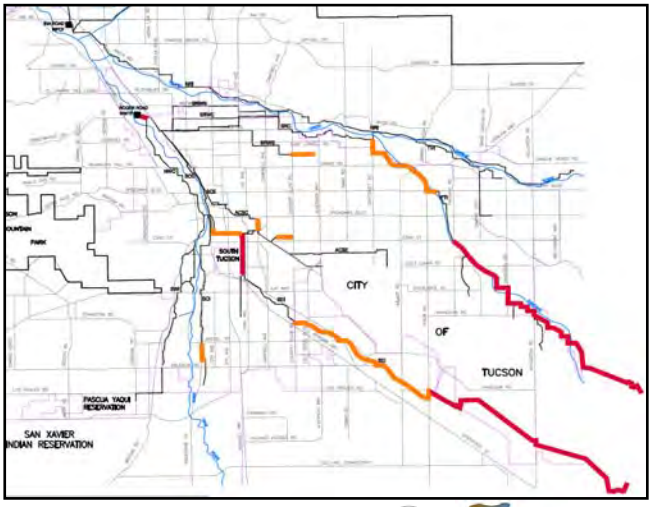
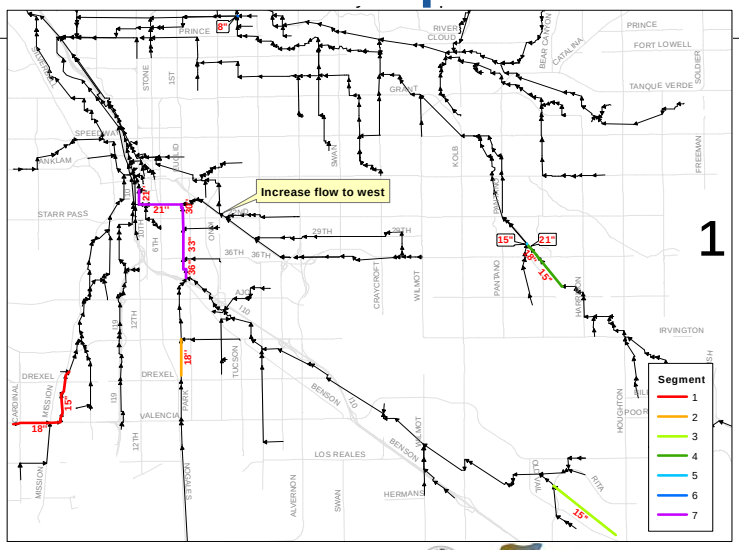


2030 Capacity Issues - Facility Plan



60

Recommended Improvements



61

Estimated Construction Costs

Segment	Item	Qty	Units	Unit Cost	Cost	Type
1	New Parallel Pipe (18" diameter)	4,828	FT	$127.08	$613,571	Open Area
	New Parallel Pipe (15" diameter)	705	FT	$268.95	$189,610	Congested Road
	New Parallel Pipe (15" diameter)	2,150	FT	$0.00	$0	Congested
	New Parallel Pipe (15" diameter)	5,636	FT	$0.00	$0	Open Area
	Segment 1 Subtotal				*$189,610*	
2	New Parallel Pipe (18" diameter)	4,712	FT	$127.08	$598,748	Open Area
	Segment 2 Subtotal				*$598,748*	
3	New Parallel Pipe (15" diameter)	10,327	FT	$105.90	$1,093,638	Open Area
	New Parallel Pipe (15" diameter)	110	FT	$105.90	$11,689	Open Area
	Segment 3 Subtotal				*$1,105,327*	
4	New Parallel Pipe (15" diameter)	83	FT	$105.90	$8,818	Open Area
	New Parallel Pipe (15" diameter)	4,373	FT	$105.90	$463,098	Open Area
	New Parallel Pipe (15" diameter)	606	FT	$105.90	$64,169	Open Area
	New Parallel Pipe (15" diameter)	223	FT	$105.90	$23,591	Open Area
	New Parallel Pipe (18" diameter)	1,183	FT	$127.08	$150,347	Open Area
	New Parallel Pipe (21" diameter)	258	FT	$148.26	$38,309	Open Area
	New Parallel Pipe (21" diameter)	203	FT	$148.26	$30,062	Open Area
	New Parallel Pipe (21" diameter)	53	FT	$148.26	$7,801	Open Area
	Segment 4 Subtotal				*$250,111*	
5	New Parallel Pipe (15" diameter)	76	FT	$229.20	$17,426	Semi-Congested Road
	Segment 5 Subtotal				*$17,426*	
6	New Parallel Pipe (8" diameter)	100	FT	$56.48	$5,647	Open Area
	Segment 6 Subtotal				*$5,647*	
7	New Parallel Pipe (36" diameter)	1,153	FT	$254.16	$293,025	Open Area
	New Parallel Pipe (36" diameter)	295	FT	$254.16	$75,060	Open Area
	New Parallel Pipe (33" diameter)	1,415	FT	$504.24	$713,468	Semi-Congested Road
	New Parallel Pipe (33" diameter)	3,875	FT	$504.24	$1,953,684	Semi-Congested Road
	New Parallel Pipe (33" diameter)	2,783	FT	$504.24	$1,403,515	Semi-Congested Road
	New Parallel Pipe (33" diameter)	151	FT	$504.24	$75,936	Semi-Congested Road
	New Parallel Pipe (30" diameter)	420	FT	$458.40	$192,677	Semi-Congested Road
	New Parallel Pipe (21" diameter)	4,597	FT	$320.88	$1,474,931	Semi-Congested Road
	New Parallel Pipe (21" diameter)	1,906	FT	$148.68	$283,421	Open Area
	Segment 7 Subtotal				*$6,097,632*	
	Fully Open Gate at Manhole 9910-21 Diversion	1	EA	$0.00	$0	
	Grand Total				***$8,264,500***	

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Estimated Construction Costs

Segment	Item	Qty	Units	Unit Cost	Cost	Type
1	New Parallel Pipe (18" diameter)	4,828	FT	$127.08	$613,571	Open Area
	New Parallel Pipe (15" diameter)	705	FT	$268.95	$189,610	Congested Road
	New Parallel Pipe (15" diameter)	2,150	FT	$0.00	$0	Congested
	New Parallel Pipe (15" diameter)	5,636	FT	$0.00	$0	Open Area
	Segment 1 Subtotal				*$803,180*	
2	New Parallel Pipe (18" diameter)	4,712	FT	$127.08	$598,748	Open Area
	Segment 2 Subtotal				*$598,748*	
3	New Parallel Pipe (15" diameter)	10,327	FT	$105.90	$1,093,638	Open Area
	New Parallel Pipe (15" diameter)	110	FT	$105.90	$11,689	Open Area
	Segment 3 Subtotal				*$1,105,327*	
4	New Parallel Pipe (15" diameter)	83	FT	$105.90	$8,818	Open Area
	New Parallel Pipe (15" diameter)	4,373	FT	$105.90	$463,098	Open Area
	New Parallel Pipe (15" diameter)	606	FT	$105.90	$64,169	Open Area
	New Parallel Pipe (15" diameter)	223	FT	$105.90	$23,591	Open Area
	New Parallel Pipe (18" diameter)	1,183	FT	$127.08	$150,347	Open Area
	New Parallel Pipe (21" diameter)	258	FT	$148.26	$38,309	Open Area
	New Parallel Pipe (21" diameter)	203	FT	$148.26	$30,062	Open Area
	New Parallel Pipe (21" diameter)	53	FT	$148.26	$7,801	Open Area
	Segment 4 Subtotal				*$786,196*	
5	New Parallel Pipe (15" diameter)	76	FT	$229.20	$17,426	Semi-Congested Road
	Segment 5 Subtotal				*$17,426*	
6	New Parallel Pipe (8" diameter)	100	FT	$56.48	$5,647	Open Area
	Segment 6 Subtotal				*$5,647*	
7	New Parallel Pipe (36" diameter)	1,153	FT	$254.16	$293,025	Open Area
	New Parallel Pipe (36" diameter)	295	FT	$254.16	$75,060	Open Area
	New Parallel Pipe (33" diameter)	1,415	FT	$504.24	$713,468	Semi-Congested Road
	New Parallel Pipe (33" diameter)	3,875	FT	$504.24	$1,953,684	Semi-Congested Road
	New Parallel Pipe (33" diameter)	2,783	FT	$504.24	$1,403,515	Semi-Congested Road
	New Parallel Pipe (33" diameter)	151	FT	$504.24	$75,936	Semi-Congested Road
	New Parallel Pipe (30" diameter)	420	FT	$458.40	$192,677	Semi-Congested Road
	New Parallel Pipe (21" diameter)	4,597	FT	$320.88	$1,474,931	Semi-Congested Road
	New Parallel Pipe (21" diameter)	1,906	FT	$148.68	$283,421	Open Area
	Segment 7 Subtotal				*$6,465,718*	
	Fully Open Gate at Manhole 9910-21 Diversion	1	EA	$0.00	$0	
	Grand Total				***$9,782,242***	

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GREELEY AND HANSEN

Pima County Wastewater Management Department

GREELEY AND HANSEN

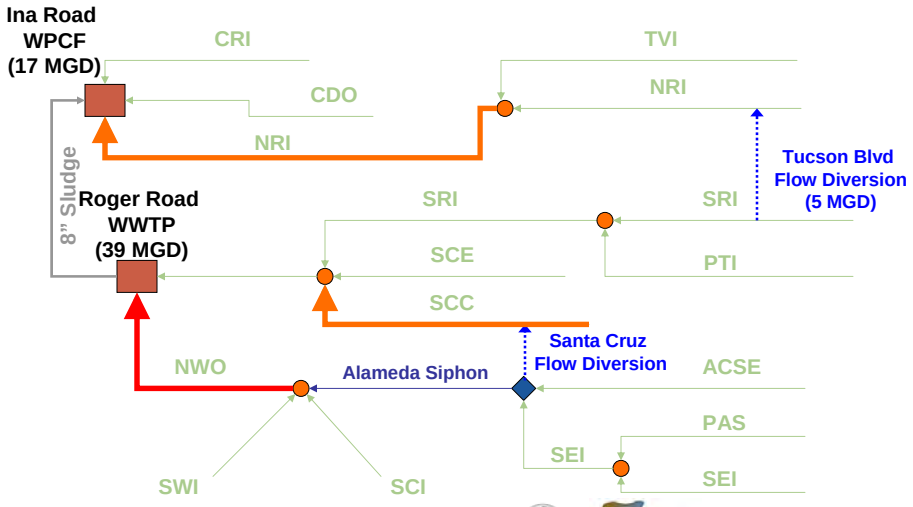
Plant Interconnect

Steve Sticklen

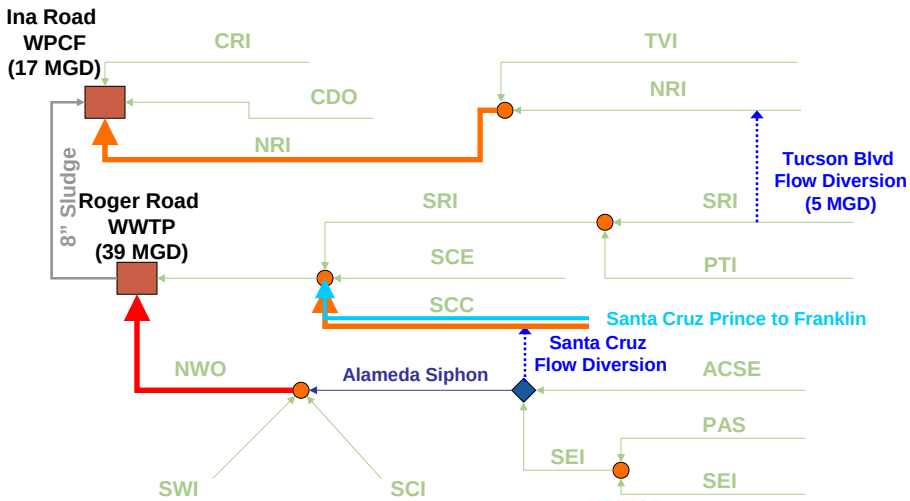
Plant Interconnect

- Current Transfer Options
  - Tucson Blvd and Craycroft Road
  - 8-inch sludge line
- Future Transfer Options
  - Existing Plan
  - Transfer Some
  - Transfer All

Mass Balance Schematic
(Existing System Configuration and Flows)



Mass Balance Schematic
(New Santa Cruz Interceptor)



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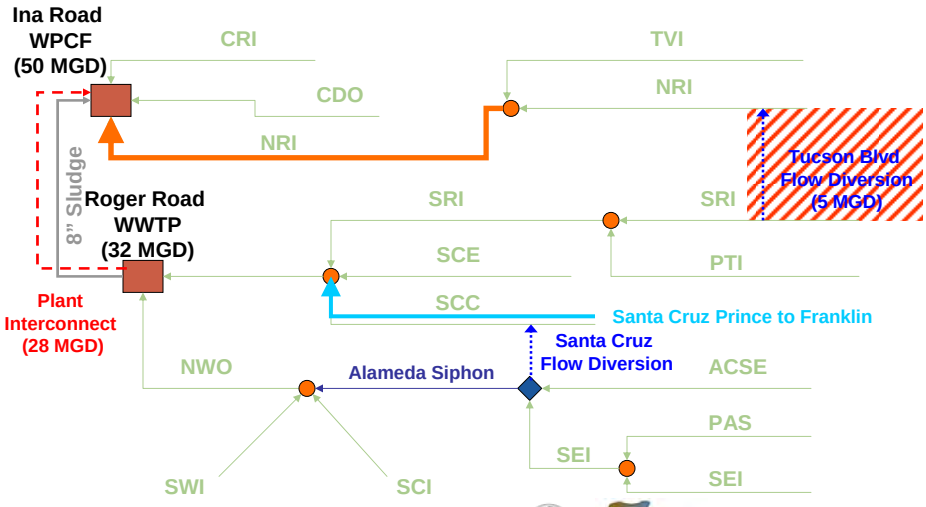
Mass Balance Schematic
(Existing Plan, 2030 Flows)



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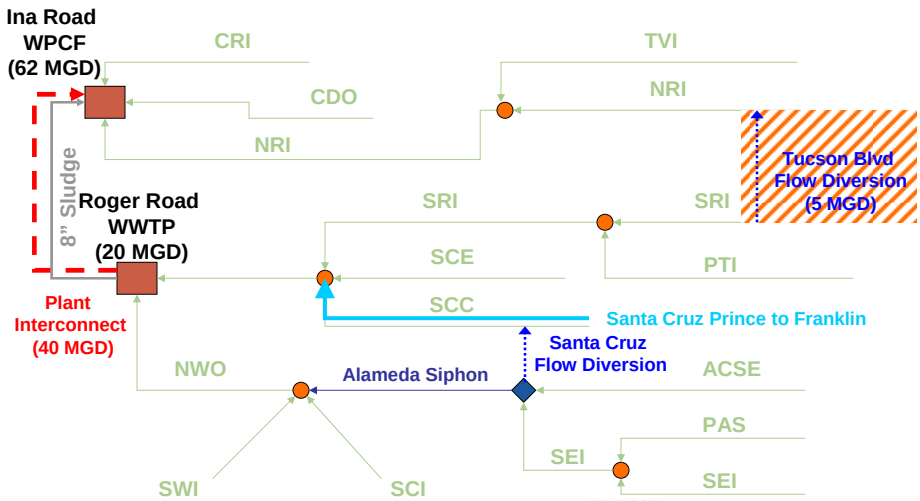
Mass Balance Schematic
(Transfer Some)



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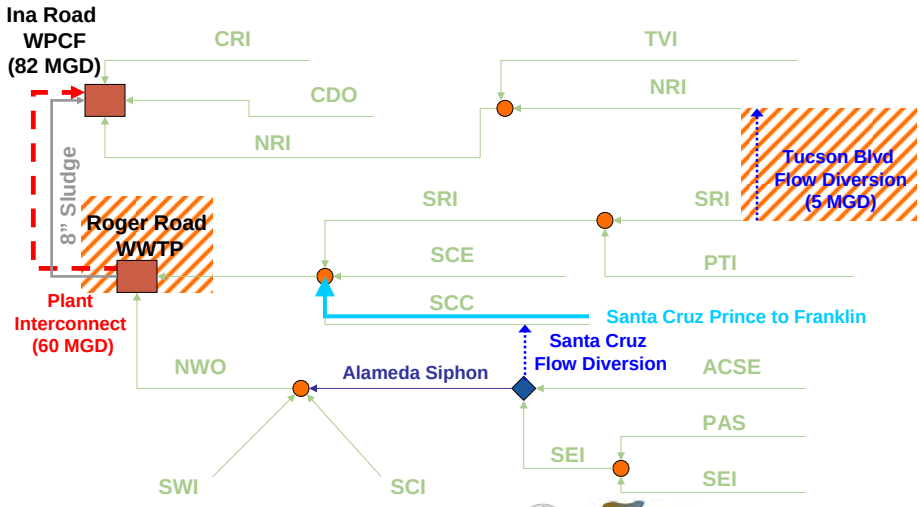
Mass Balance Schematic
(Transfer All)



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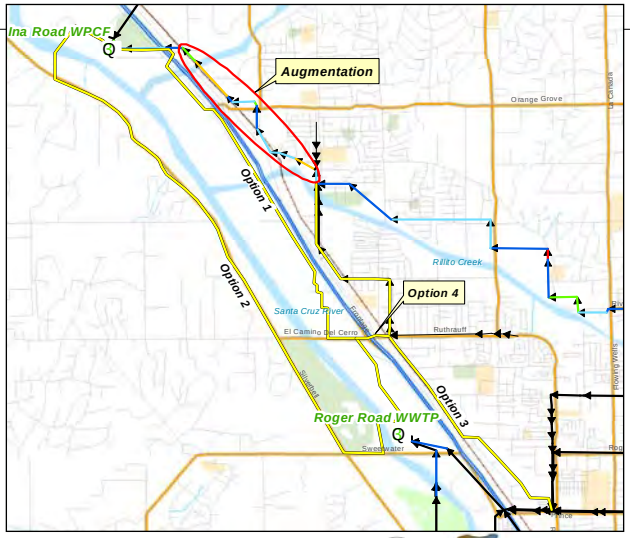
Routing Alternatives



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Summary of Interconnect Options

Option	*Roger Road (MGD)*	*Transfer (MGD)*	*Ina Road (MGD)*
Existing	32	28	50
Transfer Some	20	40	62
Transfer All	0	60	82

Does not consider diurnal variability or wet weather flows

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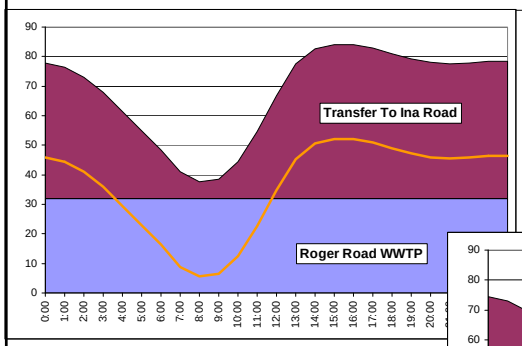
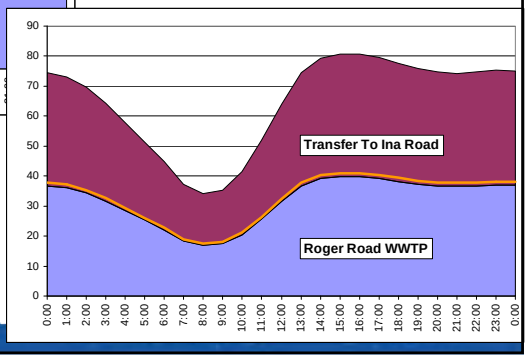
Transfer Options (Dry Weather)





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Transfer Options – "Existing" Plan

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	32	32	29	61
Transfer To Ina Road	28	3	50	0	50
Total	60	35	82	29	111

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	17.5	41	23	64
Transfer To Ina Road	28	17.5	41	6	47
Total	60	35	82	29	111

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Transfer Options – "Existing" Plan

Steady State

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	32	32	32	64
Transfer To Ina Road	28	3	50	22	72
Total	60	35	82	54	136

Diurnal Flow

	Q_{avg} (MGD)	Q_{min} (MGD)	Q_{max} (MGD)	$Q_{WetWeather}$ (MGD)	Q_{Peak} (MGD)
Roger Road	32	17.5	41	23	64
Transfer To Ina Road	28	17.5	41	31	72
Total	60	35	82	54	136

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Interconnect Options

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	54" - 72"	$15.60	R.O.W. acquistion Return pumping of 5 MGD
	Route 4	54" - 60"	$21.20	Return pumping of 5 MGD
Transfer Some	Route 1	48" - 66"	$15.30	R.O.W. acquistion Return pumping of 17 MGD
	Route 4	?	$20.80	Return pumping of 17 MGD
Transfer All	Route 1	66" - 96"	$21.30	R.O.W. acquistion Return pumping of 37 MGD
	Route 4	72" - 84"	$29.60	Return pumping of 37 MGD

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Interconnect Options

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	60" - 84"	$22.30	R.O.W. acquistion
	Route 2	T.B.D.		
	Route 3	Eliminated		
	Route 4	66" - 72"	$29.50	Return pumping of 5 MGD

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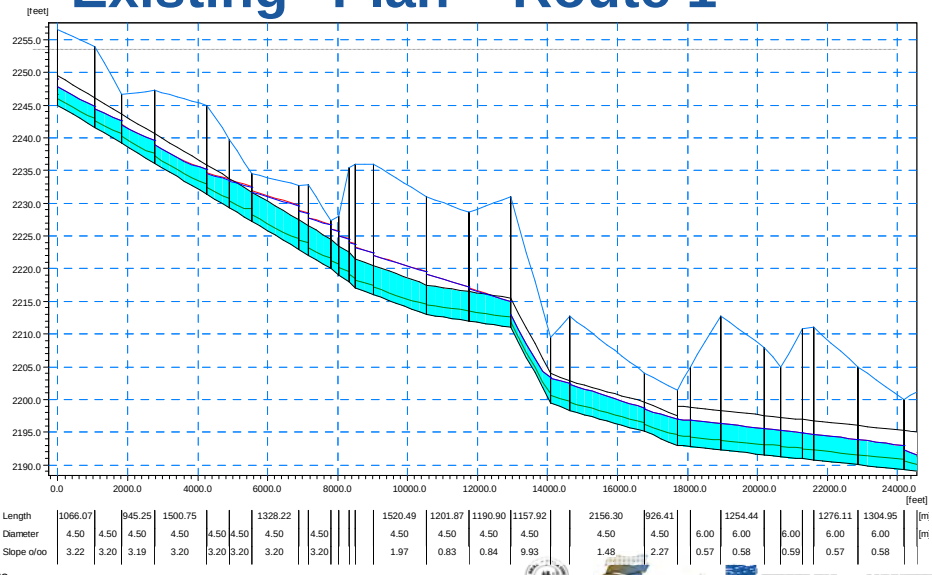
"Existing" Plan – Route 1



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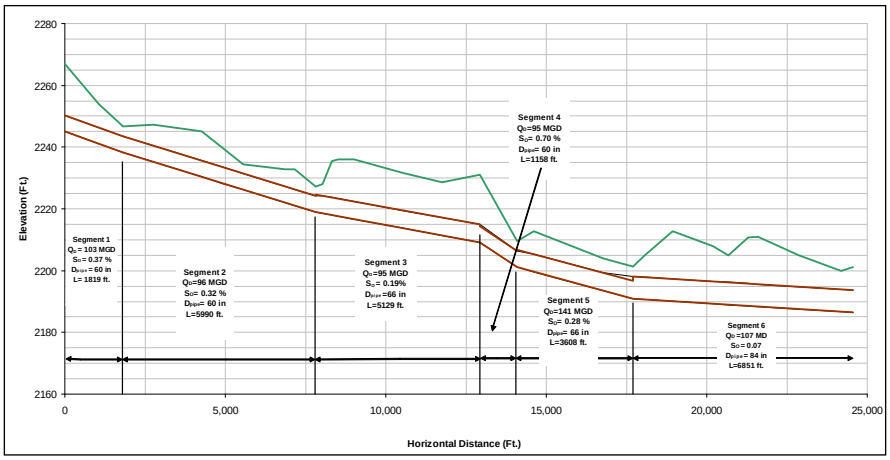
“Existing” Plan – Route 1



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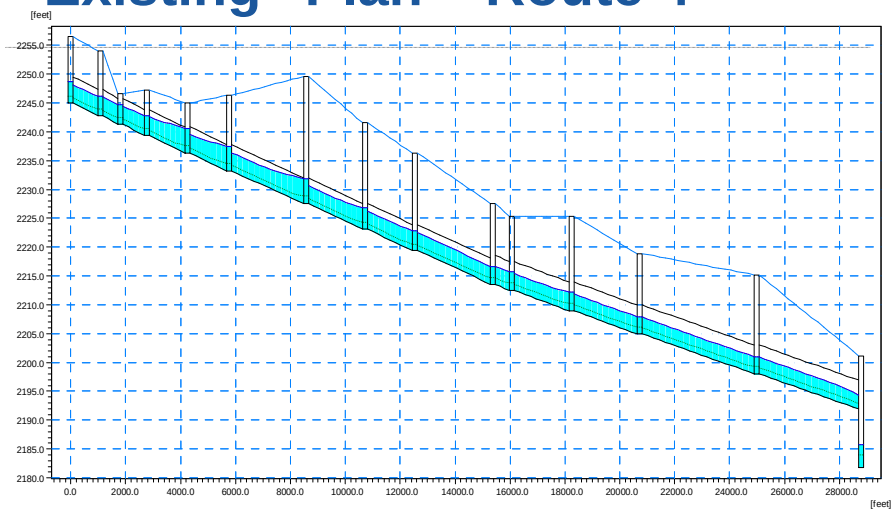
“Existing” Plan – Route 4



Length			1500.75	1496.00	2798.00	2153.00	1822.00	2847.00		2182.00	2473.00	4275.00	3790.00	[m]
Diameter	4.50		4.50	4.50	4.50	4.50	4.50	4.50		5.00	5.00	5.00	5.00	[m]
Slope o/oo	2.04		2.04	2.05	2.04	2.04	2.04	2.04		1.62	1.62	1.62	1.62	

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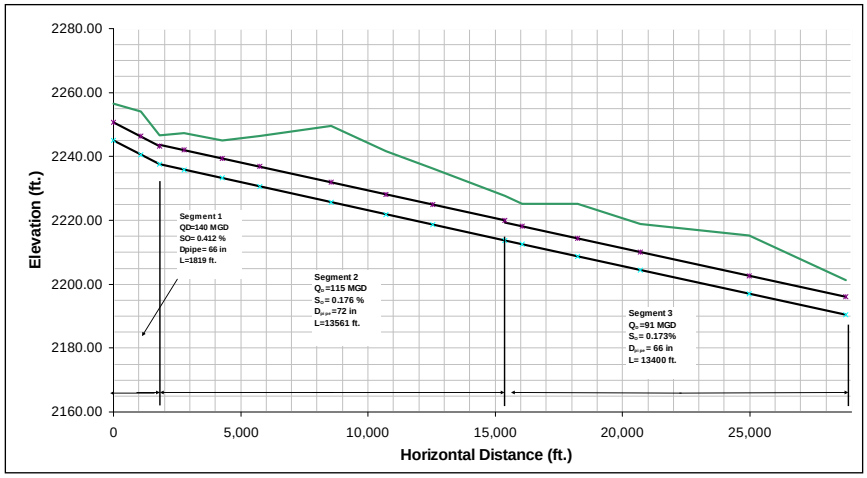
“Existing” Plan – Route 4



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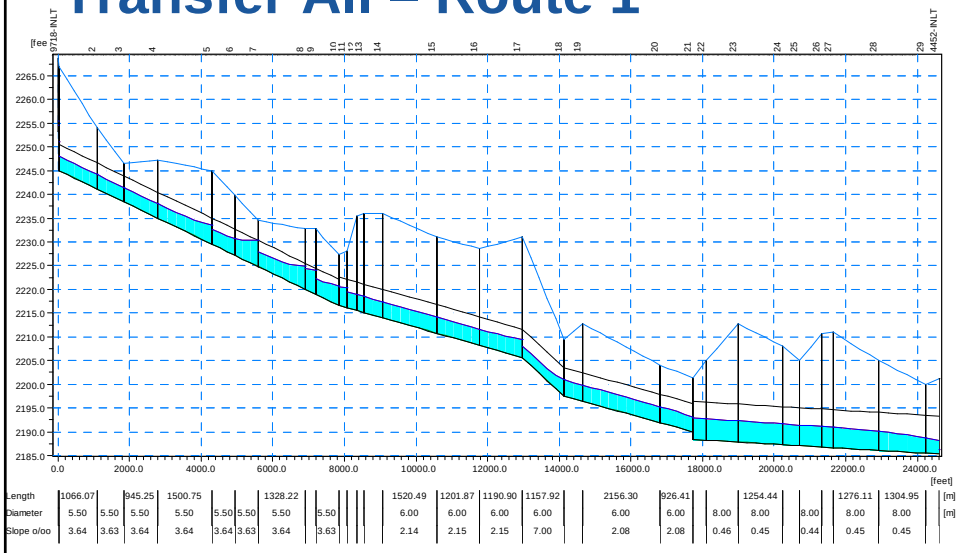
Transfer All – Route 1



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Evaluation Criteria / Cost Comparisons

Gordon Culp/Steve Sticklen

Evaluation Criteria

- Present worth cost
- Non-monetary considerations
  - Constructability
  - Long-range planning
  - Safety
  - Public acceptance
  - Maintenance
  - Rights-of-way
  - Pump stations
  - Utility conflicts
  - Traffic control
  - Environmental impacts
  - Business disruption
  - Archeological / historic sites
  - Permitting

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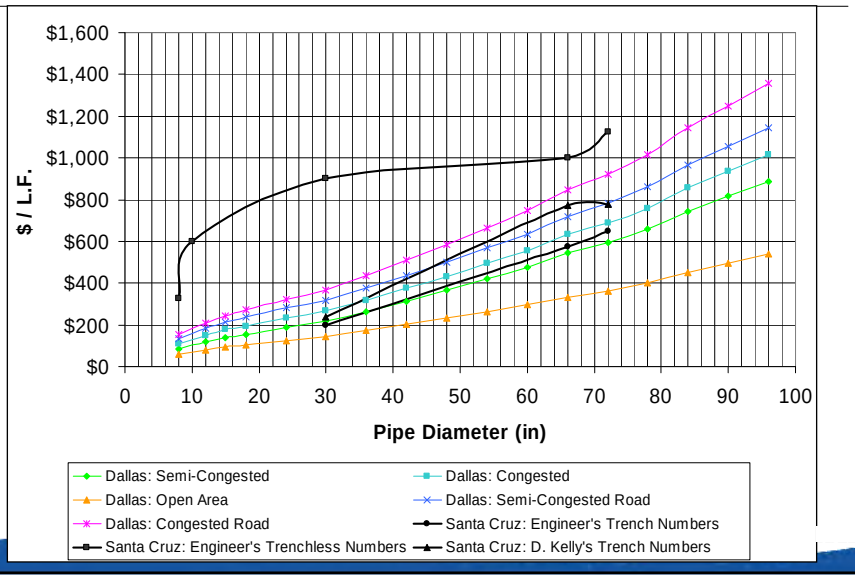
Cost Comparisons - Dallas



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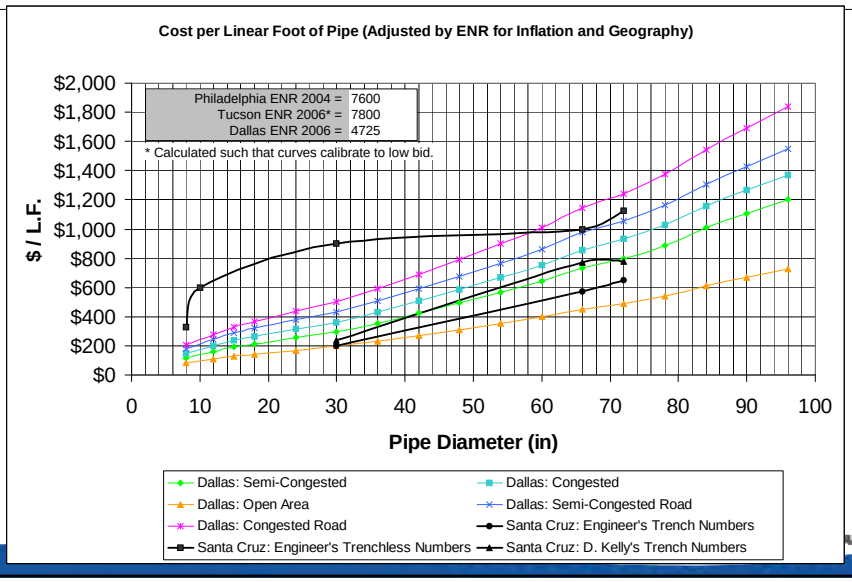
Cost Comparisons - Recalibrated



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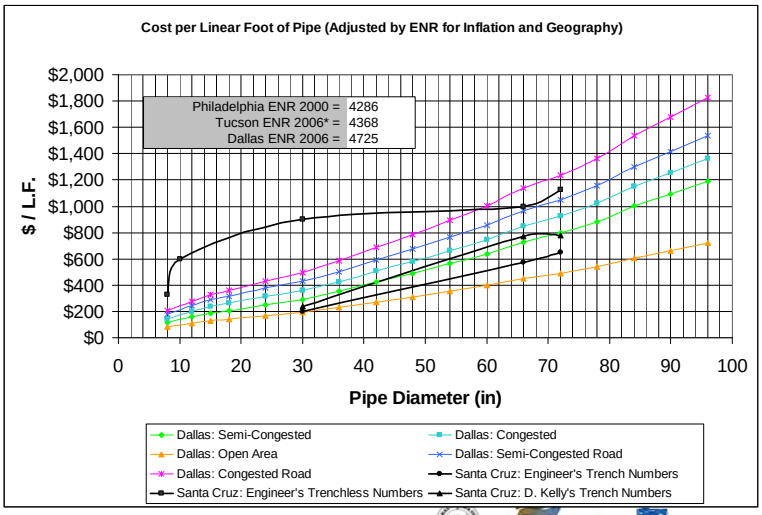
Cost Comparisons - Recalibrated



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Sewer Unit Costs

	$ / (inch*ft)				
D_{pipe} (in)	Semi-Congested	Congested	Open Area	Semi-Congested Rd.	Congested Road
8	14.42	18.19	10.29	22.68	25.61
12	13.47	16.88	8.98	20.43	23.24
15	12.66	15.99	8.48	19.30	22.00
18	11.63	14.67	7.83	17.76	20.31
24	10.60	13.17	6.98	15.81	18.19
30	9.81	12.07	6.58	14.38	16.63
36	9.84	11.94	6.48	14.11	16.40
42	10.12	12.13	6.50	14.11	16.44
48	10.27	12.21	6.49	14.10	16.48
54	10.50	12.39	6.57	14.23	16.67
60	10.68	12.53	6.65	14.35	16.85
66	11.14	12.97	6.82	14.76	17.37
72	11.12	12.91	6.80	14.66	17.28
78	11.41	13.18	6.95	14.93	17.63
84	12.00	13.80	7.24	15.57	18.41
90	12.26	14.06	7.42	15.85	18.77
96	12.50	14.29	7.58	16.13	19.13
Weighted Average =	**$11.33**	**$13.31**	**$7.06**	**$15.28**	**$17.93**

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Sewer Unit Costs

	$ / (inch*ft)				
D_{pipe} (in)	Semi-Congested	Congested	Open Area	Semi-Congested Rd.	Congested Road
8	14.32	18.06	10.22	22.52	25.44
12	13.37	16.76	8.92	20.29	23.08
15	12.58	15.88	8.42	19.17	21.84
18	11.55	14.56	7.78	17.64	20.17
24	10.53	13.08	6.93	15.70	18.07
30	9.74	11.98	6.53	14.28	16.51
36	9.77	11.86	6.43	14.01	16.28
42	10.05	12.05	6.46	14.02	16.33
48	10.20	12.12	6.45	14.00	16.36
54	10.43	12.30	6.53	14.13	16.56
60	10.61	12.44	6.60	14.25	16.74
66	11.06	12.88	6.78	14.66	17.25
72	11.04	12.82	6.75	14.56	17.16
78	11.33	13.09	6.90	14.83	17.50
84	11.91	13.70	7.19	15.46	18.28
90	12.17	13.96	7.36	15.74	18.64
96	12.41	14.19	7.53	16.02	19.00
Weighted Average =	**$11.26**	**$13.22**	**$7.01**	**$15.18**	**$17.81**

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Interconnect Options

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	54" - 72"	$15.60	R.O.W. acquisition Return pumping of 5 MGD
	Route 4	54" - 60"	$21.20	Return pumping of 5 MGD
Transfer Some	Route 1	48" - 66"	$15.30	R.O.W. acquisition Return pumping of 17 MGD
	Route 4	?	$20.80	Return pumping of 17 MGD
Transfer All	Route 1	66" - 96"	$21.30	R.O.W. acquisition Return pumping of 37 MGD
	Route 4	72" - 84"	$29.60	Return pumping of 37 MGD

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Interconnect Options

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	60" - 84"	$22.30	R.O.W. acquistion
	Route 2	T.B.D.		
	Route 3	Eliminated		
	Route 4	66" - 72"	$29.50	Return pumping of 5 MGD

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Summary and Wrap-Up

Anne Smith

Pima County Wastewater Management Department

GREELEY AND HANSEN

Closing Remarks

Mike Gritzuk

Workshop #13 Meeting Notes
Non-Metropolitan Facilities/CIP Update/Project Delivery

1. The Non-Metropolitan Facilities/CIP Update/Project Delivery Workshop for Pima County Regional Optimization Master Plan was held on January 31, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Mike Bunch
Jackson Jenkins
Jeff Nichols
PCWMD Staff
Gary Blomstrom
Ed Curley
Frank Gall
Mary Hamilton
Mike Lueken
Byron McMillan
John Munden
Jeff Prevatt
Karen Ramage
Helen Rhudy
Ron Riska, Project Manager
Mandley Rust
Ken Weber
Eric Wieduwilt
Legal
Harlan Agnew
Chuck Wesselhoff

PIMA COUNTY PROCUREMENT DEPARTMENT
Design and Construction Division
John Carter

WASTEWATER MANAGEMENT ADVISORY COMMITTEE
John Carlson

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Tim Thomure

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Eric Petersen
Andy Richardson
Harold Smith

2. Major topics of the workshop were:

- Workshop #13: Non-Metropolitan Facilities/CIP Update/Project Delivery
  - Existing Non-Metro Facilities
  - 2030 Non-Metro Facilities Configuration
  - CIP Construction Costs (2006)
  - UV Disinfection vs. Chlorination/De-chlorination
  - Plant Electrical Costs
  - Possible Construction Packages
  - Project Delivery Options/Section Criteria

A set of handouts were provided to each attendee at the workshop. Additional information was presented during the workshop and is provided in this meeting summary .

Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be utilized by the project team while conducting the study. The flip chart notes are incorporated into these meeting summary notes.

3. Mike Gritzuk welcomed the attendees to the workshop and invited the workshop to begin.

4. Andy Richardson quickly outlined the meeting topics and objectives. He further elaborated on his role as facilitator and encouraged all to participate, but informed the attendees that some items may have to be placed in the "parking lot" (on the flip charts) for later discussion to meet the established schedule.

   Overview, agenda, meeting objectives, and ground rules were covered on pages 2 through 4 of the handout.

5. Jerry Bish reviewed the current systems and operations at the County owned and operated non-metropolitan wastewater facilities. Pima County has the responsibility for wastewater management for all of Pima County except for a Designated Management Area (DMA) established for the Town of Sahuarita. There are several small communities (Ajo, Why, Lukeville) in the remote parts of western Pima County that are on separate wastewater management systems that are not part of Pima County Wastewater Management Department operations. The existing operations for those areas are not expected to change within the 25-year planning horizon.

   Planning for population growth in the Non-Metro areas includes the Sonoran Desert Conservation Plan, which serves to keep new sewers out of riparian areas and minimizes sewer extensions into conservation land areas. The Sonoran Desert Conservation Plan provides Pima County with access to effluent for riparian projects and includes a framework for negotiating effluent water projects from the Conservation Effluent Pool.

   Each of the eight non-metro facilities under operation by the Pima County Wastewater Management Department were reviewed. Service area, population served, wastewater flows, type of wastewater treatment process, size of land parcel for treatment plant, effluent receiving water/area, discharge permit requirements, reclaimed water permits, biosolids handling/treatment and biosolids disposal were presented for each of the following facilities:

   - Arivaca Junction
   - Avra Valley
   - Corona de Tucson
   - Green Valley
   - Marana
   - Mt. Lemmon
   - Fairgrounds
   - Rillito Vista

   Frank Gall noted that very little is discharged into the Black Wash at Avra Valley. Most of the plant discharge is disposed of through the percolation ponds. New BNROD facilities at Avra Valley are scheduled to be online by April/May 2007.

Frank Gall further indicated that the plant at Green Valley has not discharged into the Santa Cruz River since startup. Effluent is filtered onsite and pumped to the Quail Creek Golf Course recharge basin. The golf course recovers the water from ground wells and waters the course turf. It was noted on the wastewater treatment slide that there was also an operational lagoon at Green Valley.

At Marana a new Aquifer Protection Permit is in place. It was noted that the overflow basin is lined. The pond where the new interim Biolac system is being installed is lined with high density polyethylene. The Biolac system will be placed into operation soon.

For Mt. Lemmon there is a study underway to expand the service area by adding additional lots. The current permit flow is believed to be 12,500 gpd with a maximum flow of 17,000 gpd.

For the effluent discharge from the plants, it was noted that for Marana there was water reuse not aquifer recharge, and at Mt. Lemmon there was a NPDES permit in addition to the spray field disposal.

Under reclaimed water uses, it was noted that Green Valley does not have a riparian restoration program, however, at Canoa Ranch which is upgradient of Green Valley, there is consideration by the Pima County Regional Flood Control to include riparian restoration. Further, it was noted that the ponds at Fairgrounds and Rillito Vista were not being used for groundwater replenishment, but is used for evaporation and percolation. The Green Valley effluent is used for 100% recharge.

The new closed loop reactor system at Corona de Tuscan is scheduled to be online in April/May 2007.

The current non-metro wastewater facilities systems and operations were covered on pages 4 through 12 of the handout.

6. Jerry Bish outlined the projected Pima County wastewater system operations in 2030, based on population growth and service area expansion. By 2030, the Arivaca Junction, Fairgrounds and Rillito Vista will be planned out and incorporated into the service areas of Green Valley, Roger Road and Marana, respectively. Avra Valley will have an expanded population and service area. A portion of the area tributary to Avra Valley will be designated a rural area and will most probably not receive sewers within the planning period. Other areas tributary to Avra Valley that are not currently sewered will receive sewer extensions from the Avra Valley wastewater treatment plant, which will be expanded to meet demand.

   Mt. Lemmon is expected to serve the Summer Haven community, which will be limited in growth by the U.S. Forest Service and is completely surrounded by forest areas.

   The Northwest region will see rapid expansion of the Marana service area as population growth increases in and around Marana. The vision is within the planning period that Rillito Vista service area will be connected to the Marana facilities and will be eliminated from service.

Further, wastewater in the area down gradient from the Marana facilities will be collected at a pump station on the Pima/Pinal County line and be pumped to the Marana facilities.

A question was asked if the Marana plant should make arrangements to serve any communities/areas in Pinal County. The response is that Pinal County is outside the Pima County DMA and any service would be negotiated as a special circumstance. For planning purposes, service to Pinal County will not be considered.

Technically the area served by the Continental Ranch Pump Station can be served by gravity sewers at the Marana wastewater facilities. It was indicated in the long term that the Continental Ranch Pump Station should be eliminated and flow carried by gravity to the Marana facility. This would remove a small portion of flow from the Ina Road WPCF service area.

In the South Region, the Arivaca Junction will be phased out and flow will be carried to Green Valley. The area served by Sahuarita may be increased through ongoing joint planning area negotiations with Sahuarita, Pima Association of Governments and Pima County.

In the Southeast Region, a new facility is projected for the northwest corner of the service area near the Santa Cruz River. This plant is identified as the Southlands. This facility would be down gradient of Green Valley and Corona de Tucson and could serve those areas at some future date with appropriate planning of future sewer networks. However, in the 25-year planning horizon, the Green Valley and Corona de Tucson plants will remain and most probably be expanded over the next 25 years. A question arose at the Corona de Tucson plant as to where was the future water going to be discharged. There was a question as to why the flow from the Southlands would not be taken to the Metro facilities. The answer is that the transport of the wastewater to the Metro facilities would be very costly and is deem infeasible.

The future non-metro wastewater facilities systems and operations were covered on pages 12 through 20 of the handout.

7. Future flows along with current and planned capacity at each of the non-metro facilities was presented by Jerry Bish. Due to some last minute information future flows for each of the non-metro regions presented at the workshop were somewhat different than those presented in the workshop. The revised future flow/capacity charts presented at the workshop are attached. For the Southlands no capacity was shown since this is part of the negotiations with Town of Sahuarita and Pima County over who will serve that region. This is planned to be resolved over the next several weeks to months.

   See the supplemental information on flow and capacity for the non-metro regions at the end of the notes

8. A “first cut” of the future wastewater treatment technology for the non-metro facilities was reviewed. The basis of the evaluation was the standards set forth for the metro facilities, which is equal to or more stringent than the current permit requirements at the non-metro facilities. These are not the effluent standards that are in-place, nor are they viewed as being on the horizon, but it is reasonable to consider treating the wastewater to this level for the non-metro facilities by 2030.

The current biological nutrient removal oxidation ditch (BNROD) operation was looked at against the possible future requirements. With some augmentation to the BNROD systems could successfully meet the future requirements. Other wastewater technologies that would meet the objectives would be 5-stage Bardenpho, moveable bed reactors, and sequencing batch reactors. Although oxidation ditches have been constructed or are currently under construction to serve the non-metro service areas, there is concern that this technology may not best serve the County into the future. Currently, the wastewater facilities are in remote areas, but as the non-metro areas fill-in there will be encroachment by housing near and adjacent the sites, which will make odor control issues more of a concern. Also, there will be significant increases in land value as the non-metro communities grow. Therefore, wastewater treatment technologies with a smaller footprint that are more suitable for odor control than the oxidation ditches are of a better fit for the County's long term needs. More investigation into wastewater technologies is required before the final selection of a process. One consideration for a new technology will be the adaptability of the existing systems into the new technology.

For the future it is envisioned that the current effluent utilization will continue and be expanded. Ownership of the effluent water is being developed between the County and the water purveyors. A comprehensive regional development for the effluent would be beneficial.

For biosolids a similar comprehensive development plan is needed as a strategy to address disposal. A multiple outlet approach is recommended which allows for competition in the market place, or a dedicated disposal site, or both. Will there be a centralized biosolids processing site in the non-metro area, in addition to the Ina Road centralized facility? A centralized facility on the south side would look to mine disposal as a primary outlet versus the agricultural land disposal associated with Ina Road. More work is necessary to develop the ultimate biosolids disposal plan.

The "first cut" of the future non-metro wastewater facilities systems and operations including effluent utilization and biosolids handling and disposal were covered on pages 20 through 23 of the handout.

9. The capital improvement program (CIP) costs in 2006 dollars ($501 million) were reviewed for the metro facilities and the plant interconnect pipeline. The electrical service costs was broken down for each of the metro plants as follows: standby power at Roger Road ($7 million), power generation at Ina Road ($18.4 million) and unification costs for Ina Road ($9.6 million) to serve the future facilities. Other administrative and engineering costs, such as program management, construction management, real property, cultural resources and permits that relate to the plant upgrades and expansion were identified.

   The capital improvement program costs for Roger Road WWTP, Ina Road WPCF and the plant interconnect pipeline were covered on pages 23 through 28 of the handout.

10. Mike Gritzuk reported on a meeting with the Arizona Department of Environmental Quality (ADEQ) in which it was reported that ultraviolet (UV) disinfection with antecedent filtration may not be the way to go fro Pima County because of the expense of providing these facilities. Options such as enhanced chlorination/de-chlorination, or site specific standards in lieu of UV

disinfection were discussed with ADEQ. ADEQ indicated that they would be willing to work with Pima County on this issue in a separate meeting.

11. Jerry Bish presented the schedule for design, construction and startup of facilities to meet the regulatory deadlines set forth in the AZPDES permits. Based on the schedule and sequence of construction there are several project elements that can be delayed until after 2015 to stretch out the cost of the project for rate and bond purposes. These include: construction of 8 mgd of capacity at Roger Road, decommissioning and demolition the existing Roger Road WWTP and some sludge facilities at Ina Road WPCF. The total project can be divided into a number of project packages to take advantage of the various project delivery methods available to the County. A listing of the various project elements was provided for consideration in the subsequent presentation on project delivery. Some considerations are: more contractors involvement, spend more money locally, and cost effectiveness of the project delivery system.

    The project schedule and possible project packages were covered on pages 28 through 30 of the handout.

12. Ed Curley presented a draft 5-year CIP that includes regulatory, capacity and rehabilitation needs throughout the utility. The CIP indicates that most of the money spent over the next five-years is related to the regional optimization program. The projected costs within the CIP will double in year two of the five year plan and nearly double again over the five year span. These numbers are still being developed, but represent the probable costs of the expansion and upgrade costs. After the 5-year CIP is finalized the department will develop a 15-year CIP, to model the cost through the construction and startup period for the new facilities. The CIP will be utilized to develop the capital funding (bond) needs for the department. A need for $400 million in 2008 bonds is most likely not politically achievable.

13. Eric Petersen highlighted the available project delivery systems available in Arizona. The presentation paralleled the written text provided in the handout and covered design/build (D/B), construction-manager-at-risk (CMAR) and design-build-operate (DBO). The presentation did not cover the traditional design-bid-build project delivery, or others that include financing options (sometimes referred to as turnkey). The project delivery systems can be applied to the three major projects or associated sub-projects (project packages), and the non-metro facilities.

    For the alternative delivery systems it is important to pre-qualify the contractors. The design/build and CMAR approaches enable project cost certainty well before the project design is completed and can save time from the beginning of a project to the completion of construction. Melodee Loyer suggested that the time factor for procurement and evaluations are not normally included in the time saved. If those times were taken into account, it is suggested that there would be little time saved over the traditional design-bid-build. John Munden asked if the design needs to be approved by the State, how does that taken into account in the D/B approach. Eric Petersen indicated that the regulatory agencies will need to work with the owner to make these approaches successful.

    Mike Gritzuk indicated that the design/build experience in Arizona is limited, however, design/build has been successful in the State. A project the size of Roger Road or Ina Road

would be considered a big project and would probably be pursued by large national firms. John Carter stated that in Arizona a contractor must lead a design/build project. It was noted that some engineers hold contractor's licenses dn could lead a D/B project . Ron Riska asked that with Bardenpho selected by the County as the treatment process, would this close out D/B as a project delivery approach. The answer is no, there are other parts of the project where innovation and creativity can be integrated to make it a successful D/B project.

Frank Gall asked if there was a service life (period) on design-build-operate contracts. In response there are no state laws that limit the service period, but tax law advantages would most likely limit the period to 20 years. Under a DBO contract the contractor would be held accountable by contract for any permit violation. In all cases the County would hold the operating permit.

Under the CMAR approach there are separate contracts for design and construction. Harlan Agnew observed that depending on the project delivery approach there are different county staffing requirements. This must be considered in the ultimate selection of a project delivery approach.

The alternative project delivery and selection criteria were covered on pages 31 through 44 of the handout. In the interest of time representative projects were not discussed, but are summarized in the presentation slides included in the handout.

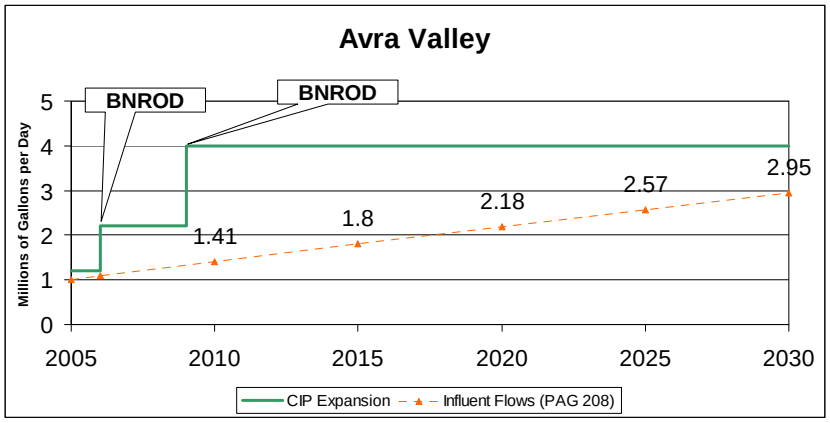
14. Eric Petersen indicated that a letter of expression is a great method to collect information for Pima County from various sources on the interest in the various project delivery approaches, including the interest of private financing to participate in public works projects. This approach was used successfully in Phoenix.

15. Mike Gritzuk closed the meeting and indicated that he looked forward to receiving the draft Regional Optimization Master Plan report and participating in Workshop # 14 to review the draft.

Agenda
Non-Metropolitan Facilities/ CIP Update/Project Delivery Workshop
January 31, 2007

Time	Topic	Presenter
8:15 am	*Pioneer Building, 4th Floor Conference Room*	
8:30 am	Opening Session	Andy Richardson
	• Welcoming Remarks	Mike Gritzuk
	• Overview of Agenda	
	• Groundrules/Role of Facilitator	
	• Confirmation of Agenda	
8:45 am	Non-Metro Existing Systems/Conditions	Jerry Bish
	• Wastewater Facilities	
	• Water Reuse	
	• Biosolids Use and Disposal	
9:30 am	Non-Metro Recommended Systems Configuration	Jerry Bish
	• Systems Configuration	
	• Treatment Processes	
	• Water Reuse	
	• Biosolids Use and Disposal	
10:30 am	Break	
10:45 am	CIP Program	Jerry Bish / Harold Smith
	• Program Cost Update	
	• UV vs. Chlorination	
	• ROMP CIP Schedule/Costs	
	• Construction Packages	
	• CIP/Revenue Requirement/Bonds Status/Issues	Ed Curley
12:15 pm	Lunch	
12:45 pm	Project Delivery Alternatives	Eric Petersen
	• Delivery Method Options	
	• Criteria for Delivery Method Selection	
1:30 pm	Summary Wrap-Up	Andy Richardson
	• Comment by Group	
	• Closing Remarks	Mike Gritzuk
2:00 pm	Adjourn	

Avra Valley – Flow/Capacity



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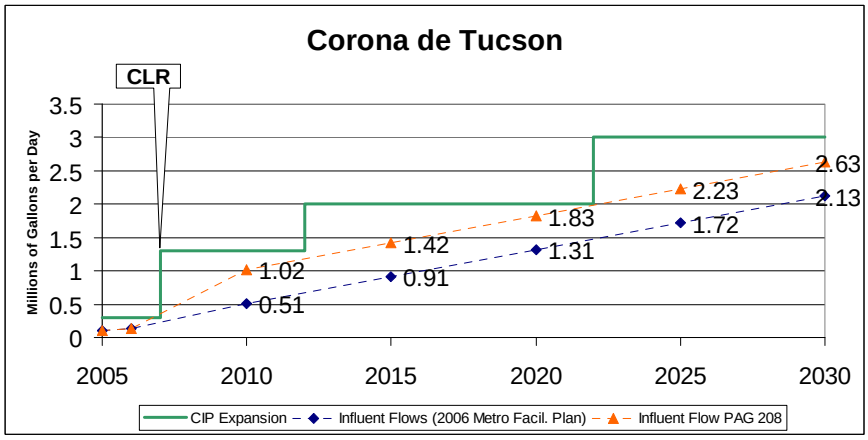
Corona de Tucson – Flow/Capacity



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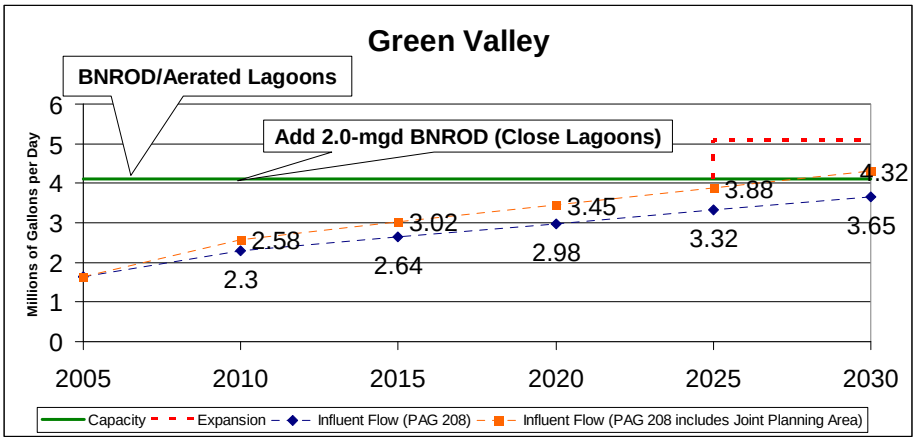
Green Valley - Flow/Capacity



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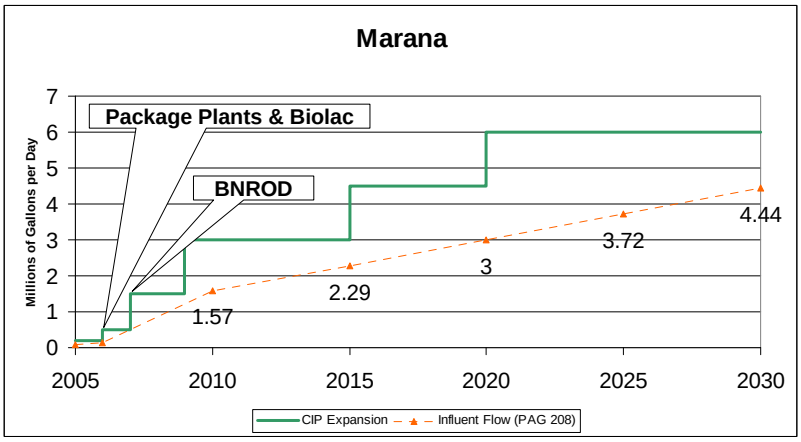
Marana – Flow/Capacity



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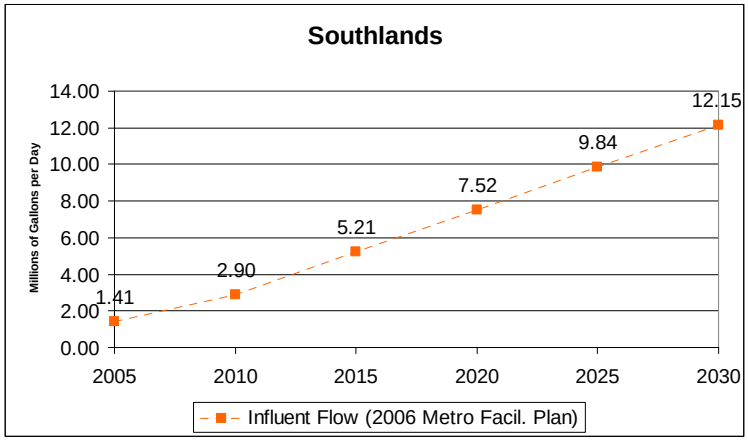
Southlands – Flow/Capacity



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Pima County Regional Optimization Master Plan

Workshop #13
Non-Metropolitan Facilities / CIP Update / Project Delivery Workshop

January 31, 2007

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator/ Previous WS Decisions
Jerry Bish	Non-Metro Existing Systems/Conditions
Jerry Bish	Recommended 2030 Systems Configuration
Jerry Bish/Harold Smith	CIP Program
Eric Petersen	Project Delivery Alternatives
Andy Richardson	Wrap-Up

2

GREELEY AND HANSEN

Welcoming Remarks

Mike Gritzuk

GREELEY AND HANSEN

Overview

Andy Richardson

Agenda

- Non-metro existing condition
- Non-metro recommended configuration
- CIP issues
- Project delivery alternatives

5

Objective

- Confirm recommended non-metro system configuration
- Confirm recommended non-metro treatment process
- Review construction packages
- Review project delivery alternatives and selection method

6

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

7

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

8

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

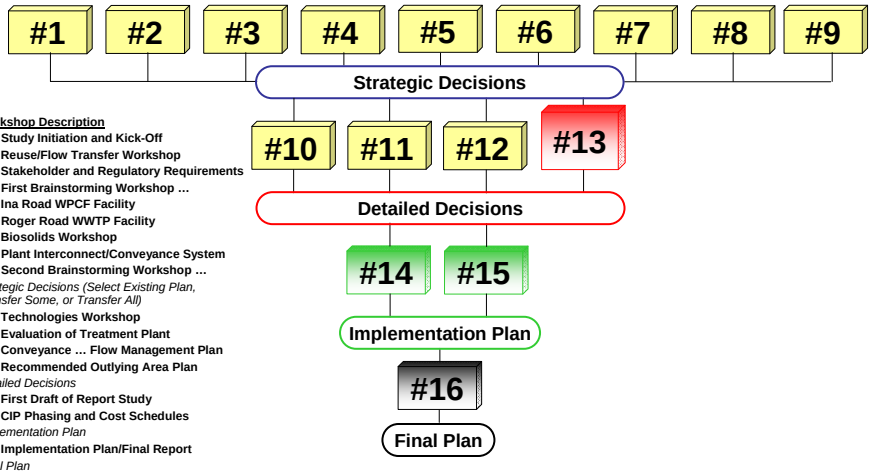
9

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

10

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

11

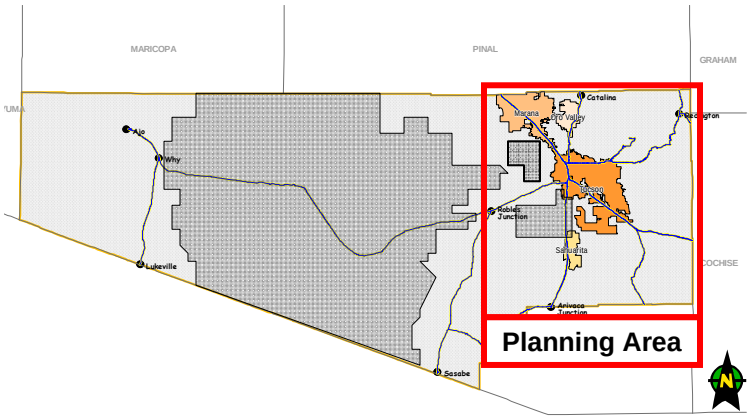
GREELEY AND HANSEN

GREELEY AND HANSEN

Non-Metro Existing Systems / Conditions

Jerry Bish

Designated Management Areas (DMAs)



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Excluded Areas

- Ajo
- Why
- Lukeville

Western Pima County

- AZ State Prison
- Sahuarita
- AZ Sonoran Desert Museum

14

Sonoran Desert Conservation Plan

- Keeps new sewer lines out of the riparian areas
- Minimizes sewer system extensions into Conservation Land System
- Negotiates Conservation Effluent Pool with City
- Provides County effluent to riparian projects

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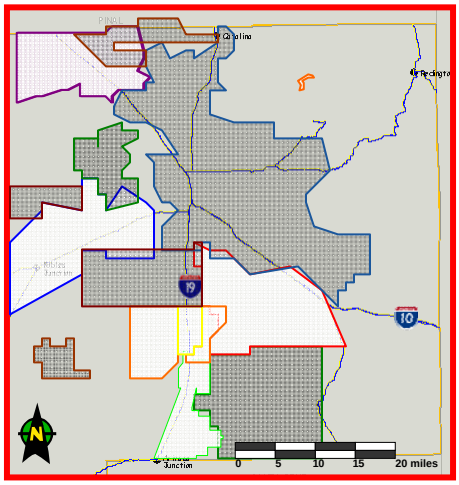
Planning Areas



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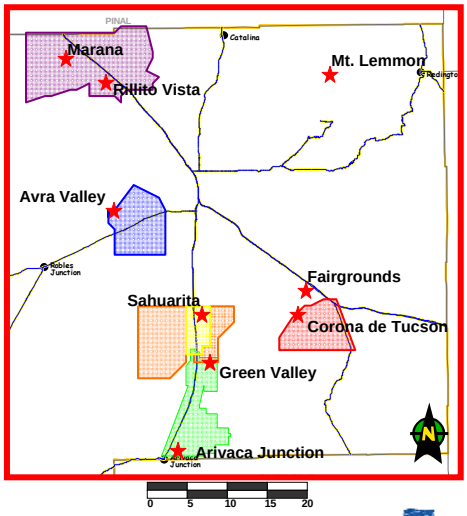
Existing Facilities/Sewer Basins



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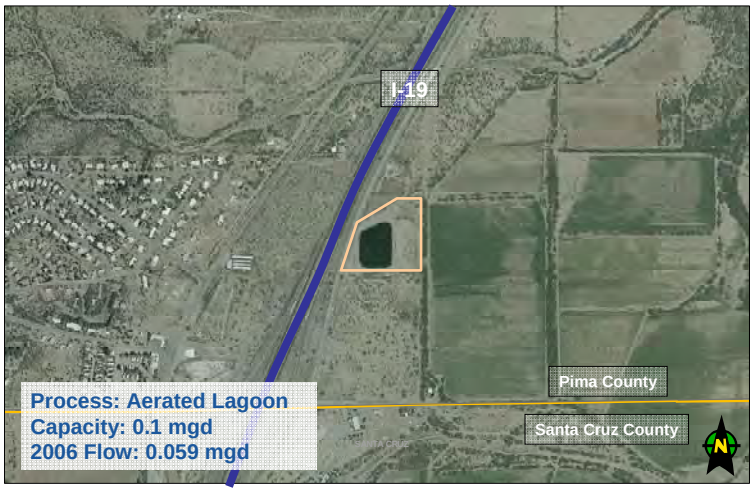
Arivaca Junction



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Avra Valley

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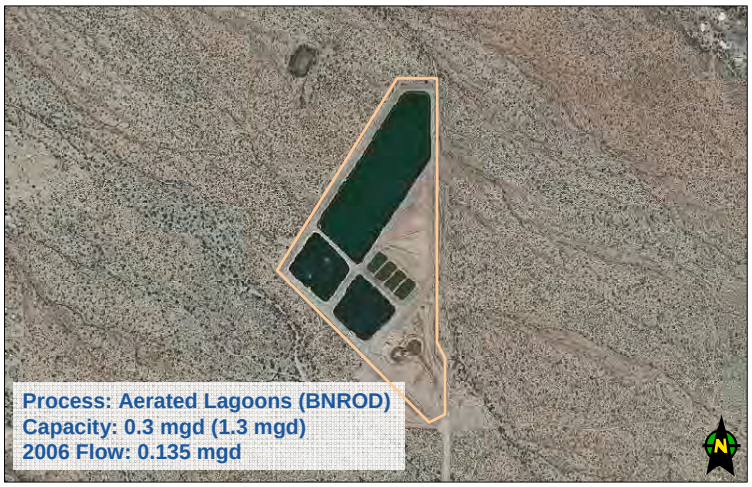
Corona de Tucson



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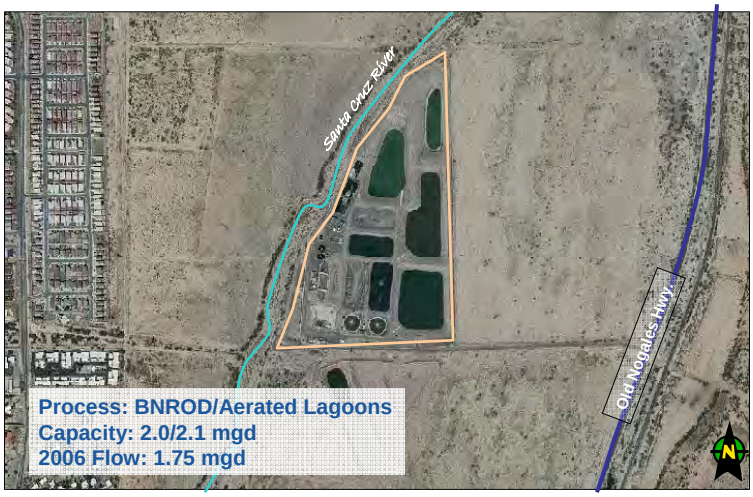
Green Valley



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Marana

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Mt. Lemmon

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Fairgrounds

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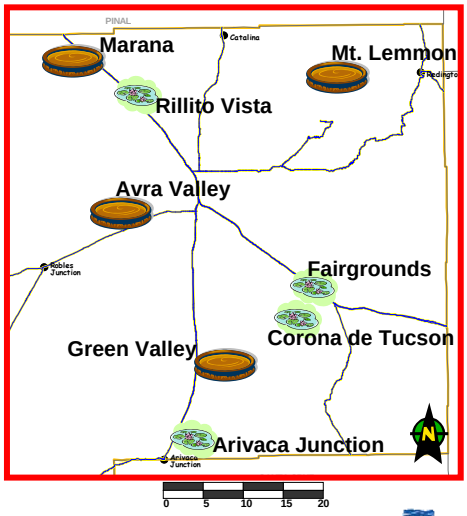
Rillito Vista

25

Wastewater Treatment



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Effluent Discharges

Facility	Receiving Area
Arivaca Junction	Perc Pond and Reclaimed Water Line
Avra Valley	Perc Pond, Storage Pond, and Spray Fields
Corona de Tucson	Evaporation Pond and SAT Basins*
Green Valley	Perc Ponds, Santa Cruz River and Reclaimed Water Line
Marana	Santa Cruz River and Aquifer Recharge
Mt. Lemmon	Spray Field
Fairgrounds	Perc Ponds
Rillito Vista	Perc Ponds

* Groundwater Recharge, in Near Future

Discharge Requirements

Discharge Location	Treatment Regulations
Percolation/Storage Ponds	Aquifer Protection Permit
Reclaimed Water Line	Reclaimed Water
Spray Fields	AZPDES
Soil Aquifer Treatment Basins	Aquifer Protection Permit
Santa Cruz River	AZPDES

Reclaimed Water Use

Facility	Type of Use
Arivaca Junction	Farm Irrigation
Avra Valley	Plant Irrigation
Corona de Tucson	Evaporation and Groundwater Replenishment
Green Valley	Robson/Quail Creek, Inc. and Riparian Restoration
Marana	Santa Cruz Discharge and Plant Irrigation
Mt. Lemmon	Reforestation
Fairgrounds	Groundwater Replenishment
Rillito Vista	Groundwater Replenishment
Canoa Ranch	Riparian Restoration

Reclaimed Water Permits

Facility	Permit	Produced (gpd)(1)	Percent of Total Treated
Arivaca Junction	Class C	40,000	68
Avra Valley	Class B+	320,000	30
Green Valley	Class A+ (BNROD) Class B (lagoon)	1,500,000	86
Marana	Class B+	57,000	38
Mt. Lemmon	Permit (AZPDES)	2,000	100

(1) 2005 Effluent Generation/Utilization Report

Biosolids Handling/Treatment

Facility	Produced (tpd)[1]	Handling/Treatment
Arivaca Junction	0.08	Dried
Avra Valley	1.51	Storage/Haul
Corona de Tucson	0.189	Dried
Green Valley	2.45	GBTs, Aerobic Dig., BFPs, Drying Beds
Marana	0.21	Storage/Haul
Mt. Lemmon	0.003	Storage/Haul
Fairgrounds	Minimal	Dried
Rillito Vista	0.02	Dried

(1) tpd=tons per day. Calculated using 2,800 dry pounds per day raw biosolids produced per mgd flow treated

Biosolids Disposal

Facility	Disposal
Arivaca Junction	Scraped and Hauled to Landfill
Avra Valley	Hauled to Roger Road
Corona de Tucson	Scraped and Hauled to Landfill
Green Valley	Mines
Marana	Hauled to Ina Road
Mt. Lemmon	Hauled to Ina Road
Fairgrounds	Scraped and Hauled to Landfill
Rillito Vista	Scraped and Hauled to Landfill

Current Activities

- Arivaca Junction
  - Lagoon closing once Canoa Ranch connection complete
- Avra Valley
  - 1-mgd BNROD Expansion construction underway

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Current Activities *(continued)*

- Corona de Tucson
  - Construction of 1-mgd BNROD nearly complete
- Mt. Lemmon
  - Service area expansion in discussion?

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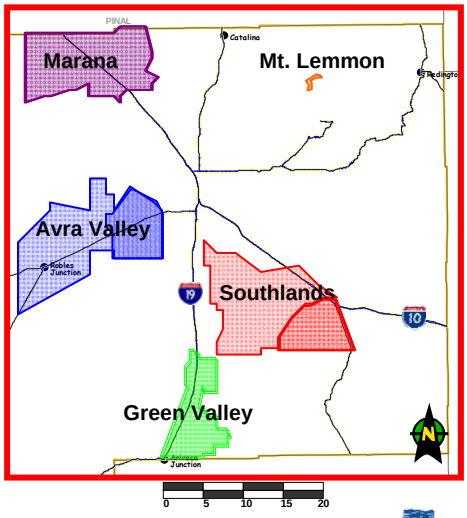
Recommended 2030 Systems Configuration

Jerry Bish

Service Areas (2030)



Influent Flow

Facility	2006 Flow (mgd)	2030 Flow (mgd)	% Increase
Arivaca Junction	0.059	0	-
Avra Valley	1.079	3.8	350
Corona de Tucson	0.135	2.7	2000
Green Valley	1.75	4.4	250
Marana	0.149	4.9	3300
Mt. Lemmon	0.0026	0.0026	-
Fairgrounds	Minimal	0	-
Rillito Vista	0.012	0	-
Southlands	0	13.7	-

37

Non-Metro Regional Operations

- Avra Valley
- Mt. Lemmon
- Northwest
- South
- Southeast

38

Avra Valley Region

- Expanded Avra Valley to match growth
- Expanded service area to match development

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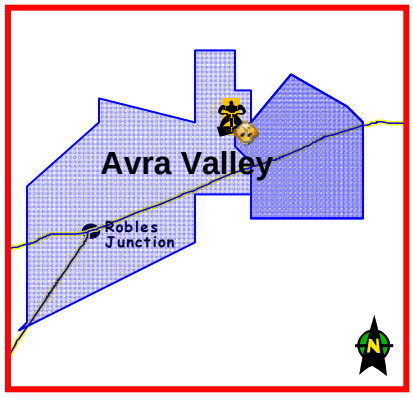
Avra Valley Region



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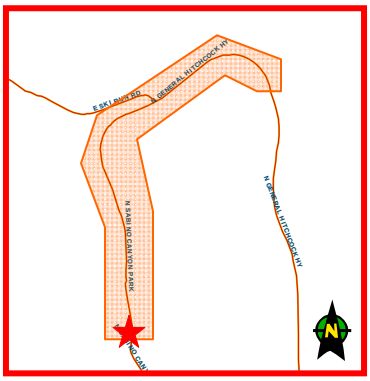
Mt. Lemmon Region

- Service area expansion discussions



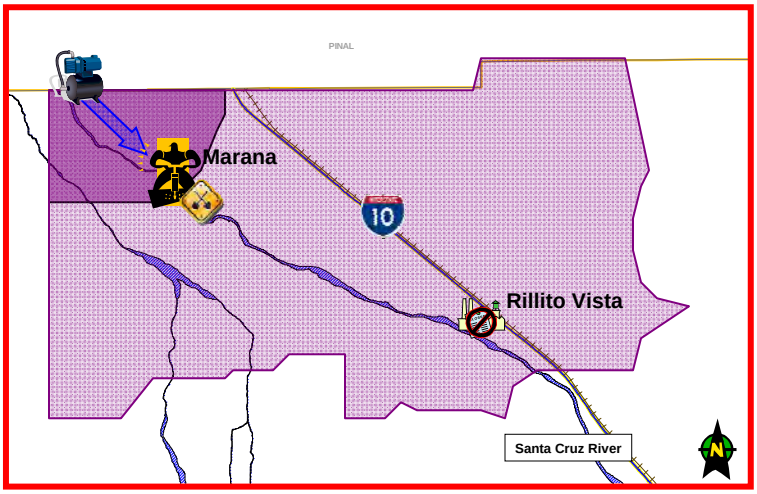
41

Northwest Region

- Expanded Marana to match growth
- Conveyed flow downstream of Continental Ranch Pump Station to Marana
- Pumped flow back from areas down-gradient
- Phased out Rillito Vista

42

Northwest Region



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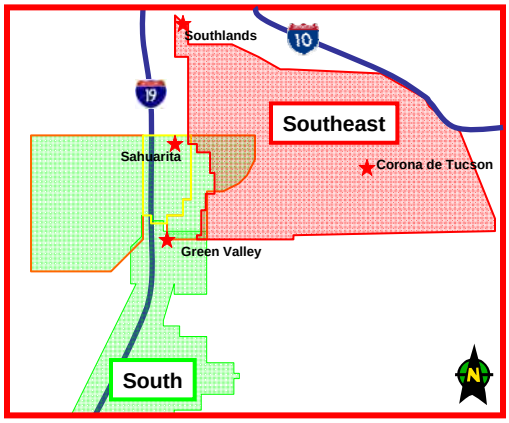
South/Southeast Regions



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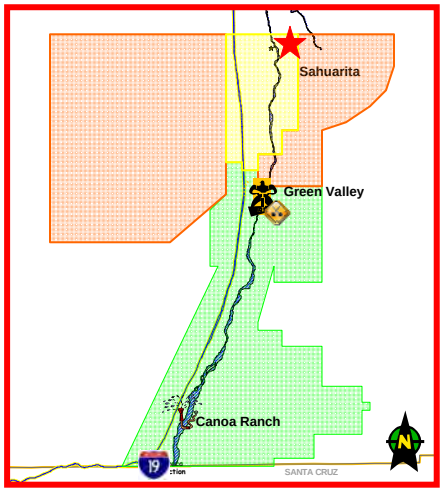
South Region



45

South Region – Green Valley

- Phased out Arivaca Junction
- Expanded Green Valley to match growth
- Water reclamation facility at Canoa Ranch?

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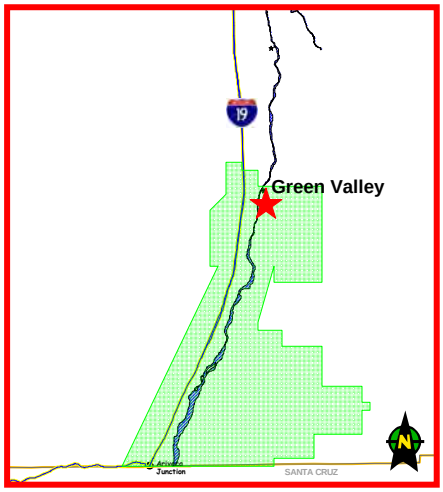
Green Valley Service Area



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South Region – Sahuarita

- Sahuarita continues as Designated Management Agency
- Absorbs Joint Planning Area?

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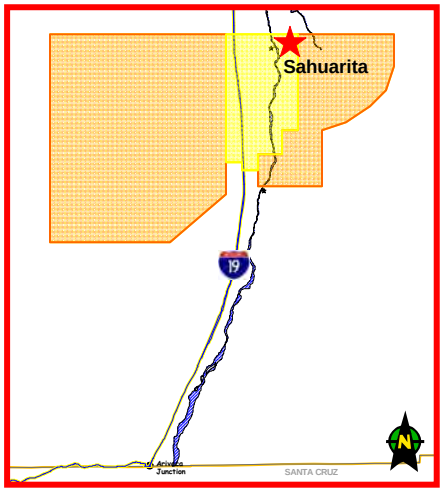
Sahuarita Service Area



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Southeast Region

- Phased out Fairgrounds and sent flow to SE Interceptor
- Expanded Corona de Tucson to match growth
- Constructed Southlands facility

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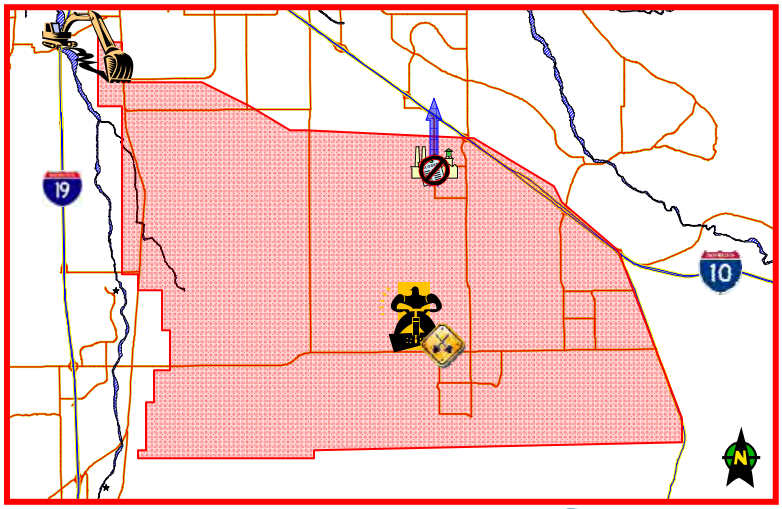
Southeast Region



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Current Wastewater Treatment

- Lagoons
- Package Plants [Extended Air]
- Oxidation Ditches

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Planning Activities

- Avra Valley [BNROD]
- Corona de Tucson [CLR]
- Marana [Biolac]

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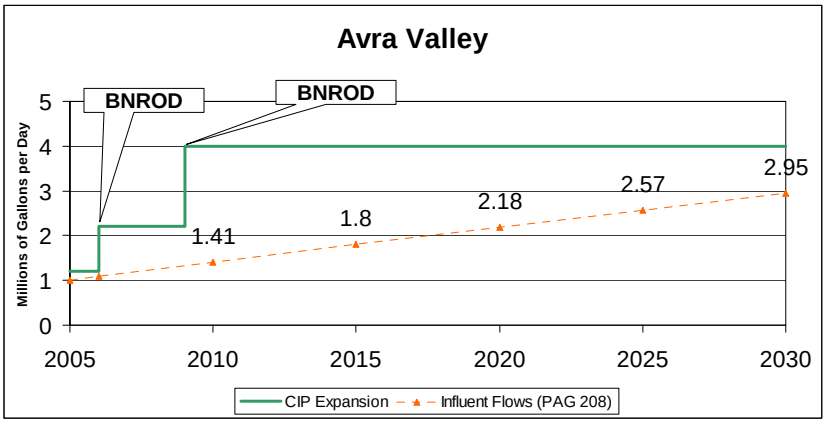
Avra Valley – Flow/Capacity



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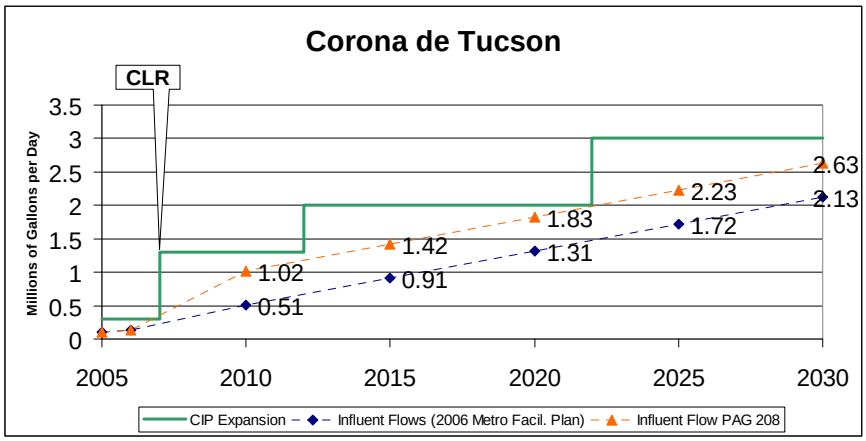
Corona de Tucson – Flow/Capacity



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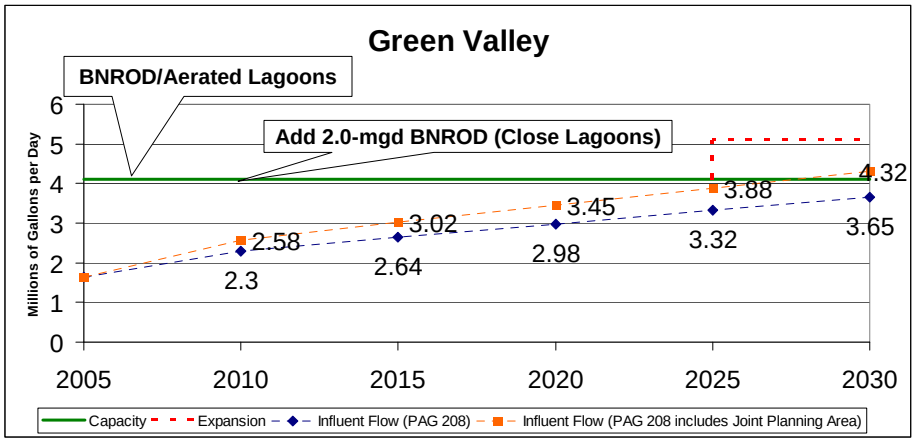
Green Valley - Flow/Capacity



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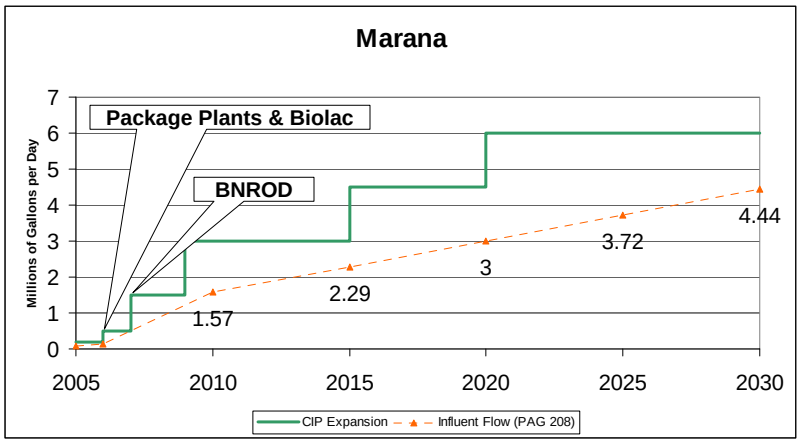
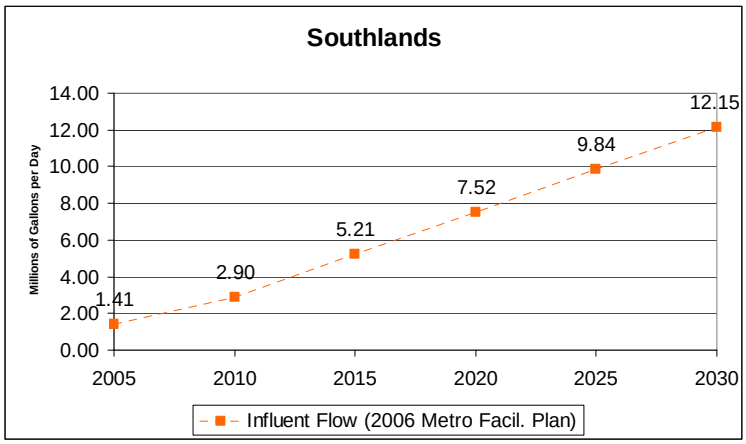
Marana – Flow/Capacity



Southlands – Flow/Capacity



Future Regulations (AZPDES)

- Total Nitrogen < 6 mg/L
- Total Phosphorus < 1 mg/L
- Pathogens
  - Non-detect 4 of 7 daily samples
  - Single sample maximum
    - Fecal coli – Not greater than 23cfu/100ml
    - E. coli – Not greater than 15cfu/100ml

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Alternatives Evaluated

- Current
  - BNROD
- Alternatives
  - 5-Stage Bardenpho
  - MBBR
  - SBR

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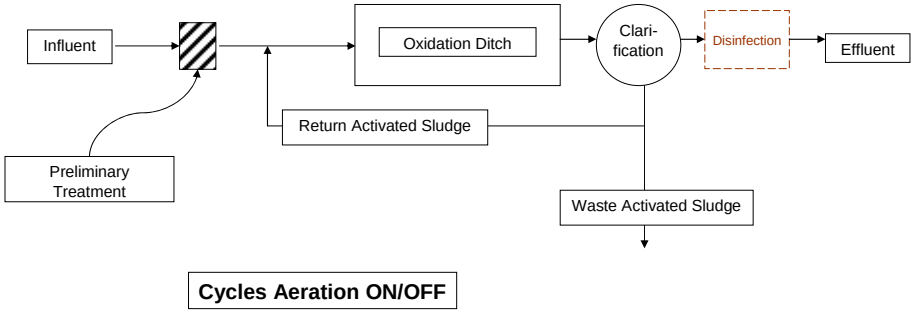
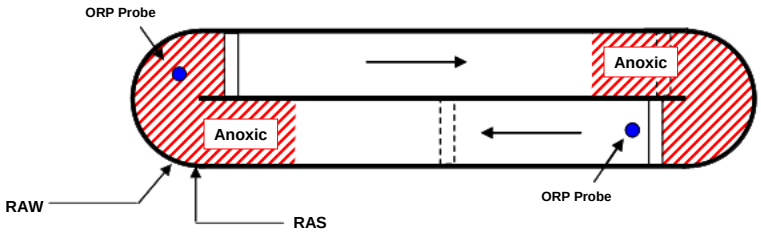
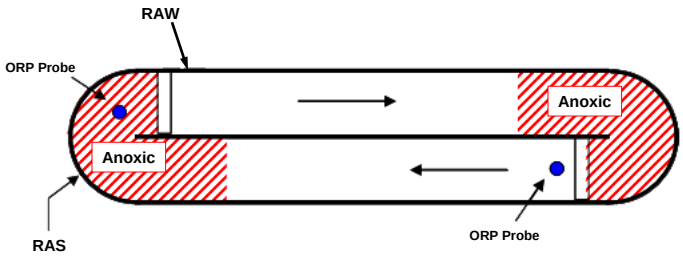
Oxidation Ditch Process



Enhanced N_2 Removal



High Strength/Low Flow



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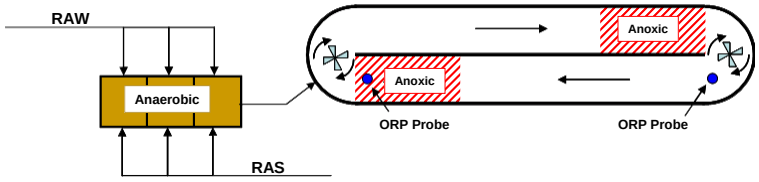
Phosphorus Removal



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Effluent Utilization

- Current Uses
- Reclaimed Water
  - Turf irrigation
- Water Reuse
  - Riparian Restoration
  - Reforestation
- Groundwater Recharge

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Biosolids Production

Facility	2006 Production (tpd)(1)	2030 Production (tpd)(1)
Arivaca Junction	0.08	*
Avra Valley	1.51	5.3
Corona de Tucson	0.189	3.8
Green Valley	2.45	8.5
Marana	0.21	6.2
Mt. Lemmon	0.003	0.003
Fairgrounds	Minimal	*
Rillito Vista	0.02	*
Southlands	*	19.2

(1) tpd=tons per day. Calculated using 2,800 dry pounds per day raw biosolids produced per mgd flow treated

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Biosolids Handling/Treatment

Facility	2030 Handling/Treatment
Arivaca Junction	*
Avra Valley	Thicken/Haul
Corona de Tucson	Thicken/Haul
Green Valley	Digestion
Marana	Digestion
Mt. Lemmon	Haul
Fairgrounds	*
Rillito Vista	*
Southlands	Digestion

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Biosolids Disposal

- Agriculture
- Mine Reclamation
- Landfill
- Dedicated Disposal Site

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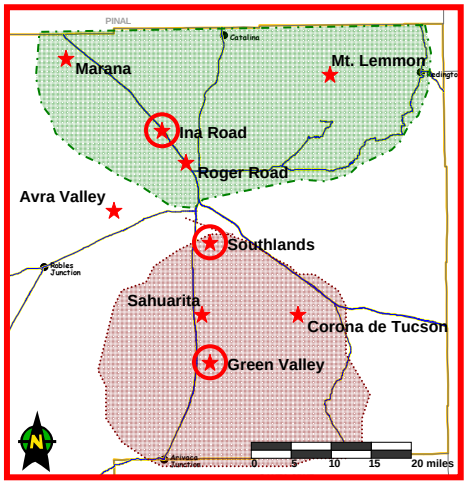
Regional Solids Processing



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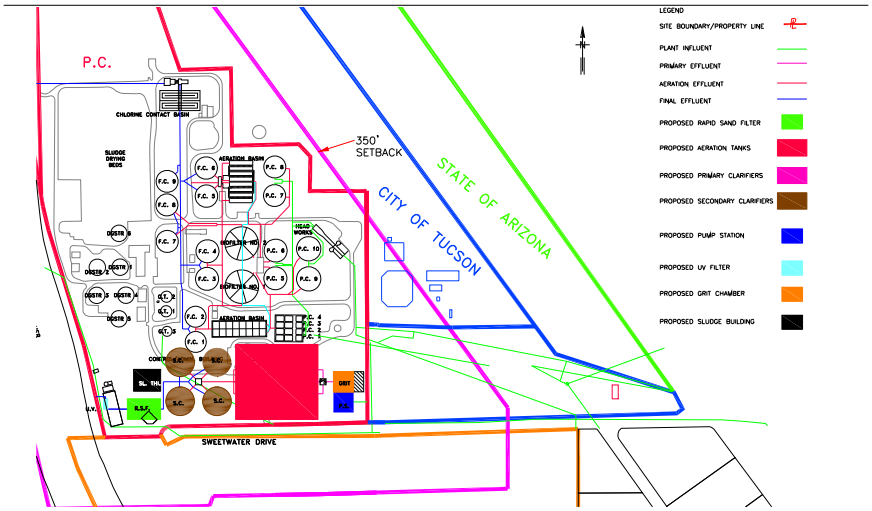
GREELEY AND HANSEN

GREELEY AND HANSEN

CIP Program

Jerry Bish / Harold Smith

Roger Road – 32-mgd "Greenfield"



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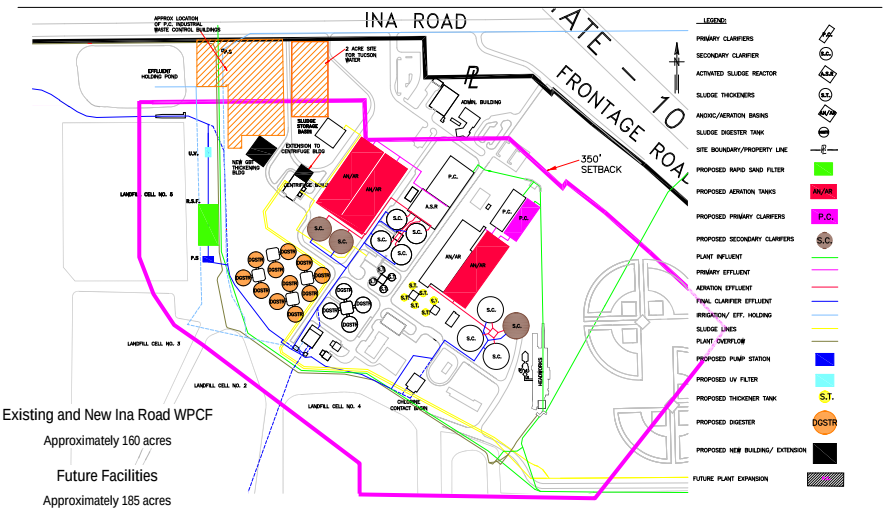
50-mgd Ina Road WPCF



Existing and New Ina Road WPCF

Approximately 160 acres

Future Facilities

Approximately 185 acres

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Project (2006) Costs

Description	Total Cost (2006) (x $1,000,000)
Roger Road	$234.8
Ina Road	$243.9
Plant Interconnect	$22.3
Total	$501.0
Misc. Electrical Service	$35.0

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Roger Road "Greenfield" 32-mgd – Project (2006)Construction Costs

Item	Description	Construction Cost (July 2006)
1	Demolition and Removal	$17,300,000
2	Influent Screenings	$3,000,000
3	Influent Grit	$2,000,000
4	Odor Control	$11,600,000
5	Primary Clarifiers	$15,400,000
6	Aeration Tanks	$57,400,000
7	Final Clarifiers	$20,200,000
8	PS to Filters/UV Disinfection	$1,800,000
9	Filters	$9,600,000
10	UV Disinfection	$11,700,000
11	Sludge Thickening & Dewatering Facilities	$2,200,000
12	Sludge Transfer Pump Station	$2,100,000
13	Sitework	$600,000
14	Paving	$700,000
15	Architectural	$13,900,000
16	Fence	$200,000
17	Irrigation / Landscaping	$500,000
	Subtotal	$170,200,000
	General Conditions, Overhead and Profit (18%)	$30,600,000
	Total	$200,800,000
	Contingency	$8,500,000
	Roger Road WWTP Construction Cost (July 2006)	$209,300,000

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Ina Road 50-mgd WPCF – Project (2006) Construction Costs

Item	Description	Construction Cost (July 2006)
1	New Influent Screenings Facility	$900,000
2	Odor Control	$13,300,000
3	Primary Clarifiers	$10,500,000
4	Aeration Tanks	$54,800,000
5	Final Clarifiers	$9,200,000
6	Pump Station to UV Disinfection	$3,000,000
7	Filters	$16,000,000
8	UV Disinfection	$23,900,000
9	Sludge Thickening & Dewatering Facilities	$10,200,000
10	Sludge Digestion Facilities	$21,900,000
11	Sitework	$400,000
12	Paving	$500,000
13	Architectural	$12,000,000
14	Irrigation / Landscaping	$200,000
	Subtotal	$176,800,000
	General Conditions, Overhead and Profit (18%)	$31,800,000
	Total	$208,600,000
	Contingency	$8,800,000
	Ina Road WPCF Construction Cost (July 2006)	$217,400,000

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Plant Interconnect – Project (2006) Construction Costs

Item	Description	Construction Cost (July 2006)
1	Interconnect Pipe	$17,400,000*
	General conditions, overhead and profit (18%)	$1,500,000*
	Total	$18,900,000*

*Does not include sludge pipe realignment nor property acquisition

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Miscellaneous Electrical Service Costs (2006)

Item	Cost
Roger Road	
Standby Power (4 megawatts)	
Construction	$6,000,000
Engineering	$1,000,000
Total	$7,000,000
Ina Road	
Power Generation Expansion/Upgrade (8 megawatts)	
Construction	$16,000,000
Engineering	$2,400,000
Total	$18,400,000
Miscellaneous Power	
Unify Power/Secondary Utility Feed Source – Ina Road	$9,600,000
Total	$35,000,000

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Engineering / Administrative Services

Engineering Services	Cost
Design	
Roger Road	$13,600,000
Ina Road	$14,200,000
Plant Interconnect	$1,800,000
Total	$29,600,000
Services During Construction (includes Resident Inspection)	
Roger Road	$11.900,000
Ina Road	$12,300,000
Plant Interconnect	$1,600,000
Total	$25,800,000

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Other Engineering / Administrative Services

- PCWMD administration
- Program management
- Construction management
- Real property
- Cultural resource
- Permits (under design/PCWMD admin)

Project Schedule and Costs

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Interconnect	**$22,300,000**															
Design		$1,338,000														
Construct				$20,962,000												
Ina Rd	**$243,900,000**															
Design 50 mgd		$14,634,000														
Construct 50 mgd						$212,193,000										
Construct Thermophilic Digestion														$17,073,000		
Roger Rd	**$234,800,000**															
Design 32 mgd			$12,660,000													
Construct 24 mgd							$148,755,000									
Demo Existing Plant									$23,800,000							
Construct 8 mgd											$49,585,000					

Total ROMP Projects Cost $501,000,000

Facilities After 2015

- 8 mgd at Roger Road WWTP
- Demolition/existing Roger Road Facility
- 2 GBT at Roger Road WTTP
- Mesophilic digester at Ina Road WPCF
- Centrifuge dewatering at Ina Road
- Thermophilic digesters at Ina Road

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Plant Interconnect Possible Construction Packages

- Plant interconnect (1 or 2 projects)

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Roger Road WWTP Possible Construction Packages

- Site preparation (temporary administration building)
- Headworks
- Bardenpho treatment (including clarifiers, solids thickening/pumping)
- Pump station/filtration
- UV disinfection

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Roger Road WWTP Possible Construction Packages *(continued)*

- Administration/control building
- Standby power generation
- Future 8-mgd Bardenpho system (including clarifier)
- Future gravity belt thickeners
- Existing Roger Road Facility demolition

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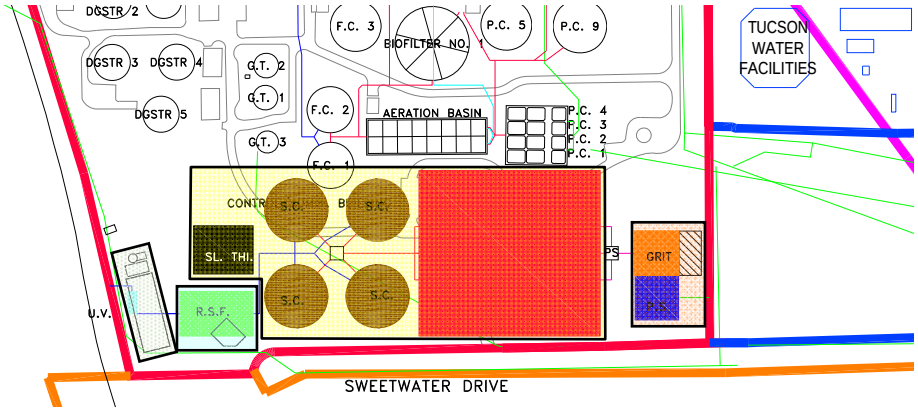
Roger Road – Construction Packages



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Ina Road WPCF Possible Construction Packages

- Site preparation
- Primary clarifier
- Bardenpho treatment (including clarifiers)
- Demolish HPO and oxygen system
- Mesophilic digestion (4 new, 4 existing)
- Gravity thickening (primary sludge)
- Gravity belt thickening (WAS sludge)
- Centrifuge dewatering
- Sludge storage

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Ina Road WPCF Possible Construction Packages *(continued)*

- Pump station/filtration
- UV disinfection
- Centralized laboratory
- Power unification/biogas power generation
- Future mesophilic digester
- Future centrifuge thickener
- Future thermophilic digesters

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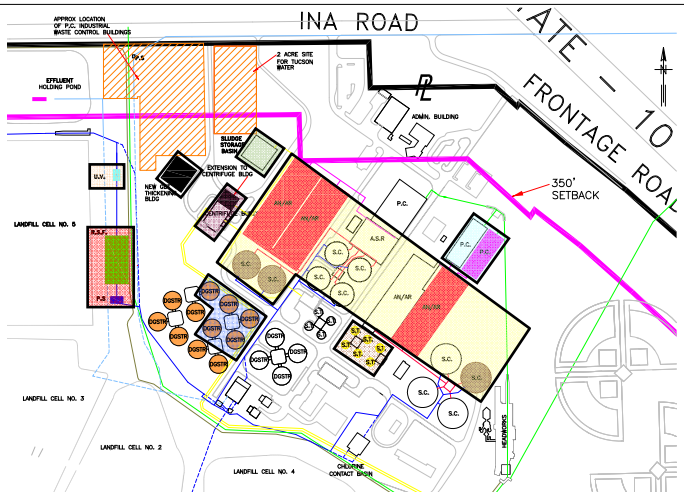
Ina Road Construction Packages



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CIP

Ed Curley

Non-Metro Facilities CIP – Next Five Years

Facility	FY	Activity
Avra Valley	2008/09	4.0 MGD Expansion
Corona de Tucson	2011/12	1.0 MGD Expansion
Green Valley	2009/10	2.0 MGD Expansion
Marana	2009/10	1.5 MGD Expansion
Mt. Lemmon	2009/10	Treatment/Conveyance Enhancements
Fairgrounds		Connection to SE Interceptor

CIP Number			Budget FY 06-07 Total	Projected FY 06-07 Total	FY 07-08 Total	FY 08-09 Total	FY 09-10 Total	FY 10-11 Total	FY 11-12 Total	Includes Total SDF
	1997 Bonds									
WL-91-001	Ina Rd WPCF Proc Chg & Exp to 37.5 mgd		$1,012,603	$612,603	$400,000					
WL-97-4L3	Tanque Verde Int., Cruycroft-Tucson Country Club		$187,762	$187,762	$250,000	$3,219,487				
WL-87-427	Arivaca Junction WWTF Sewer Extension			$0	$471,000	$2,071,000				
	2004 Bonds									
WL-04-003	Santa Cruz Interceptor, Prince-Franklin (Phase II & III)		$2,537,713	$4,572,745	$22,469,787	$12,113,935				$14,477,863
WL-04-010	New Marana WWTF Expansion BNROD		$4,250,000	$7,303,860	$10,300,000	$9,752,859				$18,332,105
WL-04-011	Avra Valley BNROD Expansion to 4 MGD		$3,174,042	$4,974,664	$30,324,000	$9,711,000				$20,089,813
WL-04-005	Tanque Verde Int., Cruycroft-Tucson Country Club					$2,682,762	$2,905,738			
WL-04-009	Marana Regional Airport Sewer Connection		$290,000	$280,000	$2,520,000					
WL-04-012	Mt. Lemmon Sewer System		$250,000	$250,000	$250,000	$500,000	$3,000,000	$3,192,082		
	Conveyance Rehabilitation		$4,538,275	$4,679,031	$3,000,000	$2,000,000	$2,048,394			
	Roger Road Rehabilitation - Includes JOC		$7,751,027	$10,163,791	$5,419,364	$3,947,699				
	2004 Bonds ROMP									
WL-03-IE 4	SCR Basin Ina/Roger Rd N4N Imp Study ROMP (Not in 5501 M)		$1,399,896	$1,349,996	$400,000					
WL-04-007	Ina Road N4N - Design Plants				$9,427,417	$1,290,822				
WL-04-007	Roger Road N4N - Design Plants				$3,434,355	$645,411				
WL-04-004	Plant Interconnect - Roger Rd. WWTF to Ina Rd WPCF		$345,000	$362,250	$1,102,500	$9,729,838	$11,179,011			
	2008 Bonds									
	Park & Hub	($35 Million)					$5,000,000	$15,000,000	$15,000,000	
	Conveyance	($25 Million)				$4,000,000	$4,000,000	$4,000,000	$4,000,000	
	Treatment Capacity Includes: Green Valley-Marana	($50 Million)				$2,000,000	$15,500,000	$15,500,000	$17,000,000	
	Ina Electrical	($35 Million)					$5,000,000	$15,000,000	$15,000,000	
	Ina/Roger NGN	($110 Million)				-	-	-	-	
	Biosolids Improvement	($40 Million)				-	-	-	-	
	Ina Lab	($20 Million)				-	-	-	-	
	Odor Control	($40 Million)				-	-	-	-	
	ROMP Subtotal					$34,851,642	$51,026,625	$84,908,129	$128,777,467	
	ROMP Total with 2004 Bonds (Inflated $30%) Through FY11/12			$362,250	$13,964,272	$48,517,113	$62,205,636	$84,908,129	$128,777,467	
	System Development Fund									
	Treatment		$7,915,473	$10,190,055	$3,202,279	$865,000				
	Conveyance		$409,034	$270,155	$1,793,526	$564,113	$2,330,300			
	Stream Crossings - Flood Protection		$1,305,982	$982,034	$1,756,744	$4,409,193				
	Pump Stations		$270,856	$295,856	$1,594,000	$1,100,000	$1,100,000	$1,100,000	$1,100,000	
	ADOT, PCDOT, COT DOT			$165,000	$4,591,356	$250,000	$250,000	$3,250,000	$5,250,000	
WL-06-IL1	Marana Colonia Project Sewer Redev. Homes Hgrs. (Reimbursable)		$881,592	$881,592						
WL-03-IL1	New Federal Prison Sewer System (Reimbursable)		$5,387,122	$5,387,122	$2,000,000					
	Total Projects in CIP		$41,906,477	$52,888,516	$104,706,328	$105,504,161	$103,340,068	$141,950,211	$186,127,467	

								Total
1997 & 2004 BONDS	$33,936,337	$66,482,202	$20,321,333	$16,021,050	$1,908,560		$0	$139,669,482
2008 BONDS	$0	$0	$6,000,000	$80,526,625	$134,408,129	$179,777,467		$400,712,221
Reimbursable	$6,268,714	$2,000,000	$0	$0	$0	$0	$0	$8,268,714
SDF	$12,683,465	$36,224,126	$79,182,828	$6,792,393	$5,633,522	$6,350,000		$146,866,334
TOTAL	$52,888,516	$104,706,328	$105,504,161	$103,340,068	$141,950,211	$186,127,467		$694,510,751

GREELEY AND HANSEN

Project Delivery Alternatives and Selection Criteria

Eric Petersen

Overview

- 3 major projects: Roger Road, Ina Road, plant interconnect
- Other CIP projects
- Review of alternative project delivery method options
- Criteria for delivery method selection

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Alternative Project Delivery Methods

- Primary
  - Design-Build
  - Design-Build-Operate
  - Construction-Manager-at-Risk
- Others
  - Design-Bid-Build
  - Job-Order-Contracting

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Design-Build (1): Description

- Single entry contracts for both design and construction
- Fixed design-build price
- Competitive proposal process
- Multiple evaluation factors
- Design requirements
- Performance standards
- Acceptance test
- Proven in Arizona and nationally

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Design-Build (2): Advantages

- One point of responsibility
- Substantial risk transfer
- Prequalification of contractor
- Willingness of proposers to invest
- Competition on factors other than price
- Collaboration on design and construction
- Early stage, lower cost price certainty
- Schedule compression
- Minimization of change orders

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Design-Build (3): Disadvantages

- Less control over design details
- Less familiarity
- Lack of long-term vested interest by DB contractor
- Possibility of smaller number of competitors
- More complex selection
- More involved negotiations

97

Design-Build-Operate (1): Description

- Single entity contracts for design, construction and operation
- Design requirements and acceptance test
- Long term operation and maintenance
- Long term repair and replacement
- Fixed operation and maintenance fee
- Performance guarantees
- Law compliance
- Workforce protection practices

98

Design-Build-Operate (2): Advantages

- Design-build advantages apply
- Operator-driven design
- Long term performance risk transfer
- Long term operating cost risk transfer
- Strong companies
- Control by contract

99

Design-Build-Operate (3): Disadvantages

- Design-build disadvantages apply
- Workforce not under direct county management
- Limited market
- Clear definition of service and workscope required

100

Risk Transfer (1): Any Method

- Risks retained under any delivery method
  - Changes in law
  - Force majeure
  - Unusual influent parameters
  - Pre-existing site and environmental conditions
  - Buried infrastructure conditions
  - General price inflation

101

Risk Transfer (2): DB/DBO

- Permitting risks
  - Terms and conditions
  - Delays
  - Non-issuance
  - Permitting cost overruns
  - Limitations

102

Risk Transfer (3): DB/DBO

- Design risks
- Design liability
- Design cost overruns
- Technological obsolescence
- Securing patents and licenses

103

Risk Transfer (4): DB/DBO

- Construction risks
- Completion risk (delay and efficacy)
- Construction cost overruns
- Disputes between designer and builder
- Labor relations

104

Risk Transfer (5): DBO Only

- Operation and maintenance risks
- O&M cost overruns
- Regulatory compliance
- Capital maintenance
- Excess electricity consumption
- Market conditions affecting sludge disposal
- Labor relations

105

Construction Manager At Risk (1): Description

- Separate Contracts for design and construction
- Select both on qualifications basis
- Specialized CM firms or general contractors
- Price not involved unless GMP offered later
- CM prepares bid packages and supervises construction performance
- Contractors contract with County when CM is agent

106

Construction Manager At Risk (2): Advantages

- Professional selection of construction interface
- Guaranteed maximum price possible
- Design phase assistance
- Delivery schedule
- Complete control of design

107

Construction Manager At Risk (3): Disadvantages

- Multiple Points of Responsibility
- Retention of Design Liability
- No Design Competition
- No Constructability Competition
- Limited Life Cycle Cost Considerations
- Degree of Design Conservatism

108

Process in Arizona – RFQ

- Selection committee
- Request for qualifications (RFQ)
- Create short-list based on criteria published in RFQ
- Short-list may contain only 3 firms
- Negotiate with the most qualified firm on the RFQ short-list

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Process in Arizona – RFQ

- RFP is distributed to every firm on the RFQ short-list
- RFP contains scoring method
- Submittals contain separate technical and price proposals (option of preliminary and final)
- Award based on highest score
- Honorarium

110

Criteria for Selection of Project Delivery Method

- Considerations
  - Procurement process
  - Design and construction
  - Operation and maintenance

111

Procurement Process Considerations

- County familiarity and experience with the project delivery method
- Transactional and engineering costs for conducting the procurement process
- Stage at which actual project costs are known
- Schedule: Time to commencement of construction
- Depth and quality of contractor market
- Selection process complexity
- Likelihood of re-design and re-bid

112

Design and Construction Considerations (1)

- Possibility of selections based on performance and qualifications
- Risk of disputes between owner-governmental agency, designer and builder
- Schedule: Time to completion of construction
- Degree of Owner-governmental agency design control
- Degree of design and construction competition and innovation

113

Design and Construction Considerations (2)

- Transfer of design, construction and acceptance liability
- Degree of design conservatism
- Suitability for "Greenfield" projects
- Suitability for modifying and expanding existing treatment facilities
- Suitability for pipeline and transmission facilities
- Guaranteed permit compliance

114

Design and Construction Considerations (3)

- Total contract price for design and construction
- Construction monitoring costs
- Likelihood of bid/proposal protests
- Likelihood of change orders

115

Operation and Maintenance Considerations

- Direct versus contract control over project operations
- Guaranteed operational performance
- Guaranteed regulatory compliance
- Overall 20-year life cycle costs of the project
- Guaranteed operating and maintenance costs
- Operational integration with entire wastewater system

116

Alternative Project Delivery in Practice

- Industry trends
- Contractor market
- Representative projects

117

Alternative Project Delivery Industry Trendlines

- Extensive use in private sector
- Cooperation among participants permissible and desirable
- Life-cycle cost perspective
- Design build industry growth
- Long term contracts
- Substantial risk transfer
- Company consolidation
- Full labor protection

118

Contractor Market

- Deep and international
- Investment grade credit companies
- Intense competition benefits municipalities
- Single, strong guarantor guarantees entire contract
- Surety role
- Worldwide research and development
- Operate dozens of plants
- Active commitment to market
- Excellent performance record

119

Representative Projects

- Phoenix (AZ)
- Lawrence (MA)
- Fulton County (GA)
- Cranston (RI)
- Seattle (WA)
- Lynn (MA)
- Washington Borough (NJ)
- Springfield (MA)
- MWRA (MA)
- Naugatuck (CT)

120

Phoenix (AZ)

- Lake Pleasant Water Treatment Plant – "Greenfield"
- 80 mgd, expandable to 320 mgd
- DBO chosen after alternative delivery methods study
- Sixth plant; current system remains publicly managed
- 15-year contract with renewal options
- RFQ (3 firms only), RFP process under new law
- Construction permit risk shifted to company

121

Lawrence (MA)

- New, replacement 15-mgd Water Treatment Plant
- Mandated by consent decree
- RFEI, RFP process under special legislation
- Pilot testing after contract execution
- Fiscal constraints mandate no rate rise
- Highly automated plant reduces O&M costs
- Meter replacement program increases revenues

122

Fulton County (GA)

- 23-mgd Camp Creek Wastewater Treatment Plant
- Expansion and treatment upgrade
- Renewal permit driven
- Vendor option to build new plant or make old plant improvement
- Modest labor protection
- Sludge included - landfill/land application
- First project under new omnibus
- DBO law

123

Cranston (RI)

- 25-year 23-mgd wastewater operations
- Maintenance, repair, replacement
- Ten capital improvements DBO
- Tertiary treatment DBO – consent decree
- Industrial pretreatment program
- Collection system responsibility
- $48 million concession fee
- Private financing of improvements

124

Seattle (WA)

- New 120-mgd Tolt River Water Plant
- Design-build-operate
- Maintain-repair-replace
- Cascade mountain reservoir source
- 88 water quality parameters guaranteed
- Current law plus enhanced standards
- Letter of credit secured company credit decline
- Success inspired Cedar River
- DBO project

125

Lynn (MA)

- CSO judicial consent decree from 1990
- "Storage, pump-back" mandated
- DEP, EPA active assistance
- First in nation "DBO" for a "CSO"
- All technical approaches allowed
- Vendors proposed total sewer separation
- New sewers, not new storm drains
- Subsurface risk constrained
- Spread out construction avoided
- "Rate spike"

126

Washington Borough (NJ)

- Small size (1 mgd)
- Greenfield wastewater project
- Traditional DBB bids vs. new DBO proposals
- DBO proposal won
- Major companies participated

127

Springfield (MA)

- Large (64 mgd) existing wastewater plant
- Newly formed W&S commission
- Company took as-is risk, capital risk
- Company performs existing sludge compost contract
- Company takes sludge product marketing risk
- Odor event fines and termination
- Vigorous management plan response
- To competition

128

MWRA (MA)

- Norembega covered water storage tank
- Design-build with 5 year warranty
- Municipal financing, operation, maintenance, repair
- Strict, detailed design requirements
- Construction contractor – driven proposal, guaranty
- 70% price, 30% technical selection
- Extended warranty

129

Naugatuck (CT)

- 10-mgd existing regional wastewater plant
- Uniroyal Corp. – current operator, 50% influent
- Sludge is incinerated; excess capacity
- "Zero" user fee rate, historically
- Mandatory improvements - tertiary treatment, incinerator upgrades
- 20 year O/M/R/R contract
- "Merchant plant" allows
- Continuation of no/low rates

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Cost Savings (DBO vs. DBB "Baseline")

City	Type	Savings
Fulton County, GA	WW	$30M
Lynn, MA	WW	$150M
Cranston, RI	WW	$50M
Seattle, WA	W	$75M
Phoenix, AZ	W	$25M

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Next Steps

- Confirm of selection criteria
- Apply criteria to projects
- Determine delivery method for each project
- Relate to sequencing and financing
- Reflect analysis and determination in final report

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GREELEY AND HANSEN

Summary

Andy Richardson

Workshop #14 Meeting Notes
First Draft of Report Study Workshop

1. The First Draft of Report Study Workshop for Pima County Regional Optimization Master Plan was held on February 21, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
Jeff Nichols
PCWMD Staff
Dave Bartos
Ed Curley
Laura Fairbanks (afternoon)
Frank Gall
Dave Garret
Mary Hamilton
Michael Kostrzewski
Mike Lueken
Byron McMillan
John Munden
Ron Riska, Project Manager
John Sherlock
Jack Van Riper
John Warner
Ken Weber
Legal
Chuck Wesselhoff

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Tim Thomure

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Gordon Culp
Joe Popeck
Andy Richardson
Vic Smith

2. Major topics of the workshop were:

- Workshop #14: First Draft of Report Study
  - Review of Chapters – 1 through 13
  - Green Power
  - Outlying Area wastewater treatment process
  - Biosolids handling/disposal
  - Enhanced chlorination

A set of handouts were provided to each attendee at the workshop. Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be utilized by the project team while conducting the study. The flip chart notes are included at the end of the meeting notes.

3. Mike Gritzuk welcomed the attendees to the workshop and invited the workshop to begin.

4. Andy Richardson quickly outlined the meeting topics and objectives. He further elaborated on his role as facilitator and encouraged all to participate. The workshop objectives were to preview the rough draft of the report, identify unsettled issues and get to closure where possible. Yet to come are the financing plan, delivery method and implementation plan. Attendees were reminded to send their comments to Ron Riska who will compile them and forward them to Greeley and Hansen. For unsettled issues the plan is to have several small group meetings in the next few weeks on topics, such as, outlying facilities wastewater treatment processes, biosolids handling/disposal, disinfection and delivery methods. It will be decided later who will be involved in each of these meetings and when they will be held.

   Overview, agenda, meeting objectives, and ground rules were covered on pages 1 through 4 of the handout.

5. Jerry Bish reviewed the purpose and summarized the content of Chapter 1. It was noted that information relating to the outlying facilities, conveyance system evaluation and CIP development were incomplete. Paul Bennett indicated that the financial study needed to be referenced in Chapter 1. Further the financial plan needs to be added to Chapter 12 and that chapter title re-titled to reference the financial plan. Melodee Loyer stated that there is a reference in Chapter 1 that the water reuse facilities at Roger Road will be decommissioned. That needs to be changed to only the filters will be decommissioned. Mike Gritzuk stated that the use of "Greenfield" is a confusing term. The term to use in the report for the new Roger Road plant will be the "Water Reclamation Facility." Jackson Jenkins suggested that a list of acronyms and definitions would be very useful to the reader. Further, it was agreed to use "outlying", not "non-metro" facilities for the satellite plants. Ed Curley stated that a better description of why the County was doing this evaluation (e.g., to meet nutrient removal goals) is needed. The strategic goals, such as, meeting ammonia toxicity requirements, odor/noise control, aesthetics and good neighbor should be listed in the chapter.

   Review of Chapter 1 was covered on pages 5 and 6 of the handout.

6. Chapter 2 on regulatory requirements was summarized by Jerry Bish. Byron McMillan wanted to make sure the plants meet the 350-foot setback requirements. This is especially important at Ina Road WPCF for odor and noise considerations. Further state in the report that the new parts of Ina Road WPCF will have odor and noise control. The response is that the Ina Road WPCF will be described with odor and noise control features and will be shown with a 350-foot setback. Melodee Loyer asked why the use of CAP water by Tucson Water affects County treatment permits at Roger Road as stated on page 2.8 of the report. Ron Riska offered that the plant effluent may be considered as an augmentation to CAP water at some distance future. Would it not also affect Ina Road WPCF effluent? Report calls it a key issue but is it? The question is how much detail should be presented on this topic is an issue, and will be reviewed after the workshop. Mary Hamilton asked if the strategies to be developed will be identified in this chapter. Ed Curley indicated that the strategies to be developed should be listed in one place and not scattered in different places. Melodee Loyer pointed out that section 2.9 calls for 11 mgd for reuse (in 2006); the text needs to clarify the timing.

   Review of Chapter 2 was covered on pages 6 and 7 of the handout

7. Chapter 3 was summarized by Joe Popeck. Jackson Jenkins stated that permanent electrical upgrades for Roger Road were estimated to be at more than $10 million. With the decision to build a new Roger Road plant, interim electrical improvements will be implemented which will cost $4 million. The report should say that $6 million has been saved. Byron McMillan asked what will be the new power supply at the Roger Road Water Reclamation Facility. The response was that two new utility feeds will be provided, one for redundancy. Jack Van Riper asked what if power from both feeds is lost. For this on-site generators are provided as backup to critical process elements. Mike Gritzuk indicated that several issues related to digester gas need to be addressed. This will be discussed later under the topic of green power.

   Ron Riska was apprehensive about the information in the report on the condition of the existing Roger Road plant. John Sherlock offered that the condition has to be mentioned, because it is part of the rationale for justifying a new Water Reclamation Facility at Roger Road. Jack Van Riper stated that the general condition of Roger Road WWTP is good but it is not compatible with upgrading to the technology needed to meet new treatment standards. Mike Gritzuk indicated that it needs to be clear why we are going to a new Water Reclamation Facility, which relates to risks and compliance. It is important to note that Pima County is not cutting back on maintenance at Roger Road WWTP pending the new plant. PCWMD is doing whatever is necessary to keep the Roger Road WWTP in compliance. Jackson Jenkins expressed a concern about the condition of the electrical equipment at Ina Road WPCF. Further, along with the electrical equipment condition issue there needs to be a decision on the use of biogas and future use of existing generation facilities.

   The Chapter 3 review was covered on pages 7 through 10 of the handout

8. Joe Popeck covered the salient features of the overall treatment strategy as written in Chapter 4. Melodee Loyer observed that under Transfer Some description the text implies that all the water needed at Roger Road for reuse will be generated at the Roger Road facility. This is not the case and will need clarification. Further, the 30 mgd/20 mgd split of effluent for reuse at Roger Road and Ina Road, respectively, occurs in year 2030. Jackson Jenkins noted that 3 mgd of the reuse water comes from Randolph Park WRF. Further, Jackson Jenkins noted that facilities do not exist to transfer reclaimed water from Ina Road to Roger Road. Melodee Loyer reminded the group that 10 mgd can be transferred through an existing Tucson Water reuse pipeline when the facilities are available at Ina Road

   Mike Gritzuk observed that for risk related costs to rehabilitate the existing Roger Road the County has been using numbers lower than the $50 to $80 million shown. These values need to be checked. Dave Garrett asked if the 8-inch sludge line from Roger Road to Ina Road will be kept. The response was yes it is part of the sludge handling strategy between plants. John Munden asked what peak flow is the Roger Road Water Reclamation Facility sized for? The answer is 64 mgd, or 2 times average flow. John Munden confirmed that the plant interconnect would be a gravity line and asked how will the solids keep from settling at low flow? This will be discussed later under the chapter on conveyance. John Munden asked how the headworks at Roger Road were sized. The plan is to provide headworks at Roger Road to treat the flows to the Water Reclamation Facility at Roger Road.

Melodee noted that the area shown at Ina Road for Tucson Water facilities was inadequate. Tucson Water is looking for 10 acres. Mike Gritzuk indicated that 10 acres was for reuse water treatment facilities, but since Ina Road will produce Class A+ water that that much land should not be needed. Melodee Loyer indicated they need room for a reservoir and pumping station. The final acreage for Tucson Water will need to be resolved outside the workshop. Tucson Water will need to prepare some layouts of their facilities. Melodee Loyer indicated that Tucson Water will be getting A+ water before they can show a layout.

Paul Bennett noted that a needed warehouse at Ina Road WPCF was not shown. The warehouse will be added to an enhanced site plan layout for the site along with the additional overflow basin. Dave Garrett also indicated a need for the odor control and solids removal at the overflow basins.

Frank Gall asked if the headworks at Ina Road were sized for a peaking factor of 2. The response was yes, but Dave Garret indicated that the current screenings compactors were not sized to deal with the peak flow, but should be.

Frank Gall asked how were the side streams handled at Ina Road WWTP? The response was that the side streams were being returned ahead of primary settling. Mass balances were used in sizing the process units to account for side streams. It was suggested to change “most reliable” to “most viable” when describing Bardenpho. It was stated that the existing 12.5 mgd BNRAS plant will be modified to the Bardenpho process.

Frank Gall asked how were the turbidity units of less than 2 NTUs going to be accomplished. Response was by using rapid sand filters. The exact type of filters is not established, it may be deep bed, could be continuous backwash. A related issue is whether the non-detect fecal coliform standards can be met without filtration. Byron McMillan suggested removing the turbidity goal of 2 NTUs from effluent standard until the disinfection process is resolved.

When flow is at 80% of capacity, ADEQ requires the County to have a plan to expand the plant. The County will need to monitor flows relative to 80% of capacity so an appropriate plan can be developed and submitted to ADEQ. This needs to be stated in Chapter 2. The report shows how the plants can be expanded beyond the total of 82 mgd. It was further noted that under the first phase with Roger Road at 24 mgd and Ina Road at 50 mgd that the County will already be beyond the 80% of capacity.

Ron Riska stated that the general basis of design for the Roger Road Water Reclamation Facility, the 50 mgd Ina Road WPCF and the plant interconnect line be included in an Appendix to the master plan report.

Review of Chapter 4 – Overall Treatment Strategy was covered on pages 10 through 20 of the handout

9. Biosolids handling and treatment are covered in Chapter 5 and was summarized by Jerry Bish. David Bartos noted that at Ina Road that waste activated sludge goes to dissolved air flotation units and the figure showing this needs to be corrected. Currently, there is a problem with detention time in the digesters at Roger Road when one of the four digesters is out of service. It was suggested that a fifth digester be provided as backup. Also, there is a need to consider a

backup at Ina Road when a digester is out of service. John Sherlock cautioned that the need for another digester at Ina Road needs to be considered soon. The master plan is a plan for the future and it would be wise to get ahead of the biosolids system needs. For digestion the plant permit has both volatile solids destruction and detention time requirements.

Frank Gall asked at what outlying facilities plant size does hauling of sludge stop and processing onsite begin? This topic will be discussed later in the workshop. Paul Bennett wants a recommendation to stop hauling biosolids based on economics.

Ed Curley suggested that Section 5.8.2 in the report lacks an understanding of the national scene. For example, California is abandoning land application. A need is to look at farm land being used, the existing contract and other farm land available in the future. If all of these aspects are covered, more critical to address Class A than document leads you to believe. Jackson Jenkins offered that Class A processes will make more gas and green credits, which may drive the County to Class A sooner. John Sherlock added that backup plans are needed in case 503 regulations (EPA biosolids requirements) change suddenly or farm sites become unavailable. Need footprint and plan that will accommodate a backup. John Sherlock wants a clear relationship between power production and sludge processing. It was offered that a discussion on struvite control will be added to the report.

Review of Chapter 5 was covered on pages 20 through 25 of the handout

10. Chapter 6 on conveyance was summarized by Jerry Bish. Mike Bunch stated that the County got a CMOM permit for the collection system in November. This will be included in Chapter 2 and referenced in Chapter 6. Mike Bunch also offered that based on a recent meeting on the N. Rillito Interceptor (NRI) reviewing capacity during wet weather, the plant interconnect line needs to be constructed as soon as possible. Conveyance is looking at operating modifications to maximize flow through the NRI along with some capital project fixes to improve capacity. Because of the NRI situation Mike Gritzuk asked if the County is in violation of CMOM. Mike Bunch stated no, because CMOM allows 10 years to fix known problem areas. Ron Riska volunteered that conveyance was also developing a best management practices for the NRI.

Ron Riska indicated that a recent hydrology based conveyance system modeling study needs to mentioned in Chapter 6. Ed Curley indicated that in section 6.5.3.1 that the interstate I-10 and 18th Street area should mention since the bond and remediation plan is in place. There is a $35 million bond issue for remediation. Byron McMillan suggested adding odor control to the CMOM issues. In the slide for standardized rule the year was shown as 2008. John Warner indicated that the rule became law on Nov 14, 2005.

In response to an earlier question on scour velocity at flows of 4 to 5 mgd, plant interconnect flow velocities will be greater than 2.5 feet per second, which should be enough to prevent solids from settling out. Depending on the final design configuration there may be an issue with solids deposition in the siphon at low flows that may require operator attention Mike Gritzuk asked how the existing sludge line in the interconnect right-of-way was going to be addressed? The response was that the sludge line will be relocated in places where it crosses the plant interconnect line. This will be a design detail.

Mike Bunch asked how much will the augmentation projects affect the CIP budget? Ed Curley indicated that it will add about $25 million. The budget has $3 million per year. Some place holder projects may be replaced by these augmentation projects. Mike Bunch indicated that $180 million is identified in a rehabilitation program Mike Bunch also indicated that there is a need to break out projects addressing regulatory requirements, rehabilitation and capacity into separate categories. If not enough dollars are available, the County will first do regulatory projects, then rehabilitation, and then capacity projects in that priority. Ron Riska indicated that some costs on the CIP schedule looked a bit squirrelly. The table needs to be checked. John Warner stated that the hydraulic evaluation in the report does not indicate much surcharging. But when he looks in manholes at times of high flow, he can't see the pipe. He expected to see more red flags. The reaches where these visual observations of surcharge occur need to be identified for the report.

Review of Chapter 6 was covered on pages 25 through 29 of the handout.

11. The recommended treatment plant plan is developed in Chapter 7 and was summarized by Joe Popeck. Mike Gritzuk asked if Ina Road could be expanded beyond 50 mgd? The response is yes, but the space will occupy the current Sports Park. Mike Gritzuk asked why there are primary settling tanks (primaries) at Ina Road WPCF, but not at the Roger Road Water Reclamation Facility. The answer was that the influent characteristics are different at Ina Road which is affected by sludge recycle. There is no sludge processing is at Roger Road. The primaries are needed to avoid separate side-stream treatment. Jim Doyle concurred with the process arrangement at Roger Road and Ina Road. It was further offered that the primaries could in the future be replaced with fine screens and then converted to some other use, such as, anoxic basins. Leaving the primaries in place for now provides for conservative space planning.

It was noted that not all of the support facilities are shown on the layouts. A small group meeting will be required to define support facilities. All of the facilities need to be shown on the layouts including the lab, personnel facilities and covered parking.

Mike Gritzuk asked if regulations require standby power. The answer is a yes and two (2) independent power feeds can meet this requirement, but many utilities are looking at standby generation as more reliable. Byron McMillan stated that under the Ina Road WPCF air quality permits, if a new generator is added, the old generators will fall under new source requirements and will probably have to be replaced. The cost to replace all of the engine generator sets is $10 million. It was suggested that it may be possible to separately permit the new generators.

The plan shows TPAD for Class A sludge, largest footprint of Class A options and is a place holder. Heat drying might be selected instead or some other method depending on markets for biosolids at the time the final decision is made. John Sherlock indicated that Cambi process is pre-digestion and would save on digester volume needed.

Mike Gritzuk asked if the architectural and landscaping themes will be the same for Ina Road and the Roger Road Water Reclamation Facility. The response is not necessarily. At Ina Road the existing facility needs to be considered. At The Roger Road Water Reclamation Facility the need is to consider uses at adjacent park. Mike Gritzuk asked where does architectural concept development stand? Ron Riska indicated there was a proposal from Greeley and Hansen to develop the architectural themes.

Mike Gritzuk indicated that there has been some public criticism that the County was just moving the odor problem from Roger Road to Ina Road by moving all sludge processing to Ina Road. This needs to be addressed in the report.

Review of Chapter 7 was covered on pages 29 through 37 of the handout.

12. The next chapter covered in the workshop was Chapter 10. Jerry Bish addressed its purpose and summarized the content. Mike Gritzuk noted that UV was included as a CIP element. This needs to be addressed consistently throughout the report once the disinfection issue is resolved. Ed Curley further indicated that other CIP elements beyond those listed such as conveyance augmentation and rehabilitation need to be added. Ron Riska indicated that follow-up meetings will need to be scheduled to address enhanced chlorination/de-chlorination, biogas power, biosolids, collection system rehabilitation/augmentation, project delivery method, and Ina Road and Roger Road site plans.

    It was asked if the nomenclature for grouping of outlying facilities as south region, southeast region, southwest region was okay. No comments were made, but will need to be decided at some point. Mike Bunch asked about the future of the Fairgrounds WWTP. The Fairground WWTP is slated to be decommissioned in the future.

    Jim Doyle asked if the plan is to thicken waste activated sludge (WAS) at the Roger Road Water Reclamation Facility. The response is yes, WAS will be thicken to 3% solids. This is required because of capacity of 8-inch sludge line. Jim Doyle offered why not put all the WAS into the interconnect line without thickening. Nitrate in sludge may help odor control in plant interconnect line. This is an option, but in any case, the plant interconnect line is the backup plan for the sludge line. On the site plan space will be reserved for WAS thickening, but note an option to use the plant interconnect line.

    Mike Gritzuk thought that the existing sludge line will go away. Paul Bennett indicated that this is a timing issue. Plant interconnect line will be constructed in 2009-2010 which will require that sludge line remain in service. John Sherlock suggested that the 8-inch line could be used for moving reclaimed water. Melodee Loyer stated that the 8-inch line will move only a small amount of water compared to existing 24-inch reclaimed water line. Maybe could use 8-inch line to pull fiber optic lines.

    Mike Bunch asked if the HAMP is mentioned? The response is yes under the conveyance section of the report. Ed Curley noted that a developer financed Swan Southland plant in the SE region may turn out to be the Southland plant.

    Review of Chapter 10 was covered on pages 48 through 50 of the handout

13. Chapter 11, alternative project delivery systems, was outlined by Jerry Bish. Melodee Loyer indicated that Tucson Water desires to be involved in alternative delivery discussions because there will be interconnections between their system and the wastewater system. Need to include interconnections in scope for designers and contractors. Mike Bunch asked if recommendations were going to be made on which delivery methods to use? The answer is yes, for each project.

The project size will be tailored to the construction market. The recommendations will include a recommendation for each project and discussion of what other project delivery methods could work.

Mike Gritzuk emphasized that a detailed implementation plan is wanted showing all contracts with delivery method for each with schedule for each for procurement, design, construction, startup over the next 15 years. John Warner asked if project size will limit competition? Under current construction contracting conditions, bonding problems will occur for contractors when project sizes exceed $350 million. To get competition, may need to keep project packages about $100 million. In today's construction climate the County may need to market projects to contractors to get effective competition.

Review of Chapter 11 was covered on pages 50 through 52 of the handout.

14. Chapter 12 review was covered by Jerry Bish Melodee Loyer opined that the facilities for Tucson Water at Ina Road will be under construction at the same time as the wastewater facilities. The plan should be clear that there will be simultaneous construction and contractors will be crawling all over each other.

Paul Bennett stated that there is a need to express what rates are needed to fund bonds. Board of Supervisors need to know that approving a $100 million project implicitly means approving rates to support $100 million in bonds. Jeff Nichols indicated that the County contract language says that as of July 1 each year, if funds are not approved, contract stops. Financial plan must identify financial needs, when bond issues are needed and what are the rate impacts. Need to see $501 million program as unified program so that it is not piecemealed. Nothing can go away in the $501 million package – can not do like in the past where wastewater department has asked for a 10% rate increase and given 6% and thus have to eliminate low priority projects. All the pieces are needed to make this work.

Review of Chapter 12 was covered on pages 53 of the handout.

15. Vic Smith presented information on green power and the engine generators at Ina Road. John Munden asked if Pima County can we use all the heat produced from the engines in this climate? The answer is yes for heating the digesters and for plant cooling. Paul Bennett asked if parts are available for the existing Ina Road generators. The answer is yes that Waukesha still make parts for these units. Mike Kostrzewski asked if you run out of biogas, do not buy natural gas and don't run an extra engine just for the heat? The answer is yes that is the most economical approach.

Jackson Jenkins stated that a clean up of the digester gas is needed at Ina Road and there is no machining tolerance left in the existing units because of all the re-machining that has been done. Furthermore, premature failure of the new replacement engine occurred at 7,000 hours vs. 40,000 hours expected has left Pima County with no confidence in the existing system operations. Vic Smith stated that the engines need to run at 80% of capacity, but are only running about 20%, this is hard on the engines and the existing gas conditioning dryer is inadequate. Mike Gritzuk asked if the plant needs to run on biogas and replace the generators? The response is yes, the plant would be better off replacing the generators. Mike Gritzuk followed up by asking why there is a

big difference between the capital cost of biogas and natural gas? In response the costs are based on 3 MW more power generation with natural gas to meet the entire plant needs, which would require new facilities, not just replacing generator and engine sets.

Jackson Jenkins stated that siloxane has been present for many years, but asked why the sudden increase in problems. Response is the changes in the base component of cosmetics. Manufacturers are using more siloxane with a marked increase in the last 5 to 6 years. Clean-up of the gas for hydrogen sulfide and siloxane will decrease maintenance requirements and would improve operation, but maintenance has been a problem. Replacement prototype from Waukesha is considered a failure. The plant can barely run 2 of 5 engines from the biogas.

Base case option -- refurbish Ina Road power plant, a major rehab. Next step up would be a "zero time" approach where the facility is replaced. Dave Garret asked if the savings shown are with digester gas only? The response is yes, but there would still be savings with a natural gas supplement, but less savings. Jackson Jenkins indicated that more information is needed to be convinced.

Mike Gritzuk inferred from the presentation that there does not appear to be an advantage to a third party approach. It was confirmed that this is correct for on-site generation, but the gas could be sent off site for green power credits. Further, Mike Gritzuk asked if green power credits would work equally for a private party and the County. The response is not exactly. Tucson Electric Power (TEP) will give County credit for only two-thirds of gas currently lost at Roger Road, which would be an incentive of $355,000 per year. Third party would get an $1.5 million incentive. Saving advantage is to use all biogas at Ina Road. There is less savings with the use of natural gas compared to commercial power rate. If a third party comes onto the County site (avoids transmission costs) and generates green power, the company and County would get credits.

An approach is to ask the market for expression of interest in third party arrangement to produce power from biogas. It may make sense for a private-public partnership. The numbers in the presentation provide a basis to evaluate third party proposals.

Review of "Green Power" was covered on the slides on pages 54 through 63 of the handout.

16. The outlying treatment processes were presented by Gordon Culp. The process matrix comparing technologies was developed with group input. Matrix values prepared by the project team were modified based on the discussion of the various wastewater processes. A copy of the modified matrix and the weighted matrix are attached at the end of these meeting notes. After reviewing the weighted matrix results, the BNROD process was top rated with Bardenpho a close second. It was stated that sequencing batch reactor (SBR) would be more economical than an oxidation ditch. At Swan Southland, a SBR system was designed and built at $6.50 per gallon of capacity. Because of the current plant situation, Ed Curley suggested that there is a need to look at best solution for each site rather than standardize the process at all sites. A question was asked of how many other cities have gone to standardized approach for satellite plants. Some have gone to standardized approach to talk to developers on what to build that may be turned over to the public agency later. It may be desirable to have the Bardenpho treatment process at each plant? Frank Gall indicated that too much has been invested at Avra Valley in oxidation ditches to change.

Mike Gritzuk suggested that there is a need to look at how to make oxidation ditch plants aesthetically more pleasing. But for newer facilities, the County needs to look at options.

The outlying wastewater treatment processes were covered on pages 63 through 66 of the handout.

17. Biosolids handling and disposal were presented by Jerry Bish. Current sludge contractor reportedly needs 2000 acres for land application. Gordon Culp asked why not rely on a private party? Metro Denver applies 86% of its digested sludge to private farms rather than use its own operation. They have a waiting list of farmers wanting the sludge. John Warner indicated that there is a need to look at markets for biosolids such as use as fuel in power plants. Jackson Jenkins indicated that the public parks would be market for dried product. Joe Popeck offered that Chicago has private company taking one-third of sludge from Stickney plant as dry solids. Ron Riska suggested that air quality permits for sludge incinerators are nearly impossible to obtain.

    Biosolids handling and disposal were covered on pages 66 through 70 of the handout.

18. The value of a request for expression of interest process by the County was discussed. Besides the alternative project delivery approaches, private sector funding, green power (biogas utilization) and disposal of biosolids are candidates for testing the marketplace for ideas and direction to be taken by the County. The expression of interest will need to be formulated and completed within the next 60 to 90 days.

19. Additional meetings are required to obtain closure on: biosolids handling and disposal, enhanced chlorination, green power, alternative project delivery and plant layouts.

20. Mike Gritzuk closed the meeting by thanking all for their active participation and to Tucson Water for providing lunch.

Agenda
Workshop #14 – First Draft of Report Study
February 21, 2006

Time	Topic	Presenter
7:45 am	*Public Works Building at 201 N. Stone Ave. – Conference Room C (Basement)*	
8:00 am	Opening Session • Welcoming Remarks • Review Agenda • Workshop Goals	 Mike Gritzuk Andy Richardson
8:15 am	Chapters 1- 4 Review (Strategic Development) 1. Introduction 2. Regulatory and Customer Requirements 3. Treatment Plant Evaluation 4. Overall Treatment Strategy	Joe Popeck/Jerry Bish
10:00 am	Break	
10:15 am	Chapters 5 -9 Review (Strategic Development) 5. Biosolids/Biogas 6. Conveyance 7. Recommended Treatment Plant Plan 8. Non-Metro Area Evaluation 9. Non-metro Overall Treatment Strategy	Jerry Bish/Joe Popeck
11:45 am	Chapters 10-13 Review (CIP Development) 10. CIP Elements 11. Alternative Project Delivery Methods 12. CIP Phasing and Costs Schedules 13. Implementation Plan	Jerry Bish
12:30 pm	Lunch	
1:00 pm	Green Power Discussion	Vic Smith
2:00 pm	Non-Metro Wastewater Process Discussion	Gordon Culp
3:00 pm	Break	
3:15 pm	Biosolids Handling/Disposal Discussion	Jerry Bish
4:15 pm	UV vs. Enhanced Chlorination Discussion	Jerry Bish
4:45 pm	Summary Wrap-Up • Comments by Group • Closing Remarks	Andy Richardson Mike Gritzuk
5:00 pm	Adjourn	

Flip Chart Notes – February 21, 2007

ADDITIONAL MEETING SUMMARY

- Biosolids
- Enhanced Chlorination
- Alternative Delivery Consideration/Expression of Interest
- Green Power
- Roger Road and Ina Road. site plans

ROMP REPORT

- Chapter 1 – Need to address odor (good neighbor issue)
  - Page 1.4 – decommission filters only at water reuse facility
  - Need to mention reuse water treatment facility
  - Water Reclamation Facility for "New" instead of "Greenfield" for Roger Road
  - Add list of common terms up front
  - For Non-Metro use "Outlying Facilities"
  - Add discussion on odor
- Use of pump stations belong in Chapter 1 – "Guiding Principles"
- Chapter 3 – Address electrical decision at Roger Road with savings of $6 million
- Show 3 to legal for review
- Reclaimed water program
  - Add 3 mgd at Randolph Park and address effluent shares available
  - Confirm risk cost range of $50 to $80 million
- Ina Road site needs to have space for:
  - Tucson water 2 acres vs. 10 acres
  - Warehouse space
  - Emergency overflow basin # 4
  - Laboratory location?
- Headworks sized for a peaking factor of 2
- Where does side stream flows go? Plant processes sized for them.
- Change <u>reliable</u> to <u>viable</u> on summary
- Do we still want a 2 NTU effluent quality? Base on "Re-look" at CL_2 disinfection
- Add 80% discussion and charts in s 2 & 4 per ADEQ Requirements
- Provide basis of design for each major element as a separate deliverable:
  - Plant Interconnect
  - Ina Road
  - "New" water reclamation facility
- Biosolids – need to address what is being done now with regards to biosolids and what new facilities are required – need to forecast when a new digester is needed
- Need to consider asbestos removal costs at Roger Road since old plant includes some. Cost in estimates
- Need to add economic analysis on when Biosolids should no longer be hauled – want recommendation in Chapter 5
- "Include in 5 a discussion on biosolids as it relates to the "reality" in Pima County and CA that there could be a greater driver for class "A"
- Consider separate treatment process for struvite control

- Get CMOM permit information and place in Chapter 2.
- In Chapter 6 make reference to comprehensive hydraulic study and include scope and completion date.
- Indicate in report where existing programs are in place to take care of identified problems need "Cross – Reference Effort"
- Identify odor control effort
- Break conveyance program into:
  - Regulations
  - Rehabilitation
  - Capacity

  } For CIP Representation
- Review conveyance cost table"
- ID areas where field observations do not match model results
- Air Quality Permit Implications of adding a new generator – all would have to be looked at as new
- With new digesters – what is the new estimated gas production?
- Need to address comments on transferring smell from Roger Road to Ina Road
- CIP Elements Add
  - Conveyance and other ones related to the program
  - Fairgrounds WWTP listed in Southeast
- What is the plan for sludge from Roger Rd.?
  - Place in plant interconnect. No.
  - Need to decide impacts of 8" sludge link and plant interconnect design
- Southland WWTF (Developer Financed)
- Recommendation first on alternative delivery followed by what other methods will work
- Show conveyance CIP in areas: Regulations, Rehabilitation and Growth
- Add Tucson water facilities to Ina Road. expansion program
- Need to show how funding fits into future rate increases
- Melodee Loyer was acknowledged for submitting consolidated report comments from Tucson Water. Those comments will be considered in the next report draft

GREEN POWER

- Vic Smith to talk w/ Jackson Jenkins about engine generator issues
- Zero time option
- Alternatives: natural gas and all commercial power
- Expression of interest meetings next step

OUTLYING FACLITIES PROCESS

- Site specific process selection at each facility of the outlying areas

ENHANCED CHLORINATION

- Is BADCT timing negotiable – when does it kick-in?

EXPRESSION OF INTEREST

- Areas of interest:
  - "Green" power biogas
  - Funding
  - Biosolids disposal regional and outlying
  - Project delivery

- Tasks
  1. Develop EOI letter
  2. Meeting w/respondents
  3. Report on findings
  4. Meet w/Pima County on steps forward

Modified System Evaluation Matrix

Criteria	Rank				
	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	4	4	3	5	2
Environmental Impact	4	4	3	3	3
Feasibility	3	5	4	3	3
Operational Capability	4	4	3	2	4
Land Required	4	3	4	4	5
Maintenance	5	5	3	3	2
Public Acceptability	3	3	3	5	5
Reliability	3	4	3	3	2
Sludge Production	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4
Odor Control	4	3	4	3	4
Total	41	44	37	38	37

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Modified Weighted System Evaluation Matrix

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBBR	SBR	MBR	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	5	4	4	3	5	2	20	20	15	25	10
Environmental Impact	4	4	4	3	3	3	16	16	12	12	12
Feasibility	3	3	5	4	3	3	9	15	12	9	9
Operational Capability	4	4	4	3	2	4	16	16	12	8	16
Land Required	2	4	3	4	4	5	8	6	8	8	10
Maintenance	4	5	5	3	3	2	20	20	12	12	8
Public Acceptability	5	3	3	3	5	5	15	15	15	25	25
Reliability	4	3	4	3	3	2	12	16	12	12	8
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	4	16	16	16	16	16
Odor Control	5	4	3	4	3	4	20	15	20	15	20
Sum of Weighted Ranks							155	160	137	145	137

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Pima County Regional Optimization Master Plan

Workshop #14
First Draft of Report Study

February 21, 2007

Workshop Presenters

Mike Gritzuk	Welcome/Closing
Andy Richardson	Facilitator
Jerry Bish	Chapters 1, 2, 5, 6, 8-13
Joe Popeck	Chapters 3, 4, 7
Vic Smith	Green Power
Gordon Culp	Non-Metro Wastewater Processes
Andy Richardson	Wrap-Up

2

GREELEY AND HANSEN

Welcoming Remarks

Mike Gritzuk

GREELEY AND HANSEN

Overview

Andy Richardson

Agenda

- Review Draft ROMP Report chapters
- Discussion topics
  - Green power
  - Non-metro WW treatment process
  - Biosolids handling/disposal
  - UV vs. enhanced chlorination

5

Objective

- Receive critical comments on Draft Report
- Identify open/unsettled issues
- Advance open/unsettled ROMP issues to closure
- Identify who, what and when necessary for issue closure

6

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

7

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

8

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

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Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

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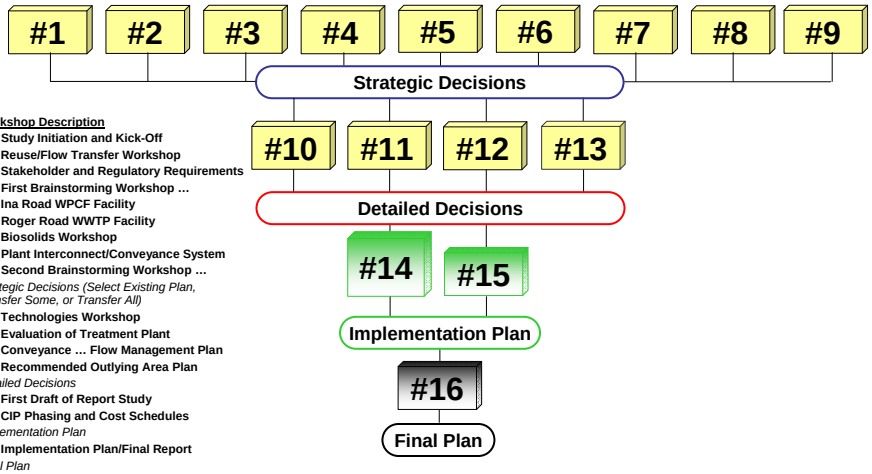
Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

11

GREELEY AND HANSEN

GREELEY AND HANSEN

First Draft Regional Optimization Master Plan

Jerry Bish/Joe Popeck

GREELEY AND HANSEN

Chapter 1 – Introduction

Jerry Bish

Chapter 1 – Introduction

- Sets forth purpose of master plan and establishes basis for report
- Identifies strategic issues / sets strategic direction
- Integrates Capital Improvement Plan

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GREELEY AND HANSEN

Purpose

- Identify optimal strategy for wastewater treatment
- Identify optimal biosolids treatment / disposal
- Provides 25-year road map
- Develop key decisions through consensus process

15

Needed Additions

- Add non-metro facilities
- Add conveyance evaluation
- Add CIP development

16

Chapter 2 – Regulatory and Customer Requirements

Jerry Bish

Regulatory and Customer Requirements

- Governing agencies
  - US EPA
  - ADEQ
  - Pima County Department of Environmental Quality
- Permits (metro/non-metro facilities)
  - AZPDES
  - APP (new for Marana)
  - Air quality
  - Reclaimed water

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Regulatory and Customer Requirements *(continued)*

- Water reuse
  - Intergovernmental agreements
  - Underground storage recharge / recovery
- Cultural / historic preservation
- Regulatory closure requirements at Roger Road

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GREELEY AND HANSEN

GREELEY AND HANSEN

Chapter 3 – Treatment Plant Evaluation

Joe Popeck

Existing Treatment Capacity

- Roger Road WWTP
  - Permitted capacity = 41mgd
    - Preliminary and primary treatment
    - Biotowers with Activated sludge, final clarifiers
    - Chlorine disinfection
    - Anaerobic digestion

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Condition Assessment – RR WWTP

- Summary of condition assessment
  - Most major structures appear in generally good condition
    - However, clarifiers and aeration tanks are not functionally optimal for conversion to BNR process
    - Flow distribution is marginal and cannot be readily improved
  - Most major equipment appear in generally good condition
    - However, major equipment may not be of required capacity for BNR process

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Condition Assessment – RR WWTP

- Summary of condition assessment
  - Most major electrical components appear in generally good condition
    - However, system is ungrounded Delta – not optimal for equipment such as VFD's
  - Significant lack of I&C
    - Fiber optic system installed
    - PLC's and other SCADA devices to permit remote monitoring/operation not fully utilized

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Condition Assessment – RR WWTP

- Summary of condition assessment
  - Roger Road facilities, due to condition and functional risk are deemed marginal for conversion to BNR
  - Planned improvements for several areas of the plant are necessary to maintain treatment effectiveness regardless of the final decision on the long-term continued use of Roger Road WWTP

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Existing Treatment Capacity

- Ina Road WPCF
  - Permitted capacity = 37.5 mgd
    - Preliminary and primary treatment
    - 25-mgd HPO activated sludge, final clarifiers
    - 12.5-mgd BNRAS, final clarifiers
    - Chlorine disinfection
    - Anaerobic digestion

25

Background / Condition Assessments

- Summary of condition assessment
  - Most Major Structures appear in generally good condition
  - Most Major Equipment appear in generally good condition
  - Most Major Electrical Components appear in generally good condition
  - Significant lack of I & C

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Background / Condition Assessments

- Summary of condition assessment
  - Much of the Ina Road Facility that would be used either as a BNR process component or support process is viable.
    - However, HPO tanks are not functionally optimal for conversion to BNR process

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Condition Assessment – IR WPCF

- Summary of condition assessment
  - Planned Improvements for several areas of the plant are necessary to maintain treatment effectiveness prior to modifications for plant-wide BNR.

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Chapter 4 - Overall Treatment Strategy

Joe Popeck

Overall Treatment Strategy

- Future wastewater flows and characteristics
- Treatment strategy alternatives with three flow-split options
- Reclaimed water program
- Biological nutrient removal (BNR) treatment alternatives
- Alternative evaluation criteria
- Evaluation of alternatives
- Selection of recommended alternative
- Preliminary sizing facilities
- Summary

30

Future Wastewater Flows

Wastewater Flow Split Options Used for Plant Evaluations

Flow Split Options *	Flow to Roger Road, mgd			Flow to Ina Road, mgd		
	Current	Future	Total	Current	Future	Total
Existing Plan	22.6	9.4	32.0	36.5	13.5	50.0
Transfer Some	14.1	5.9	20.0	45.0	17.0	62.0
Transfer All	0.0	0.0	0.0	59.1	22.9	82.0

* Randolph Park WRF capacity of 3.0 mgd is not included.

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Future Wastewater Flows and Characteristics

Selected Year 2030 Wastewater Characteristics

Based on Complete Mass Balance

Parameter	Units	RRWWTP		IRWPCF	
		Primary Influent	Primary Effluent	Primary Influent	Primary Effluent
Flow	mgd	33.2	32.6	52.6	51.4
COD	mg/L	659	443	689	456
BOD_5	mg/L	301	214	324	229
$sBOD_5$	mg/L	121	123	123	126
TSS	mg/L	310	126	358	146
VSS	mg/L	243	104	282	123
TKN	mg/L	47	46	63	61
TP	mg/L	10	10	15	14

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Treatment Strategy Alternatives with Three Flow-Split Options

- Existing Plan
  - At both Roger Road and Ina Road, continue to follow present long-range CIP project schedule to address capacity and regulatory needs of both RRWWTP and IRWPCF
- Transfer Some
  - Maintain a facility at the RRWWTP to continue to provide effluent to the adjacent Tucson Reclaimed Water Treatment Plant (TWTP), and direct remainder of influent flows to IRWPCF
- Transfer All
  - Transfer all wastewater flow from the RRWWTP service area to IRWPCF and decommission RRWWTP

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Reclaimed Water Program

- Reclaimed water program
  - Effluent water will be made available to Tucson Water for reclaimed water service at the future RRWWTP and IRWPCF. Plan allows for approximately 30 mgd at RRWWTP and approximately 20 mgd at IRWPCF based on allocated effluent water shares.
  - Up to 7 mgd would be made available for discharge into the Santa Cruz River at the RRWWTP site.
  - This may require that up to 5 mgd (existing plan) and as much as 37 mgd (transfer all plan) of the IRWPCF effluent be transferred to the RRWWTP site via a pumping station/force main system.

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Biological Nutrient Removal (BNR) Treatment Alternatives

- Treatment process alternatives were developed to meet the goal of future effluent limits for nutrients with the following criteria:
  - Ammonia nitrogen concentration of 2 mg/l or less
  - Total nitrogen concentration of 8 mg/l or less
  - Total phosphorus concentration of 1mg/l or less

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Biological Nutrient Removal (BNR) Treatment Alternatives

- Initial screening of BNR process alternatives
  - Modified Ludzack-Ettinger (MLE)
  - Bardenpho
  - Step-feed nitrification and denitrification (NDN)
  - Integrated fixed-film activated sludge (IFAS)
  - Membranes (MBR)
  - Biostyr and Biofor systems
  - Activated sludge/nitrifying trickling filter (AS/NTF)
  - Biotowers/nitrifying activated sludge (BT/NAS)
  - Moving bed bioreactor (MBBR)

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Biological Nutrient Removal (BNR) Treatment Alternatives

- BNR processes selected for detailed evaluation
  - Ability to achieve the effluent goal
  - Adaptability to remove emerging contaminants of concern
  - Is high dose of methanol required?
  - Can use existing Biotowers at RRWWTP?
  - Is it flexible for Bio-P removal?
  - Are capital costs in the range of Bardenpho? (Initial comparative cost analysis showed the lowest life cycle cost with Bardenpho)
  - Can use existing tankage?
  - Can achieve turbidity less than 2 NTU?
  - Can be applied with high purity oxygen (HPO)? (IRWPCF has a HPO system)
  - Are O&M costs in the range of Bardenpho? (Initial comparative cost analysis showed the lowest life cycle cost with Bardenpho)
  - Has the process been used in biological nitrogen removal in the plant size of larger than 20 mgd for more than three years?

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Biological Nutrient Removal (BNR) Treatment Alternatives

- Processes carried forward for detailed evaluation:
  - Bardenpho
  - MLE
  - IFAS
  - BT/NAS for RRWWTP and Bardenpho for IRWPCF

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Alternative Evaluation Criteria

- Technical criteria
  - Operability
  - Proven process
  - Life cycle cost
  - Site compatibility
  - Resource consumption
  - Ease of operation and maintenance during construction

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Alternative Evaluation Criteria

- Financial criteria
  - Capital costs
  - Operation and maintenance (O&M) costs
  - Present worth of capital and O&M costs

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Alternative Evaluation Criteria

- Non-economic factor criteria
  - Cost (exclusive of risk-related costs involved in the rehab RRWWTP option)
  - Schedule
  - Constructability
  - Flexibility
  - System Reliability
  - System Operability
  - Environmental Impacts
  - Water/Waster System Optimization
  - Public Acceptance
  - Potential for Cost Sharing
  - Effect on Financing

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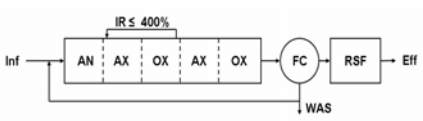
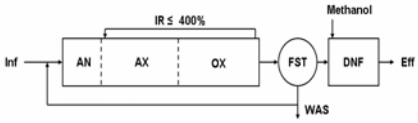
Evaluation of Alternatives

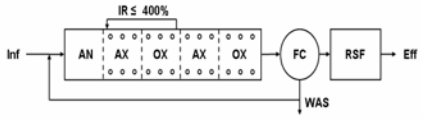
Typical 5-Stage Bardenpho Process Diagram



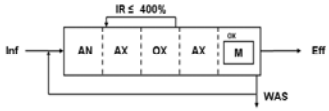
Typical MLE Process Diagram



Typical IFAS Process Diagram



Typical MBR Process Diagram



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Evaluation of Alternatives

Summary of Technical and Financial Evaluation of Alternatives for RRWWTP

Criteria	Bardenpho RR/IR	MLE RR/IR	IFAS RR/IR	BT/NAS RR/IR
Operability	0 / 0	0 / 0	0 / 0	0 / NA
Proven process	+ / +	+ / +	0 / 0	0 / NA
Life cycle costs	+ / +	- / -	- / -	- / NA
Site compatibility	+ / +	- / -	+ / +	+ / NA
Resource consumption	+ / +	- / -	- / -	- / NA
Ease of maintaining treatment capacity during construction	+ / +	+ / +	+ / +	+ / NA
Recommended process	Yes	No	No	No

Notes: 0 means neutral; + means positive; – means negative; NA means not applicable; RR means RRWWTP; and IR means IRWPCF.

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Evaluation of Alternatives

Capital and Present Worth (PW) Costs of Alternatives (1) (2)

Process	Flow Split RR/IR = 32/50		Flow Split RR/IR = 20/62	
	PW	Capital	PW	Capital
Bardenpho at RR&IR	$431	$287	$464	$319
IFAS at RR&IR	$439	$295	-	-
MLE at RR&IR	$446	$300	-	-
BT/NAS at RR and Bardenpho at IR	-	-	$479	$327

(1) Physical limitations of existing trickling filters at RRWWTP limit the BT/NAS process application to the 20/62 mgd flow split

(2) The costs are shown in million dollars

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Evaluation of Alternatives

Capital and Present Worth (PW) Costs for Bardenpho Process with Three Flow Split Options (1)

Flow Split	Capital Cost	PW Cost
RR=32 mgd IR=50 mgd	$287	$431
RR=20 mgd IR=62 mgd	$319	$464
RR=0 mgd IR=82 mgd	$375	$514
RRGF=32 mgd IR=50 mgd	$320	$457
RRGF=20 mgd IR=62 mgd	$340	$480

(1) The costs are shown in million dollars.

Risk Related Costs, Roger Road Rehab

- Schedule – added inflation, increased risk of missing deadlines, risk of moratorium **(one year delay, inflation at 5% =$8.5M, added inspection and field overhead = $0.9M, steel and concrete price volatility = $6.9M, permit violations=$9.1M)**
- Constructability – increased risk of changed conditions claims **(10-30% = $17M-$51M)**
- Operability – patchwork of old and new **(10 added staff = $7.3M present worth)**

Risk Related Costs, Roger Road Rehab

- Reliability – increased risk of failure of older plant components **($25,000 per day for permit violations)**
- Environmental impacts – increased chance of disrupting treatment during construction **($25,000 per day for permit violations)**
- Risk related costs estimated at **$50,000,000-$80,000,000** exclusive of moratorium effects

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Evaluation of Alternatives

- Non-economic factor criteria are included in the list shown below:
  1. Cost
     (exclusive of risk-related costs involved in the rehab RRWWTP option)
  2. Schedule
  3. Constructability
  4. Flexibility
  5. System Reliability
  6. System Operability
  7. Environmental Impacts
  8. Water/Waster System Optimization
  9. Public Acceptance
  10. Potential for Cost Sharing
  11. Effect on Financing

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Evaluation of Alternatives

Non-economic Factor Criteria Evaluation Matrix with Complete Scores (Rating scale of 1-5 with a rating of 5 being most favorable)

Crit-eria	Weig-hting	Un-weighted Score					Weighted Score				
		RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF =32 IR=50	RRGF =20 IR=62	RR=32 IR=50	RR=20 IR=62	RR=0 IR=82	RRGF=32 IR=50	RRGF=20 IR=62
1	5	5	4	2	4	3	50	40	20	40	30
2	5	3	3	5	5	5	15	15	25	25	25
3	3	2	2	4	5	4	6	6	12	15	12
4	4	3	3	5	5	5	12	12	20	20	20
5	4	4	4	5	5	5	16	16	20	20	20
6	4	3	3	4	4	4	12	12	16	16	16
7	4	3	3	4	4	4	12	12	16	16	16
8	5	5	4	3	5	4	25	20	15	25	20
9	5	1	2	2	3	2	5	10	10	15	10
10	3	5	4	3	5	4	15	12	9	15	12
11	3	5	4	2	4	3	15	12	6	12	9
Total		39	36	39	49	43	183	167	169	219	190

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Selection of Recommended Alternative

- Recommendation
  - Use Bardenpho process at both plant locations
  - Use a flow split of 32 mgd for RRWWTP and 50 mgd for IRWPCF
  - Use Greenfield design for RRWWTP plant and rehabilitation for the IRWPCF facilities
  - Implement Greenfield design at RRWWTP without primary treatment

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Preliminary Sizing Facilities

- Preliminary sizing of facilities
  - The facility for RRWWTP and IRWPCF was sized to adequately treat the future wastewater loads and to consistently meet the future effluent requirements meeting the treatment goals. The facilities were initially sized based on conventional design approach and confirmed by the GPS-X modeling.
  - Hydraulic capacity for the RRWWTP and IRWPCF is based on a peak hourly flow rate of 2.0 Average Daily Flow.

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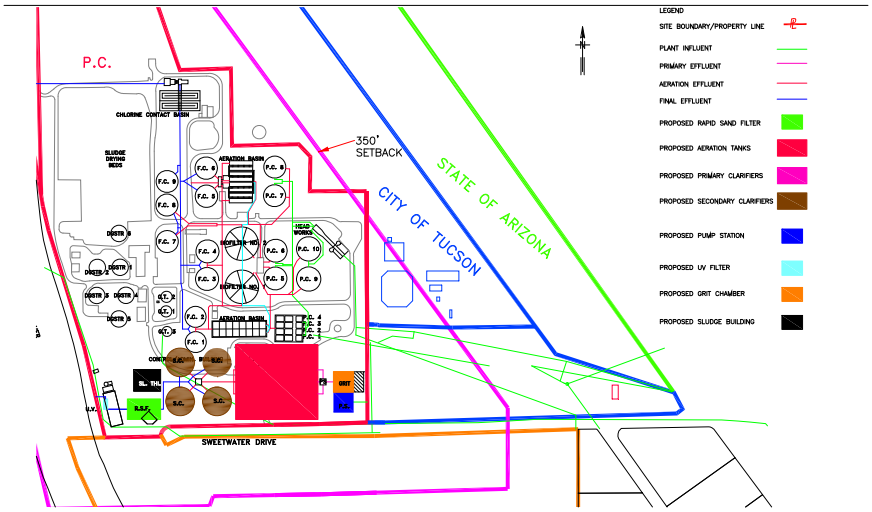
Roger Road – 32-mgd "Greenfield"



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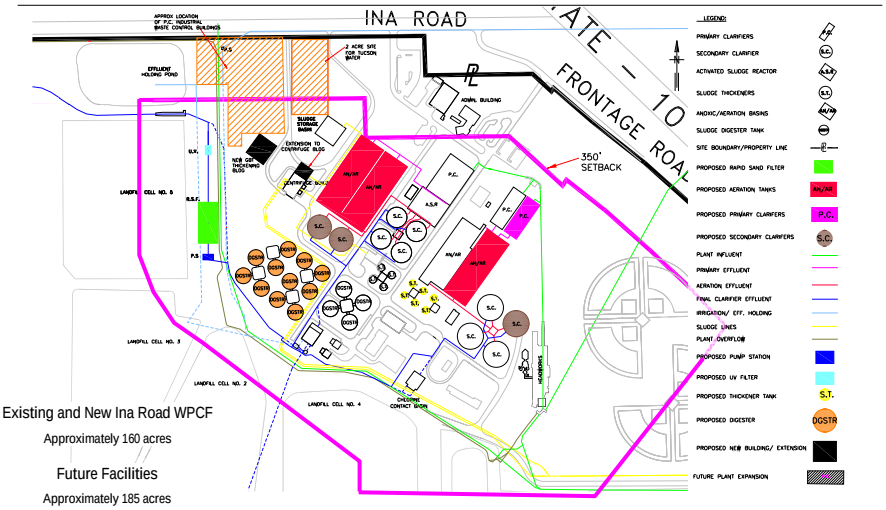
50-mgd Ina Road WPCF



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Summary

- 2030 wastewater flows in the Roger Road and Ina Road service areas were estimated based on population projections and flow estimates contained in PCWMD 2006 document. The year 2030 total flow within the two service areas is approximately 85 mgd.
- Wastewater characteristics were determined based on information contained in 2004-2005 GPS-X modeling, future loadings predicated on water conservation, and mass balance with recycle flows from expected future biosolids operation. Because of higher recycle contribution, the nutrient concentrations in the IRWPCF influent were substantially higher than the RRWWTP influent. Peaking factors were estimated based on operating data.
- Among a number of flow-split options reviewed, three flow-split options were selected for flow split between the treatment plants for further analysis and these include:
  - 32 mgd to RRWWTP and 50 mgd to IRWPCF
  - 20 mgd to RRWWTP and 62 mgd to IRWPCF
  - All 82 mgd to IRWPCF

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Summary

- Due to expected stringent effluent requirements and effluent reuse requirements, a high degree of treatment would be required and the effluent goals were set at:
  - Ammonia nitrogen concentration of 2 mg/l or lower
  - Total nitrogen concentration of 8 mg/l or lower
  - Total phosphorus concentration of 1 mg/l or lower
  - Turbidity of 2 NTU or lower
- To meet effluent goals, a combination of biological nitrogen removal processes and biological phosphorus (Bio-P) removal was found to be most cost effective.
- A review of biological nutrient removal (BNR) processes for nitrogen and phosphorus removal resulted in consideration of nine processes which were screened based on economic and non-economic criteria. As a result, four alternatives were selected for further evaluation:
  - Bardenpho
  - MLE
  - IFAS
  - BT/NAS (for treatment of 20 mgd at RRWWTP)

55

Summary

- Four BNR alternatives were further evaluated based on technical and economic criteria. Bardenpho process was determined as most reliable and cost effective process for both treatment plants.
- Using the Bardenpho process, flow split options were analyzed based of technical and economic criteria. Flow-split option of 32 mgd to RRWWTP and 50 mgd to IRWPCF was determined as most reliable and cost effective option.
- Greenfield option of replacing the existing RRWWTP with a new treatment plant at the Roger Road location was evaluated. Considering cost uncertainties involved in rehabilitating and modifying the RRWWTP and considering non-economic factors, the Greenfield option was determined to be most favorable option for the Roger Road facility.

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Summary

- Preliminary sizing was made for both treatment plants based on conventional design approach and was confirmed with GPS-X modeling. No chemical use is required for the Greenfield RRWWTP, but some amount of alum (or ferric chloride) will be required at the IRWPCF when phosphorus removal becomes a requirement in the future. This is due to relatively high nutrient concentration in the IRWPCF influent and insufficient carbon source to support both denitrification and Bio-P. Chemical will remove additional amount of P, after Bio-P removal, to meet the effluent P requirement in the future.

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Project (2006) Costs

Description	*Total Cost (2006) (x $1,000,000)*
Roger Road	$234.8
Ina Road	$243.9
Plant Interconnect	$22.3
Total	$501.0
Misc. Electrical Service	$35.0

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Chapter 5 – Biosolids

Jerry Bish

Chapter 5 – Biosolids

- Existing Class B facilities
- Mesophilic digesters at Roger Road
  - Sludge transfer pipeline to Ina Road
- Mesophilic digesters at Ina Road
- Centralized sludge loading operation

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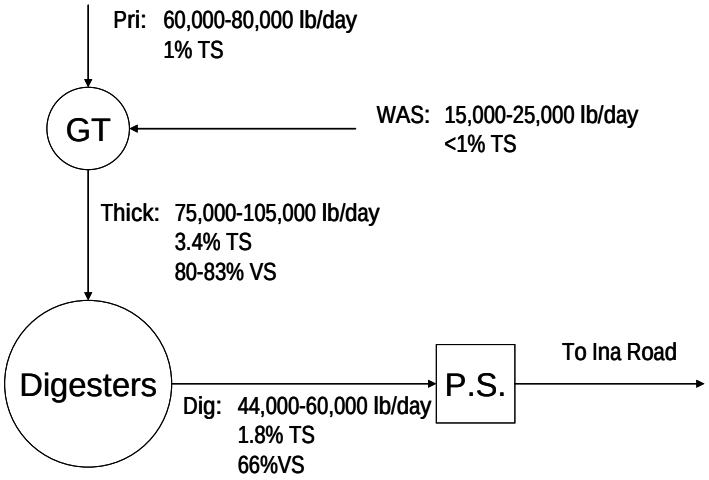
Existing Roger Road WWTP Biosolids Diagram (@38.3 mgd)



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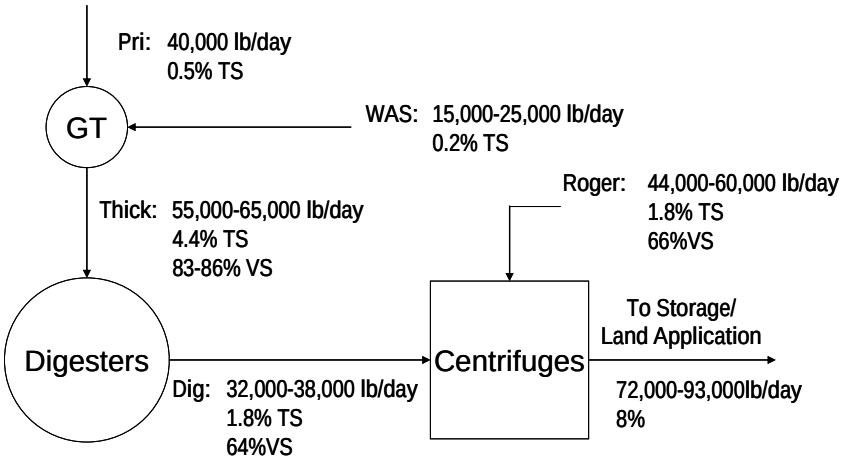
Existing Ina Road WWTP Biosolids Diagram (@23.4 mgd)



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Non-Metro Facilities

Location	Current, tpd(1)	Processing, Disposal
Marana	0.28	storage, hauled ⇒ Ina
Rillito Vista	0.014	---
Avra Valley	2.2	storage, hauled ⇒ Roger Road
Green Valley	5.7	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction	0.09	---
Corona de Tucson	0.16	Evaporation, hauled to landfill when pond is cleaned
Pima Co. Fairgrounds	0.004	Evaporation, hauled to landfill when pond is cleaned
Mt. Lemmon	0.018	storage, hauled ⇒ Ina
Southlands	0.0	---
Total	8.47	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated.

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Future Solids Streams

- Roger Road WWTP

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Waste Activated Sludge	1.72	0.7	100,600	76,400
Thickened WAS (to Ina Road Digestion)	0.36	3.0	90,500	68,800
Thickener Overflow	1.36	0.1	10,100	7,600

- Ina Road WPCF

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Primary Sludge	1.15	1.0	95,300	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

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Non-Metro Biosolids

Location	Future, tpd(1)	Processing, Disposal
Marana	6.16	storage, hauled ⇒ regional facility
Rillito Vista	0.00	---
Avra Valley	5.26	storage, hauled ⇒ regional facility
Green Valley	6.79	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction	0.00	---
Corona de Tucson	3.77	storage, hauled ⇒ regional facility
Pima Co. Fairgrounds	0.00	---
Mt. Lemmon	0.003	storage, hauled ⇒ regional facility
Southlands	14.7	separate processing and disposal
Total	36.68	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

Class B Processes

Process	Requirements
Aerobic Digestion	MCRT of 40 days @ 20°C or MCRT of 60 days @ 15°C
Air Drying	Dry on beds for 3 months, with 2 months ≥ 0°C
Anaerobic Digestion	MCRT of 15 days @ 35-55°C or MCRT of 60 days @ 20°C
Composting	5 days @ 40°C and 4 hours of the 5 days @ 55°C
Lime Stabilization	Lime addition to pH 12 and maintained for 2 hours

Class A Processes

Process	Requirements
Thermophilic Aerobic Digestion 1	MCRT of 10 days @ 55-60°C
Heat Drying 1	Direct or Indirect Gas Drying to ≤ 10% moisture content and solids temperature of 80°C
Heat Treatment 1	MCRT of 30 minutes @ 180°C
Composting 1	3 days @ 55°C for in-vessel or static pile 15 days @ 55°C for windrow
Pasteurization 1	30 minutes @ 70°C
Alkaline Stabilization 2	pH 12 and maintained for 72 hours with biosolids ≥ 52°C for 12 hours, followed by air drying to 50% TS
Time/temperature 3	Process meets detention time at temperature requirements by solids concentrations given in 503 regulations or has been given equivalency by USEPA (TPAD and batch thermophilic digestion for example)

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Available Markets

- Agricultural land application
- Landfilling
- Mine tailing reclamation
- Dedicated land disposal
- Alternative land application option (Class A) – landscaping products
- Feed as fertilizer (Class A with amendments)
- Waste-to-energy (screen process)

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Class A Drivers

- Regulations (state/federal)
- National biosolids partnership – environmental management system participation
- Local community pressure

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Class A Facilities Arrangement

- Temperature phased anaerobic digestion
- Heat drying
- Cambi process

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Recommendations

- Centralize biosolids handling / treatment
- Continue with Class B / land apply
- Ready to adapt to changes in disposal market

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Biogas Use

- 500 million cubic feet per year
- Options
  - Continue biogas for power generation / engine-driven equipment
  - Sell biogas to third party for commercial use
  - Purchase power from local utility and use biogas for heating and cooling functions

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Struvite Control

- Control strategies that can be employed
  - Glass line piping downstream of digesters (minimize attachment)
  - Add ferric chloride, ferric sulfate or alum at digesters to form vivianite (minimize formation)
  - Research and pilot testing of magnesium hydroxide addition at anaerobic digester or to centrate to precipitate out struvite
    - If added at digester, struvite bound in sludge
    - If added to centrate, requires aeration and separation
  - Facilities often take multiple strategy approach

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Chapter 6 – Conveyance System Evaluation

Jerry Bish

Chapter 6 – Conveyance System Evaluation

- Comprehensive system review
- Hydraulic capacity analysis
  - Existing
  - Future
- Wet weather capacity impacts
- Plant interconnect pipeline
- CIP capacity projects

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Regulatory Standards – CMOM

- 2008 – Standardized Rule
- Convey peak dry and wet weather flows
- Convey 10-year-24-hour rain event
- Upgrade deficient system elements within 10 years
- Prevent SSOs
- Capital Improvement Plan

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Regulatory Standards – Other

- Max Dry Weather d/D = 0.75
- Appropriate peaking factor
- Wet weather allowance based on:
  - Percentage of peak dry weather flow
  - Gallons per acre
- Minimum depth of cover = 3 feet
- V_d = 2 – 10 feet/second

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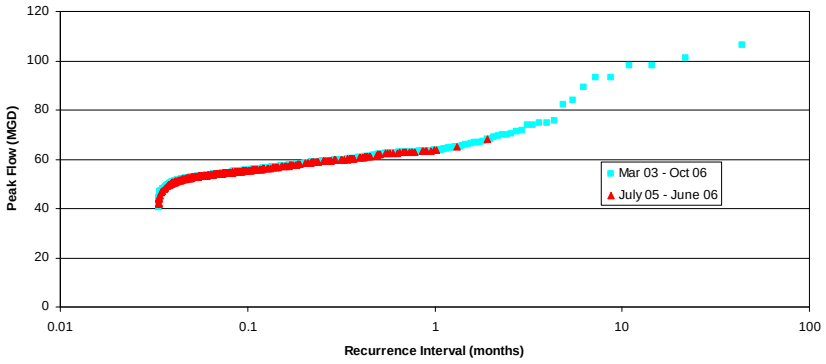
Roger Road Peak Flow Analysis

Results in 264 gpd/acre



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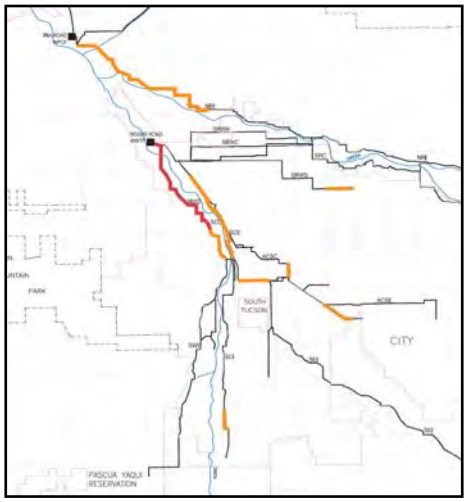
Existing Capacity Issues



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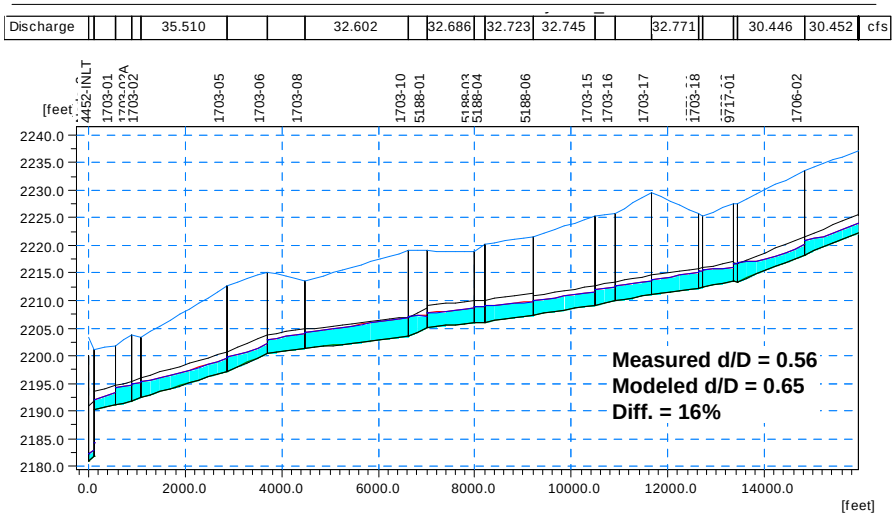
NRI Profile



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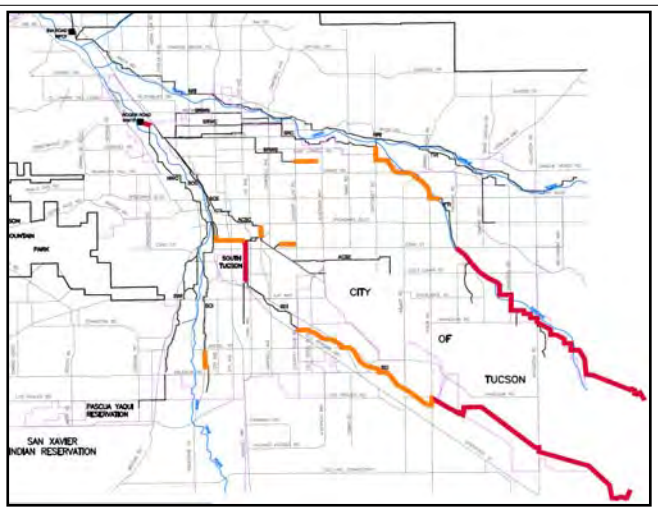
2030 Capacity Issues



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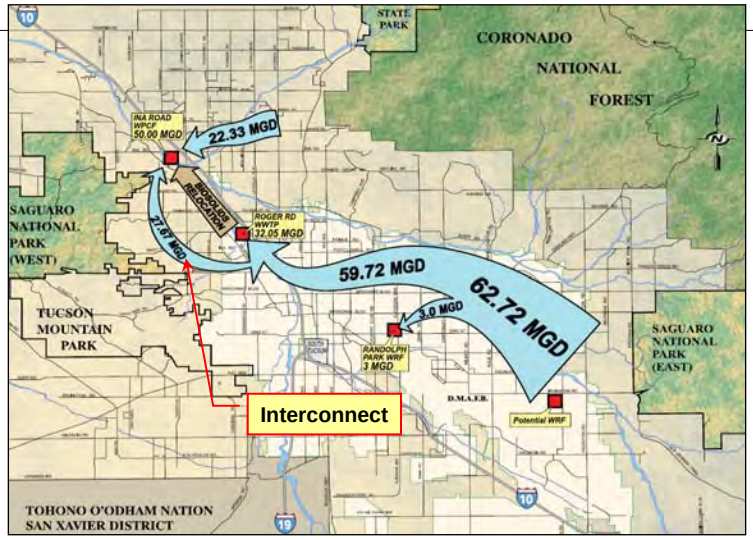
Plant Interconnect



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Interconnect Costs

	Route	Pipe Size	Cost (millions)	Not Included
Existing Plan	Route 1	54" - 66"	$18.90	R.O.W. acquisition
	Route 2	54" - 66"	$29.60	
	Route 4	54" - 72"	$28.00	
Transfer Some	Route 1	54" - 60"	$17.80	R.O.W. acquisition
	Route 2	54" - 66"	$28.90	
	Route 4	48" - 66"	$25.90	
Transfer All	Route 1	66" - 96"	$26.70	R.O.W. acquisition Return pumping of 37 MGD
	Route 4	72" - 84"	$37.10	Return pumping of 37 MGD

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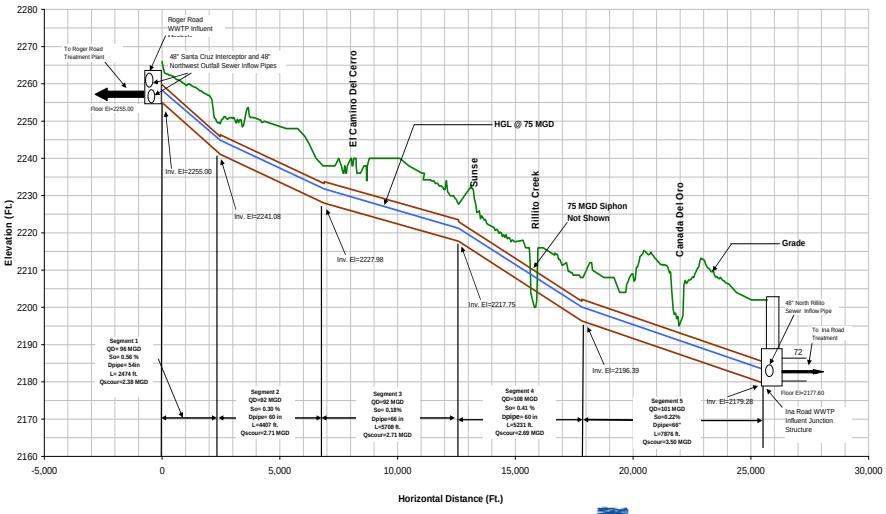
Plant Interconnect – Route 1



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CIP Projects

Project	MH Start	MH End	Year	Item	Qty	Units	Unit Cost	Cost	Type
1	4636-30A	4190-05A	2020	Replace 18" pipe with 21"	10,336	FT	$290.22	$3,000,000	Congested
				Project 1 Subtotal				*$3,000,000*	
2	6036-21	3979-101	2015	Replace 18" pipe with 24"	1,193	FT	$433.58	$513,000	Congested Road
	3919-101	6031-01		Replace 18" pipe with 24"	5,466	FT	$166.33	$913,000	Open Area
				Project 2 Subtotal	*6,669*			*$1,426,000*	
3	8635-11	8635-10	2020	Replace 18" pipe with 21"	620	FT	$350.02	$217,000	Semi-Congested Rd.
				Project 3 Subtotal				*$217,000*	
4	5627-08A	9907-49	2010	Replace 15" pipe with 24"	5,050	FT	$376.69	$1,902,000	Open Area
				Project 4 Subtotal	*5,050*			*$1,902,000*	
5	8130-01	1779-02	2016	Replace 30" pipe with 42"	1,163	FT	$271.29	$313,000	Open Area
	9917-20	9910-21		Replace 33" pipe with 36"	5,402	FT	$504.30	$2,724,000	Semi-Congested Road
	6887-01	6862-01		Replace 30" pipe with 42"	3,875	FT	$588.84	$2,281,000	Semi-Congested Road
	1779-02	6887-01		Replace 30" pipe with 42"	1,416	FT	$588.84	$833,000	Semi-Congested Road
	9910-21	9910-19		Replace 36" pipe with 42"	660	FT	$506.07	$278,000	Congested
				Project 5 Subtotal	*12,306*			*$6,429,000*	
6	8149-05	1726-29	2010	Replace 15" pipe with 21"	3,943	FT	$401.46	$1,583,000	Congested Road
	3983-05	8149-05		Replace 15" pipe with 24"	887	FT	$376.69	$334,000	Semi-Congested Road
	1726-29	1726-26		Replace 18" pipe with 24"	1,368	FT	$433.58	$592,000	Congested Road
	1726-26	1726-19		Replace 24" pipe with 30"	3,776	FT	$428.37	$1,618,000	Semi-Congested Road
				Project 6 Subtotal	*9,994*			*$4,137,000*	
7	4630-09	4630-02	2016	Replace 21" pipe with 24"	3,013	FT	$166.33	$501,000	Open Area
				Project 7 Subtotal	*3,013*			*$501,000*	
8	1761-09	1761-01	2010	Replace 18" pipe with 24"	4,712	FT	$376.69	$1,775,000	Semi-Congested Road
				Project 7 Subtotal	*4,712*			*$1,775,000*	
9	6628-01	6604-16A	2010	Replace 8" pipe with 15"	100	FT	$287.54	$29,000	Semi-Congested Road
				Project 7 Subtotal	*100*			*$29,000*	
10	9521-02	9549-05	2020	Replace 15" pipe with 18"	1,008	FT	$317.61	$319,000	Semi-Congested Road
				Project 7 Subtotal	*1,008*			*$319,000*	
Misc			2010	Fully Open Gate at Manhole 9910-21 Diversion	1	EA	$0.00	$0	
	1708-22	6604-16A		36" Reverse Sewer	2,160	FT	$504.00	$1,094,000	
				Grand Total				*$20,819,000*	

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Chapter 7 – Recommended Treatment Plant Plan

Joe Popeck

Recommended Treatment Plant Plan

- Transportation corridors and other area infrastructure
- Land use and area development
- Special projects
- Location of future treatment expansions
- Expansion of treatment infrastructure
- Expansion of treatment utilities and utility corridors
- Architecture and landscape
- Support facilities
- Year 2030 master plan layout for selected alternative
- Summary

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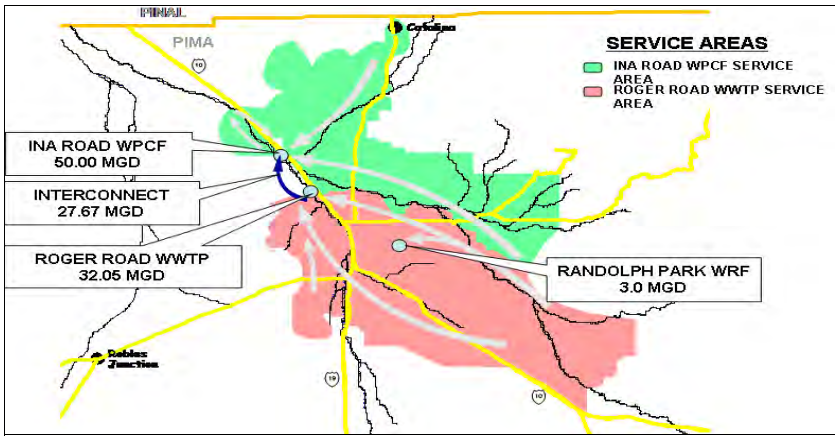
Recommended Treatment Plant Plan

Year 2030 Location of Major WWTPs Relative to the Metropolitan Tucson Service Area



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Transportation Corridors and Other Area Infrastructure

Major Transportation Corridors Near Treatment Plants

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Land Use and Area Development

- Current Land Use
  - Current land use is limited to existing treatment facilities at both treatment plant locations, except sports complex with baseball diamonds at the southeast side of Ina Road WPCF facilities

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Land Use and Area Development

Future Area Development Site Plan for RRWWTP

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Special Projects

- The Tres Rios Del Norte Project Ecosystem Restoration Feasibility study is being conducted by the Corps of Engineers with support by Pima County Regional Flood Control District (PCRFCD), City of Tucson and City of Marana. The study covers 18 miles of the Santa Cruz River from Prince Road to North Sanders Road and encompasses 19,800 acres. Objectives of the study are:
  - Ecosystem restoration
  - Flood damage control
  - Groundwater recharge
  - Recreation
  - Cultural resource preservation

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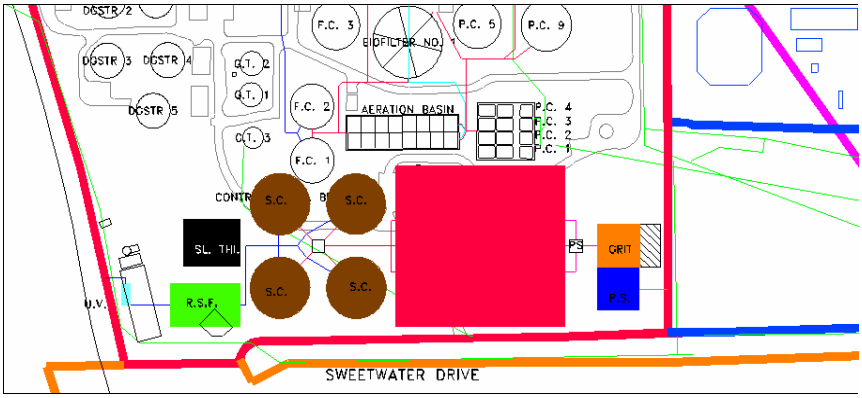
Location of Future Treatment RRWWTP

Roger Road – 32 MGD Facility



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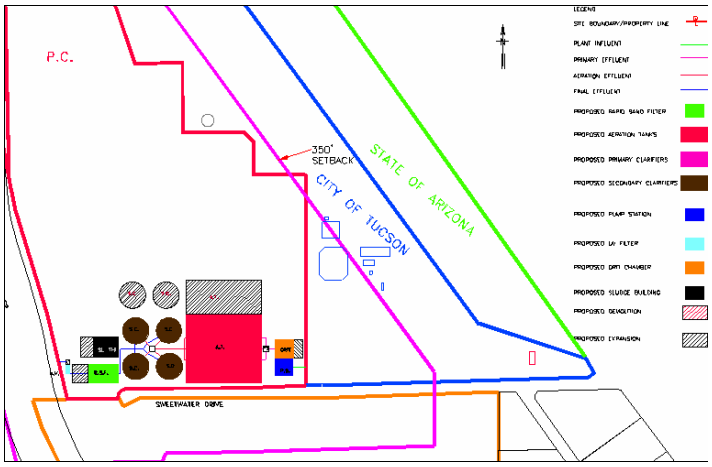
Location of Future Treatment Expansions

Roger Road WWTP Future Expansion Beyond Year 2030



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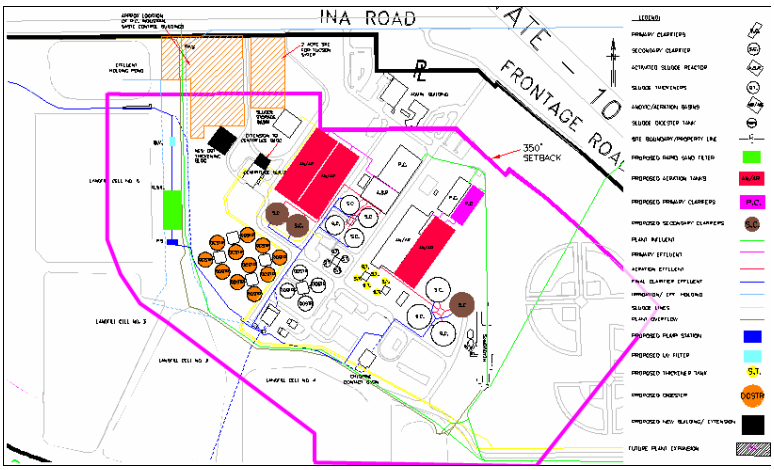
Location of Future Treatment IRWPCF

Ina Road WPCF 50 MGD Site Plan for Year 2030



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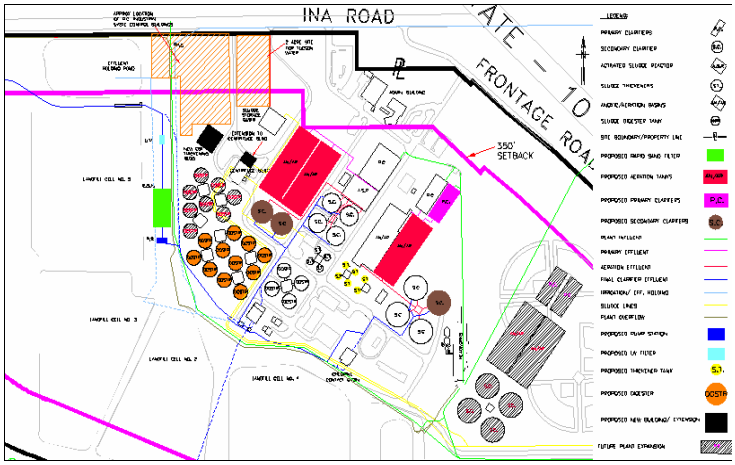
Location of Future Treatment Expansions

Ina Road WPCF Future Expansion Beyond Year 2030



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Expansion of Treatment Utilities and Utility Corridors

- Power Supply – Roger Road WWTP
  - Plant is presently served by a 2400 volt, 3-phase, 3-wire delta ungrounded electrical service from Tucson Electric Power Company
  - Utility service drop consists of 3-500kVA transformers feeding a Main Switchgear that is configured in a hot sequence arrangement with six fusible contactors
  - 2400 volt power is distributed to Power Centers and transformers throughout the site
  - Motor control centers are configured in a Main-Tie-Main circuit breaker arrangement with one main served from the utility source and the other from plant generators

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Expansion of Treatment Utilities and Utility Corridors

- Power Supply – Roger Road WWTP *(continued)*
  - Plant generators consist of 3-400kW, 480 volts, 3-phase, 3-wire delta ungrounded natural/methane duel fuel engine driven generators
  - Existing power distribution system will remain to serve the existing plant with minor alterations made to provide power to interim and temporary plant improvements
  - Plant to be served with a new power distribution system
  - System will have redundant power sources

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Expansion of Treatment Utilities and Utility Corridors

- Power Supply – Ina Road WPCF
  - Plant is served from two utility sources with multiple service drops and on site generators
  - Original treatment plant constructed during the 1970's and Centrifuge Building added in the 1980's is powered by generators at the plant power generation facility
  - Plant expansion is powered from three separate Tucson Electric Power (TEP) incoming utility electric services

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Expansion of Treatment Utilities and Utility Corridors

- Power Supply – Ina Road WPCF *(continued)*
  - Plant power generation system consists of seven 650kW, 4160 volts, 3-phase generators connected in parallel to 4.16kV Switchgear "A/B"
  - Three TEP incoming utility electric services are located at the Headworks, New RAS/WAS Pump Station and the Blower Building

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Expansion of Treatment Utilities and Utility Corridors

- Power Supply – Ina Road WPCF *(continued)*
  - A unified power distribution system will be implemented as plant is expanded
  - Unified system will feature redundant power sources. This will consist of dual utility sources, on site generators or combinations of both
  - Three existing utility services will ultimately be decommissioned and equipment combined into new distribution system

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Expansion of Treatment Utilities and Utility Corridors

- Potable Water Supply
  - Potable water is supplied to RR WWTP and IRWPCF by Tucson Water
  - A new potable water supply network will be provided for new Greenfield facility at Roger Road WWTP and the existing potable water system will be decommissioned upon startup of new facilities

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Expansion of Treatment Utilities and Utility Corridors

- Reuse Water Supply
  - At RR WWTP up to 30 mgd of plant effluent will be available to Tucson Water from new Greenfield Plant
  - At IR WPCF up to 20 mgd of plant effluent will be made available to Tucson Water
    - New supply, reservoir system, distribution disinfection system and distribution piping will be constructed by Tucson Water on a parcel of land at IRWPCF, provided by Pima County

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Expansion of Treatment Utilities and Utility Corridors

- Plant Air Supply
  - New plant air supply system will be provided for new Roger Road WWTP facilities
  - Existing plant air supply system at the Ina Road WPCF will be upgraded to facilitate needs for the expanded future facilities

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Architecture and Landscape

- Existing facilities consist of a wide variety of architectural styles and landscape types, reflecting independent decisions made at each plant expansion
- Through the year 2030 planning horizon, architectural and landscaping design will be guided by a single architectural and landscape theme to harmonize existing and new facilities consistent with new land use plan

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Support Facilities

- Odor Control
  - Year 2030 plan will provide a long-term solution for potential odors from both collection system and wastewater treatment plants. Odor control measures will include:
    - Minimize odor potential in collection system with pH adjustment, oxygen addition and chemical addition
    - Cover openings and channels
    - Collect and treat odorous air
    - Disperse treated air into atmosphere in a manner to minimize odor impact to surrounding communities

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Support Facilities

- Personnel Facilities (to be developed)
- Maintenance Facilities (to be developed)
- Laboratory Facilities (to be developed)
- Parking (to be developed)
- Support Facilities (to be developed)
- SCADA (to be developed)
- Chemical Handling (to be developed)
- Security (to be developed)
- Plant Stormwater Plan (to be developed)

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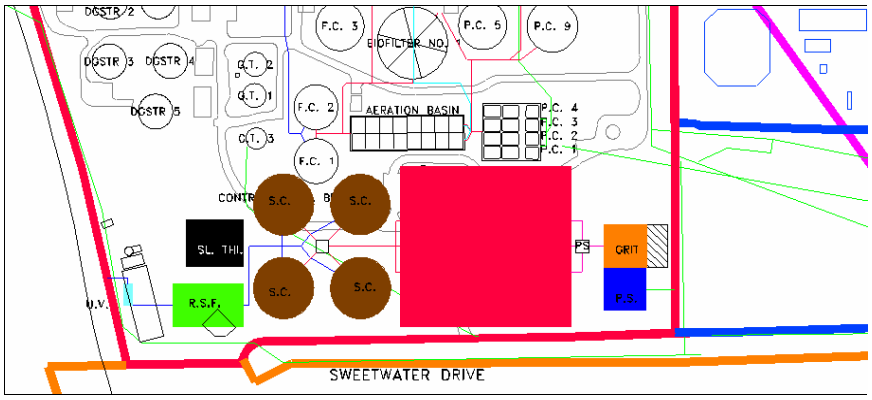
Year 2030 Master Plan Layout for Selected Alternative

Roger Road WWTP – Year 2030 Master Plan Layout



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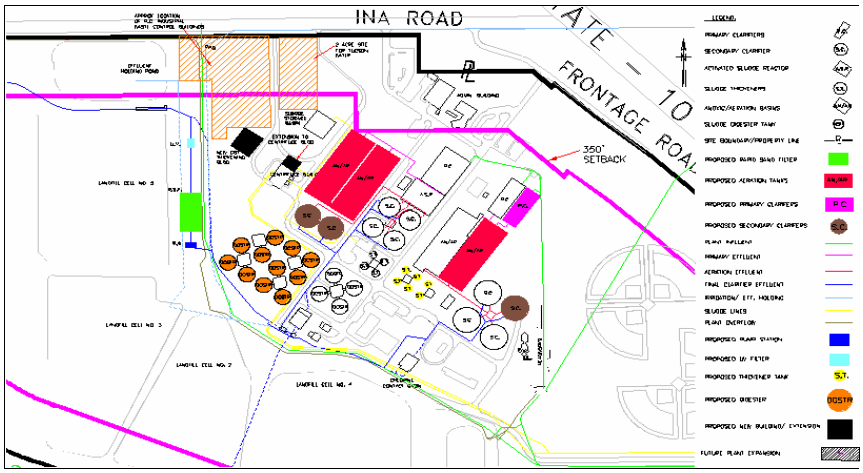
Year 2030 Master Plan Layout for Selected Alternative

Ina Road WPCF – Year 2030 Master Plan Layout



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Summary

- Recommended treatment plant plan for the year 2030 provides a new plant at Roger Road WWTP and an expansion of existing plant at Ina Road WPCF
  - Transport corridors and storm water and flood control measures
  - New multi-faceted recreational, commercial and ecological development adjacent to the RR WWTP
  - Ecosystem restoration and creation of riparian habitat in the Santa Cruz River
  - Provision for future expansion beyond the year 2030 at both treatment facilities
  - New infrastructure to be constructed
  - Existing infrastructure to be expanded, upgraded or demolished
  - Expansion of infrastructure to accommodate the increased flows to be handled at both plant locations
  - Provision for new and/or expansion of the utilities including power, potable water, reuse water and plant air supply.
  - Architecture and landscape amenable to provide public friendly image
  - Complete Plant-wide Odor Control at each facility and the Conveyance System

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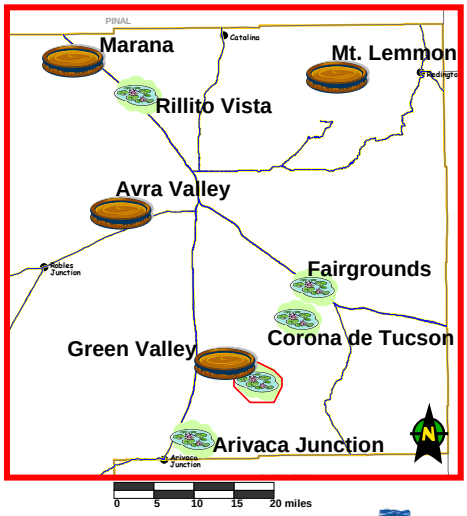
Chapter 8 – Non-Metropolitan Area Evaluation

Jerry Bish

Non-Metro Facilities



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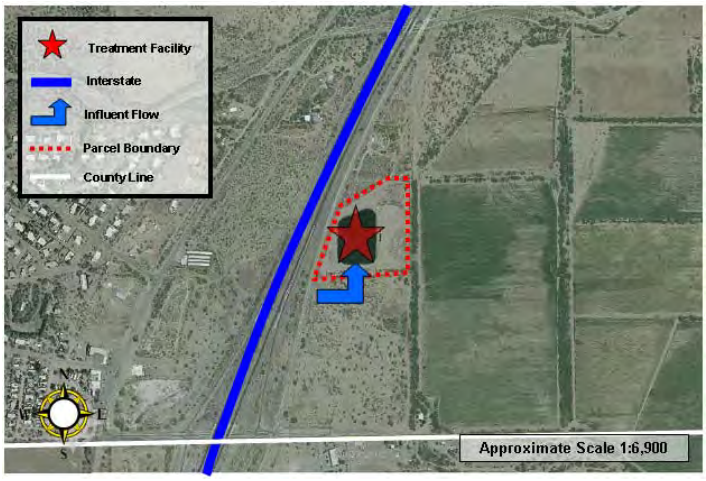
Arivaca Junction WWTF



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Avra Valley WWTF

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Corona de Tucson WWTF

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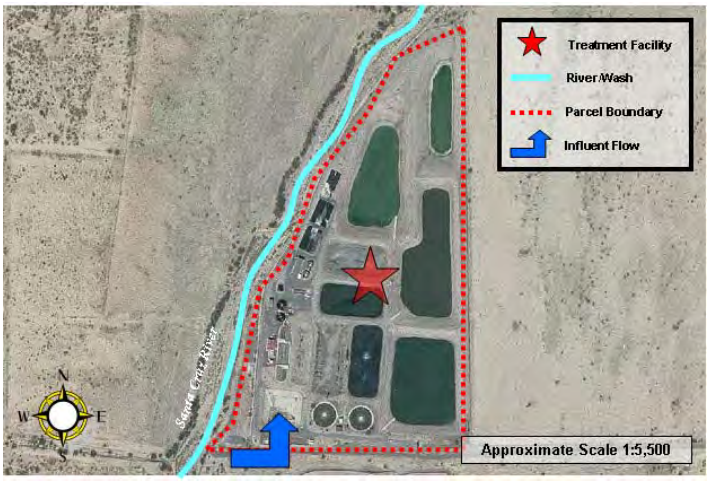
Green Valley WWTF



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Marana WWTF

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Mt. Lemmon WWTF

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Pima County Fairgrounds WWTF

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Rillito Vista WWTF

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Reclaimed Water Permits

Facility	Permit	Produced (gpd)(1)	Percent of Total Treated
Arivaca Junction	Class C	40,000	68
Avra Valley	Class B+	320,000	30
Green Valley	Class A+ (BNROD) Class B (lagoon)	1,500,000	~~86~~ 100
Marana	Class B+	57,000	38
Mt. Lemmon	Permit (AZPDES)	2,000	100

(1) 2005 Effluent Generation/Utilization Report

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Summary of Non-Metro Facilities

Facility	Facility Parcel Area (acres)	Design Capacity (mgd)	Current Treatment Technology	Current Effluent Utilization
Arivaca Junction	10.5	0.1	Partially mixed, aerated lagoon	Percolation/evaporation. Class C delivered to Reventone Ranch.
Avra Valley	~~280~~ 139*	1.2	BNROD	Plant irrigation (Class B+). Percolation/evaporation.
Corona de Tucson	200	0.3	Partially mixed aerated lagoons	Evaporation, SAT.
Green Valley	68	2.0 BNROD 2.1 lagoon	Primarily BNROD. Excess inflow sent to aerated lagoons.	Delivered to Quail Creek for irrigation (Class A+). Plant irrigation (Class B). Percolation.
Marana	156	0.2	Smith & Loveless BNR package plants. Interim Parkson Biolac.	Plant irrigation (Class B+). Possible riparian restoration.
Mt. Lemmon	1.7	0.015	Enclosed extended air package plant.	Spray field irrigation.
PC Fairgrounds	8.8	0.035	Stabilization ponds.	Percolation/evaporation.
Rillito Vista	-	0.02	Stabilization ponds.	Percolation/evaporation.

*Additional 140-acres of land adjacent to facility parcel.

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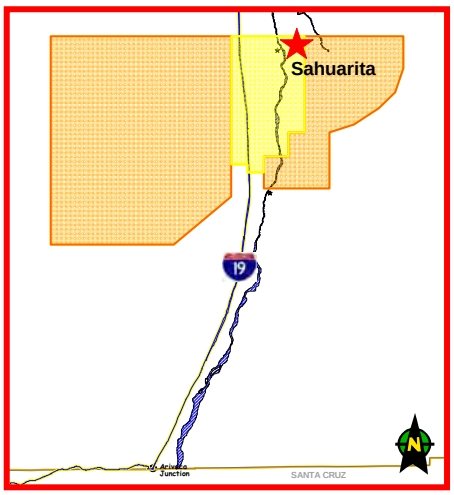
Sahuarita Designated Management Agency

- Negotiation to modify service-area



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Flow Projections

Facility	2010	2015	2020	2025	2030
Avra Valley	1.4	1.8	2.2	2.6	3.0
Corona de Tucson	0.5	0.9	1.3	1.7	2.1
Green Valley	2.7	3.1	3.6	4.0	4.4
Marana	1.6	2.3	3.0	3.7	4.4
Mt. Lemmon	0.002	0.002	0.002	0.002	0.002
Southlands (excludes Corona)	1.2	3.6	6.0	8.2	10.5

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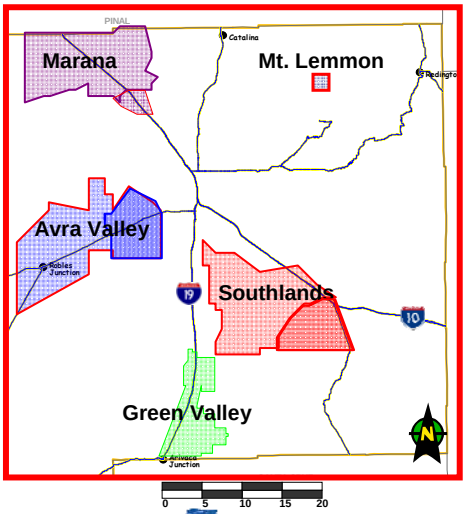
Service Areas (2030)

- Change Avra's service-area



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Current Water Reuse

Current Water Reuse		
Facility	**Permit**	**Use**
Arivaca Junction	Class C	Reventone Ranch (Agriculture)
Avra Valley	Class B+	Spray Field Disposal
Green Valley	Class A+	Robson/Quail Creek, Inc. (Turf Irrigation)
Marana	Class B+	~~Santa Cruz River Discharge and~~ Plant Turf Irrigation
Mt. Lemmon	~~USFS~~ AZPDES Permit	Spray Field Disposal

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Current Biosolids Production

Current Biosolids Production		
Location	**Produced (tpd)**	**Processing, Disposal**
Arivaca Junction	0.09	-
Avra Valley	2.2	Storage, transported to Roger Road
Corona de Tucson	0.16	Evaporation, hauled to landfill when pond is cleaned
Green Valley	5.7	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana	0.28	Storage, transported to Ina Road
Mt. Lemmon	0.018	Storage, transported to Ina Road
PC Fairgrounds	0.004	Evaporation, hauled to landfill when pond is cleaned
Rillito Vista	0.014	-
Total	**8.47**	

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Future Biosolids Production

Future Biosolids Production						
Location	**Produced (tpd)**					**Processing, Disposal**
	2010	**2015**	**2020**	**2025**	**2030**	
Arivaca Junction	-	-	-	-	-	-
Avra Valley	3.12	3.67	4.20	4.73	5.26	storage, hauled ⇒ regional facility
Corona de Tucson	1.50	2.07	2.63	3.21	3.77	storage, hauled ⇒ regional facility
Green Valley	2.79	3.79	4.79	5.80	6.79	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Marana	3.79	4.40	5.00	5.60	6.20	storage, hauled ⇒ regional facility
Mt. Lemmon	4.22	4.22	4.22	4.22	4.22	storage, hauled ⇒ regional facility
PC Fairgrounds	-	-	-	-	-	-
Rillito Vista	-	-	-	-	-	-
Southlands	1.68	5.04	8.40	11.48	14.70	separate processing and disposal
Total	**17.10**	**23.19**	**29.24**	**35.04**	**40.94**	

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Chapter 9 – Recommended Non-Metropolitan Area Treatment and Expansion Plan

Jerry Bish

Influent Wastewater Characteristics

Characteristic	Non-Metro Facility Influent Concentrations (mg/L)
BOD_5	300
$SBOD_5$	125
COD	590
TSS	270
VSS	220
TKN	57
TP	10

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Probable Effluent Quality

Parameter	Effluent Quality
BODs	< 6 mg/L
TSS	< 10 mg/L
NH4-N	< 1 mg/L
TN	< 10 mg/L
TP	< 1 mg/L
Pathogen removal	No detect in 4 of 7 samples/week. None exceeding 23cfu/100ml
pH	6.8 – 7.2

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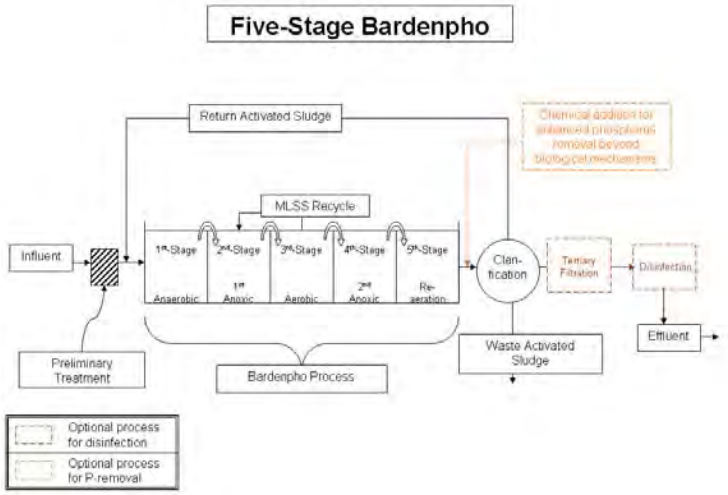
Bardenpho Process



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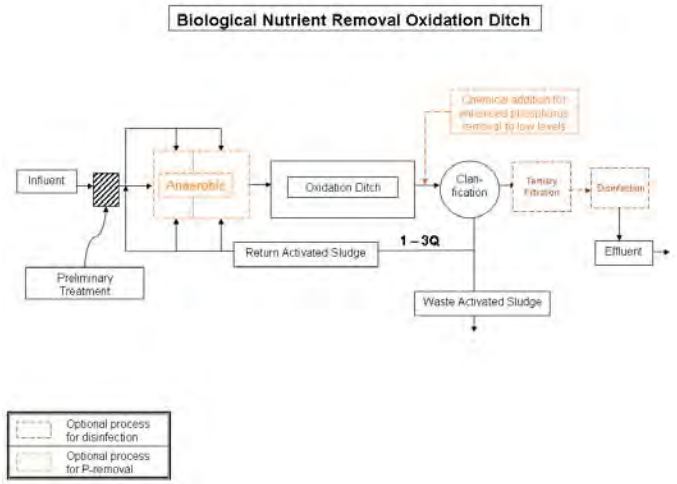
BNROD



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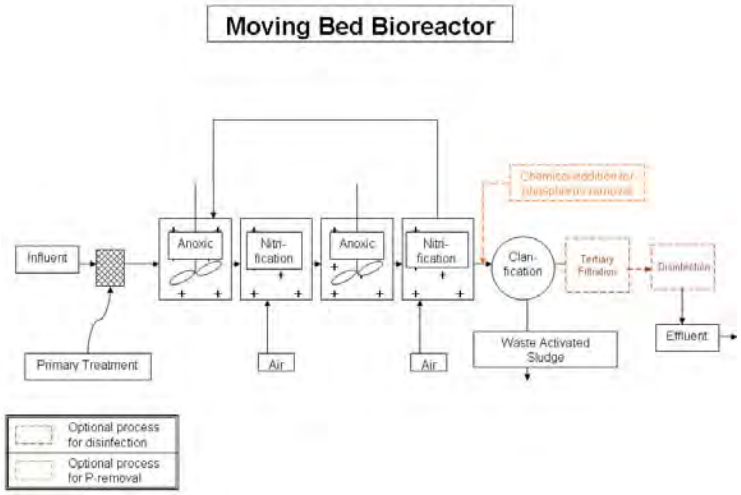
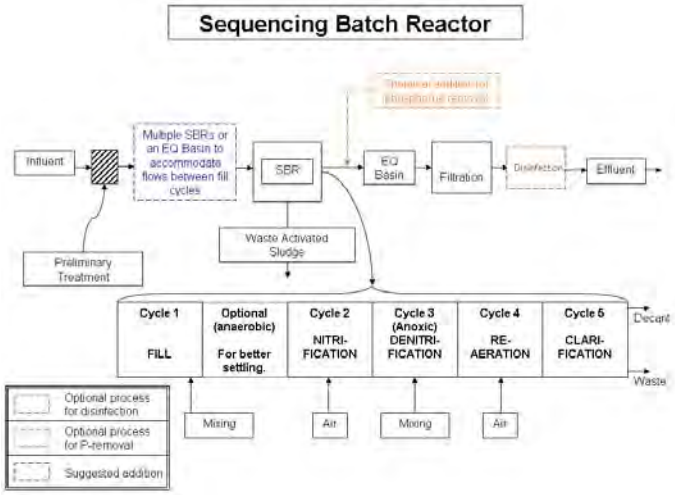
MBBR

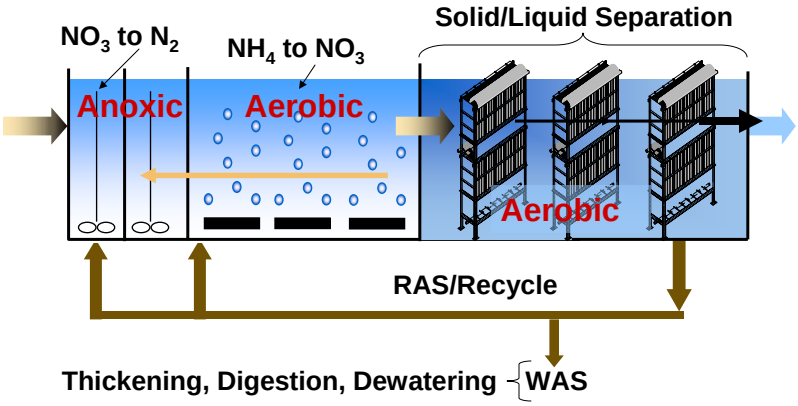


134

SBR



Membrane Bio-Reactor



Evaluation Matrix

Criteria	WF	Bardenpho	[illegible]	[illegible]	[illegible]	[illegible]	BNROD	MBBR	SBR
Cost	5	[illegible]	[illegible]	3	5	[illegible]	[illegible]	15	25
Environmental Impact	4	[illegible]	4	1	2	[illegible]	[illegible]	4	8
Feasibility	3	[illegible]	1	4	[illegible]	[illegible]	[illegible]	12	9
Operation Compatibility	4	[illegible]	3	4	[illegible]	8	[illegible]	16	4
Land Required	2	[illegible]	4	[illegible]	[illegible]	6	[illegible]	2	4
Maintenance	4	[illegible]	1	[illegible]	4	8	[illegible]	12	16
Public Acceptability	4	[illegible]	3	[illegible]	1	16	[illegible]	8	4
Reliability	4	[illegible]	[illegible]	[illegible]	3	8	[illegible]	16	12
Sludge Production	1	3	[illegible]	4	2	[illegible]	[illegible]	4	2
Water Reuse Potential	4	2	[illegible]	[illegible]	[illegible]	[illegible]	16	4	12
Sum of Weighted Rank[illegible]						[illegible]	96	93	96

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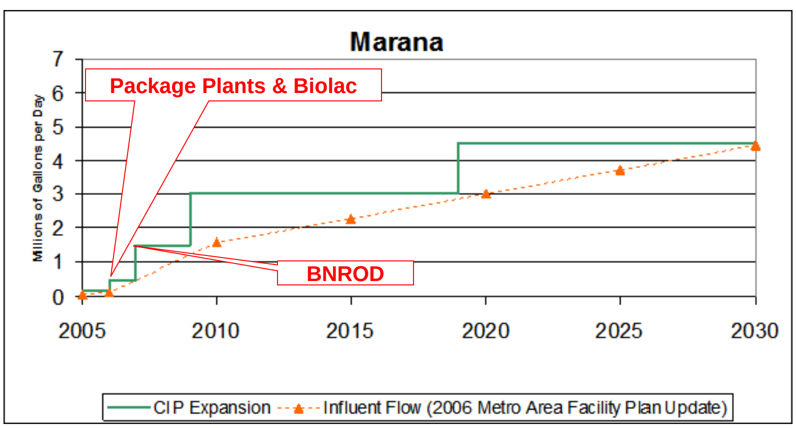
Marana – Flow/Capacity



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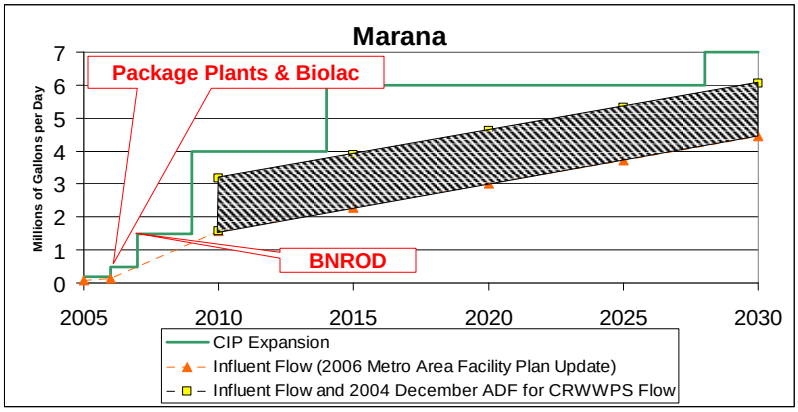
Marana – Flow/Capacity



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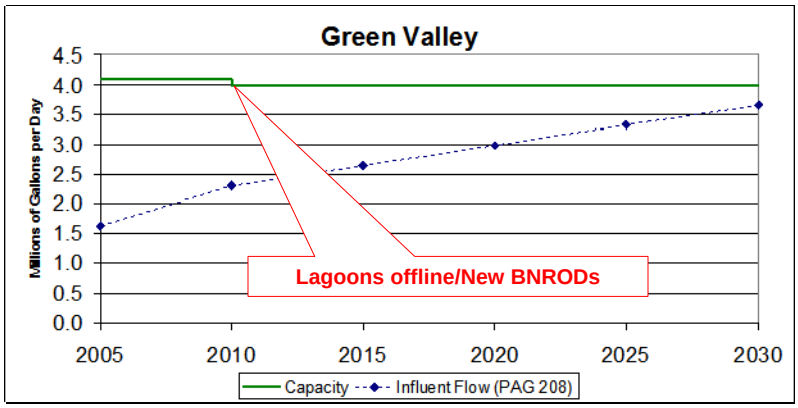
Green Valley – Flow/Capacity



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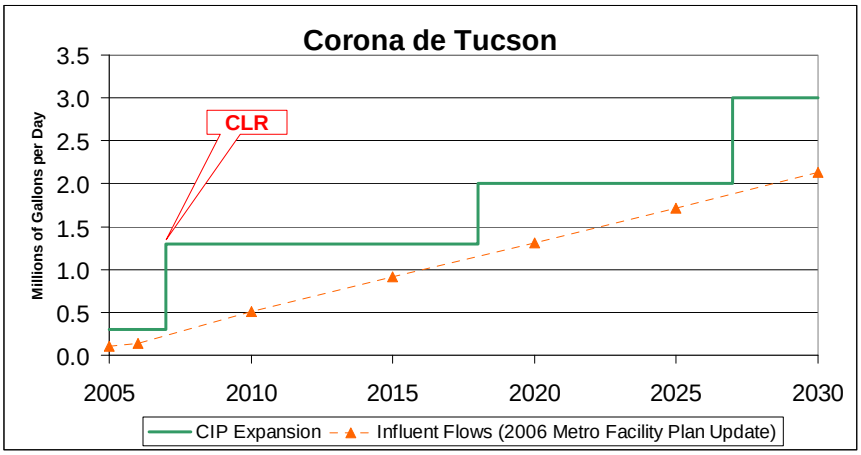
Corona de Tucson –Flow/Capacity



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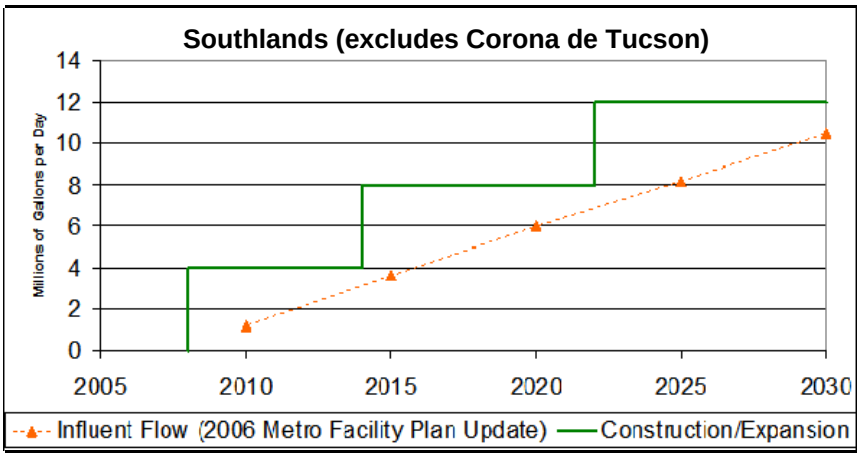
Southlands – Flow/Capacity



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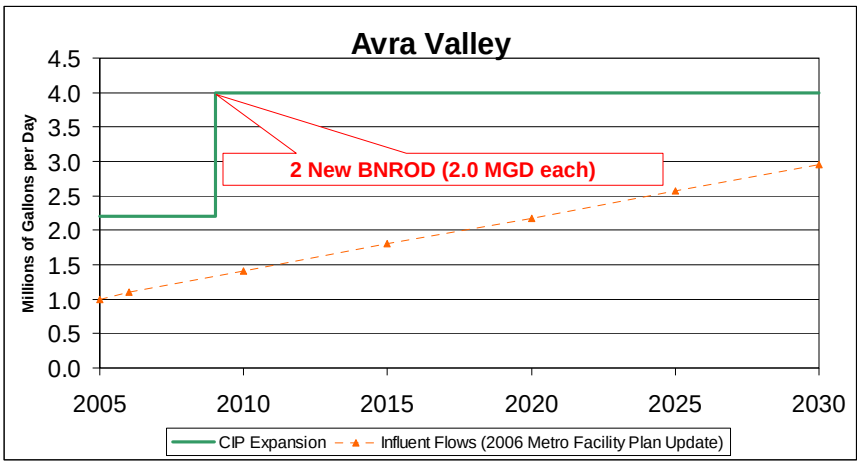
Avra Valley – Flow/Capacity



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Chapter 10 – CIP Elements

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CIP Elements

- Plant interconnect
- Roger Road
- Ina Road
- Support Facilities
- Non-Metro Facilities Expansions

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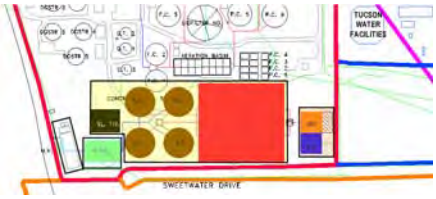
Roger Road WWTP

- Site preparation (temporary administration building)
- Headworks
- Bardenpho treatment (including clarifiers, solids thickening/pumping)
- Pump station/filtration
- UV disinfection
- Administration/control building
- Standby power generation
- Future 8-mgd Bardenpho system (including clarifier)
- Future gravity belt thickeners
- Existing Roger Road Facility demolition



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Ina Road WPCF

- Site preparation
- Primary clarifier
- Bardenpho treatment (including clarifiers)
- Demolish HPO and oxygen system
- Mesophilic digestion (4 new, 4 existing)
- Gravity thickening (primary sludge)
- Gravity belt thickening (WAS sludge)
- Centrifuge dewatering
- Sludge storage
- Pump station/filtration
- UV disinfection
- Centralized laboratory
- Power unification/biogas power generation
- Future mesophilic digester
- Future centrifuge thickener
- Future thermophilic digesters

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Non-Metro Facilities Expansion

- Southwest Region
  - Avra Valley WWTF
    - Expansion 1 (from 1.2 to 2.2 MGD)
    - Expansion 2 (Phase out existing BNROD and start up 2 new BNROD trains providing a total treatment capacity of 4.0 MGD)
    - Expansion 3 (rehabilitate old BNROD to add 1.6 MGD of treatment capacity)
- Southeast Region
  - Corona de Tucson WWTF
    - Expansion 1 (from 0.3 to 1.3 MGD)
    - Expansion 2 (from 1.3 to 2 MGD. This requires closing the lagoons and adding a new 1 MGD treatment facility.)
    - Expansion 3 (from 2 to 3 MGD)
  - Southland WWTF
    - Expansion 1

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Non-Metro Facilities Expansion

- South Region
  - Green Valley WWTF
    - Expansion 1 (from 4.1 MGD BNROD/Aerated Lagoon to 4.0 MGD BNROD)
    - Expansion 2 (from 4.0 MGD to 5 MGD)
    - Decommission Arivaca Junction WWTF
- Northwest Region
  - Marana WWTF
    - Expansion 1 (from 0.5 to 1.5 MGD)
    - Expansion 2 (from 1.5 to 3 MGD)
    - Expansion 3 (from 3 to 4.5 MGD)
    - Expansion 4 (from 4.5 to 6 MGD)
    - Decommission Rillito Vista WWTF
- Mt. Lemmon WWTF
  - No change unless changes in area restrictions

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Chapter 11 – CIP Delivery Method

Jerry Bish

Alternative Delivery Methods

- Design-Build
- Design-Build-Operate
- Construction-Manager-At-Risk
- Design-Bid-Build

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Procurement Method Selection Considerations

- Procurement process
- Design and construction
- Operation and maintenance

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Chapter 12 – CIP Phasing and Cost Schedules

Jerry Bish

Chapter 12 – CIP Phasing and Cost Schedules

- *Capital Projects*
  (Include final agreed upon ROMP projects and costs)
- *Other Capital Projects*
  (Include 15-year CIP information)
- *Total Capital Plan*
  (Include 15 year CIP information)
- Zero Coupon Bonds and Capital Appreciation Bonds
  (Insert current data on interest rates for zero coupons)
- State Revolving Funds
  (Provide current information regarding availability of WIFA funds)

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Chapter 12 – CIP Phasing and Cost Schedules

- *Baseline Financing Plan*
  (Evaluate options once costs finalized)
- Customer Impacts
  (CIP data required)
- *Applicability of International Finance to Pima County*
  (Requires further research)

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Chapter 12 – CIP Phasing and Cost Schedules

- *Private Financing Approaches in the United States*
  (Requires further research)
- Private Activity Bonds
  (Update to address pending legislation that may make PABs a more viable option)
- Tax-Exempt Corporation
  (Update after further discussions with the County)
- *Private Financing Case Studies in the United States*
  (Requires further research)

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Chapter 13 – Implementation Plan

Jerry Bish

Chapter 13 – Implementation Plan

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Interconnect	**$22,300,000**															
Design																
		$1,338,000														
Construct																
				$20,962,000												
Ina Rd	**$243,900,000**															
Design 50 mgd																
		$14,634,000														
Construct 50 mgd																
					$212,193,000											
Construct Thermophilic Digestion																
														$17,073,000		
Roger Rd	**$234,800,000**															
Design 32 mgd																
			$12,660,000													
Construct 24 mgd																
							$148,755,000									
Demo Existing Plant																
									$23,800,000							
Construct 8 mgd																
											$49,585,000					

Total ROMP Projects Cost $501,000,000

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Implementation Details

- List of CIP projects
  - Metro/Non-Metro Facilities
  - Conveyance
- Scheduled implementation
- Project delivery
- Funding source

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Other Topics

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Chapter 5.8 – Biogas Utilization

Vic Smith

2014 Biogas Production

(@ 550 BTU per cubic foot)

479 MCF per year

263 kMBTU per year

2,633 kTherms per year

30,070 kBTU per hour

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Raw Natural Gas Value

(@ $1.00 per therm)

$2,633,000 per year

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Some Other Assumptions and Clarifications

- Boiler efficiency 75%
- Electricity cost $0.09/kWH
- Over time, natural gas and electricity will escalate at approximately the same rate per energy value
- 1 kW = 3,414 BTU per hour
- M = 1,000,000
- k = 1,000
- BTUH = BTU per hour
- 1 Therm = 100,000 BTU

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Biogas Options

- On-site electricity and heat generation (combined heat and power, CHP 1 and 2)
- On-site heat and cooling generation only (heating and cooling use, HCU1)
- Third party use and agreements (TPU 1 and 2)

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Combined Heat and Power System Alternatives

- Turbines
- Microturbines
- Fuel cells
- Sterling (external combustion) engines
- IC (internal combustion) engine-generators*

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Primary CHP Selection Criteria

- Mechanical and electrical efficiencies
- Tolerance to biogas impurities
- Fit with and adaptability to existing power plant systems
- Proven technology
- Cost per kW
- Emissions

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IC (Internal Combustion) Engine Generators – Energy Balance by System and Percentage

System	% Energy in	Useful Energy
*Electricity	35%	35%
*Jacket Water	28%	28%
*Exhaust Recovered	13%	13%
Exhaust Lost	12%	
Lube Oil	5%	
Intercooler	3%	
Radiation	2%	
Generator	2%	
	100%	76%

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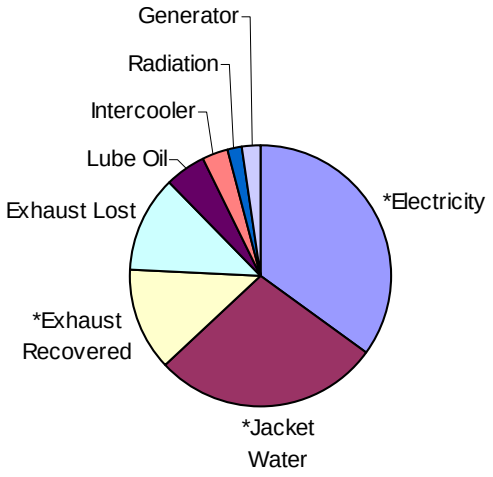
IC Engine Energy Balance – By System



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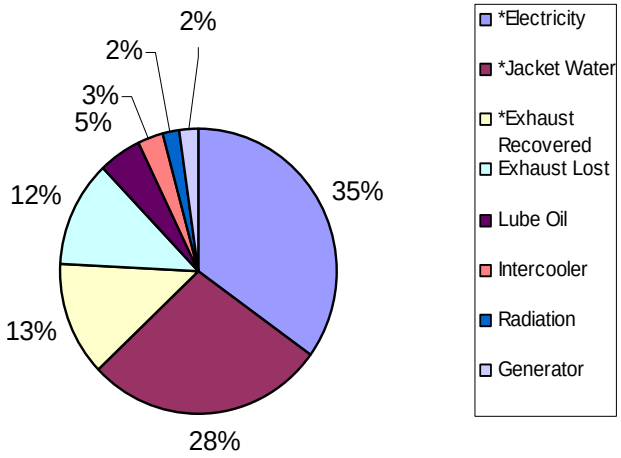
IC Engine Energy Balance – By Percentage



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Existing Power Plant IC Engine Capacities

Maximum Electric	4,550 kW
Maximum Thermal	22,400 kBTUH

Assuming One Standby and 80% of Max Output

Nominal Electric	3,120 kW
Nominal Thermal	12,400 kBTUH

Coincidental, but a surprisingly good match for projected biogas production.

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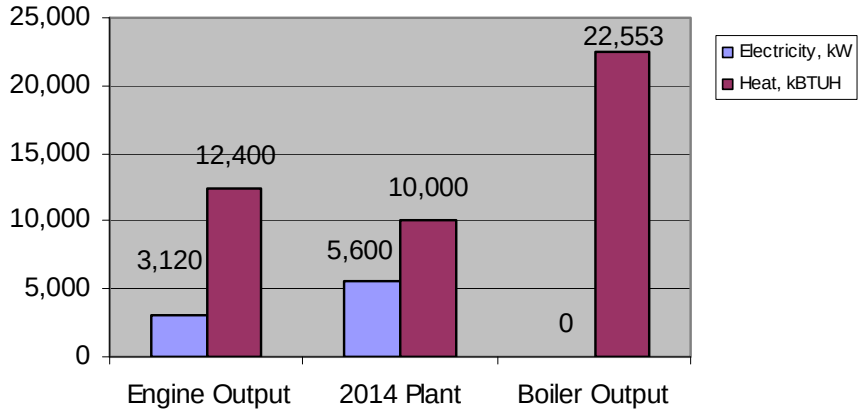
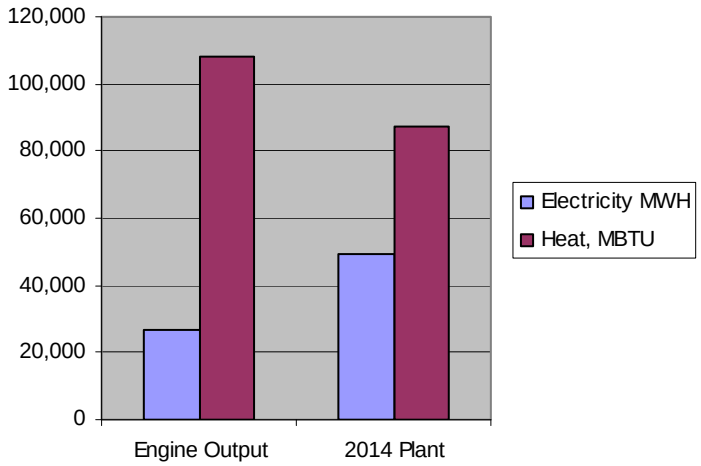
IC Generator and Boiler Outputs Compared to Projected Plant Demands



172

IC Engine Annual Energy Output Compared to Projected Plant Usages



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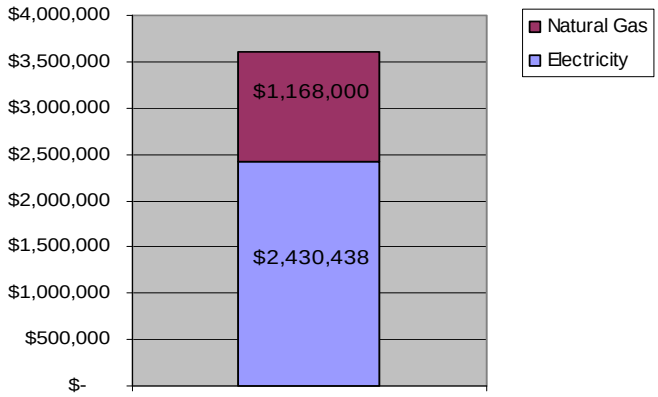
Annual IC Engine Savings



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Incremental Savings

As the size of the energy recovery facility increases:

Case 1:	**All biogas produced electricity and heat are consumed**
Case 2:	**All biogas produced electricity and part of the heat are consumed**
Case 3:	**NG is used to produce electricity up to the average demand**
Case 4:	**NG is used to produce electricity up to the peak demand**

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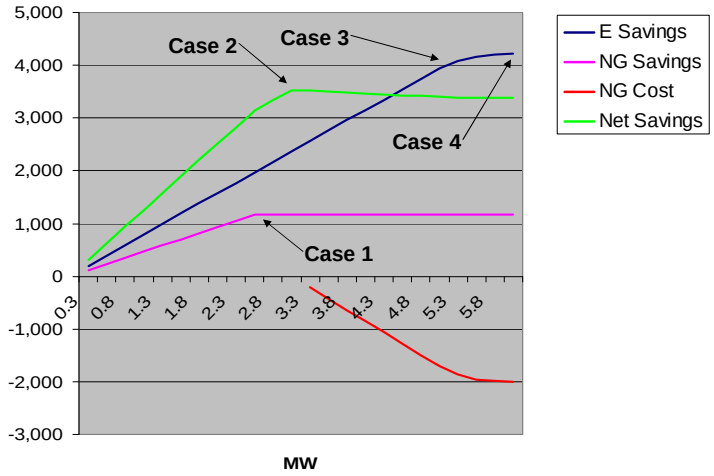
Incremental Savings ($ x 1,000)



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Savings by Case, $kWH

Case 1:	**All biogas produced electricity and heat are consumed**	**$0.13**
Case 2:	**All biogas produced electricity and part of the heat are consumed**	**$0.09**
Case 3:	**NG is used to produce electricity up to the average demand**	**($0.05)**
Case 4:	**NG is used to produce electricity up to the peak demand**	**($0.05)**

Cases 1 and 2 are representative of Option CHP1
Cases 3 and 4 are representative of Option CHP2

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Biogas Options and Alternatives

- Combined heat and power
  - CHP1: Biogas consumption only
  - CHP2: Biogas consumption and natural gas consumption to supply remaining electrical usage
- Heating and cooling use
  - HCU1: Biogas consumption for heating and cooling only
- Third party use and agreements
  - TPU1: Off-Site energy developer use
  - TPU2: On-Site energy developer (or operator) use

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CHP 1 and 2 Economics
($ x 1,000)

Option and Alternative	Capital Cost	Energy Savings	Operating Costs	Annual Savings
CHP1: BG only	5,500 to 12,000	3,595	1,475	2,125
CHP2: BG + Nat Gas	25,000 to 30,000	3,375	1,975	1,400

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CHP1 Cost Considerations

- Capital costs
  - Value of existing power plant
    - Central cooling
    - Cooling distribution
    - Central process and space heating
    - Heating distribution
    - Engine heat rejection systems
    - General infrastructure
  - Changes needed
    - New generators and synchronization
    - New electrical addition and remodeling
    - Gas conditioning
  - Closely matches projected 2014 biogas output

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CHP1 Cost Considerations
(continued)

- Operating costs
  - Gas conditioning
    - Hydrogen sulfide
    - Siloxanes
  - Consumables
  - Major overhauls (and other contract work)
  - Personnel

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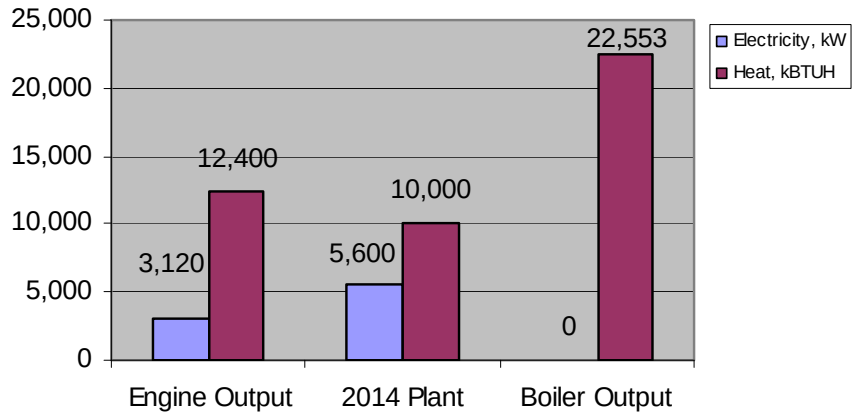
HCU1 Economics

Heating and cooling uses less than 45% of the biogas



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TPU1: Off-Site 3rd Party Use Economics

- The energy developer accrues capital and operating costs similar to those of PCWMD in option CHP1
- The energy developer faces additional capital and operating costs for gas transport
- At this point in time, there are no significant capital incentives, operating rebates or tax deductions for TPU1 (or TPU2)

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TPU2: On-Site 3rd Party Use Economics

- The energy developer does not have a significant labor advantage; other costs like consumables, overhauls, etc., are similar
- This alternative may be cumbersome from a labor relations perspective
- Proposed green and renewable initiatives are available to both PCWMD and the energy developer

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Green and Renewable Energy Incentives – REST

- Arizona Corporation Commission- Environmental Portfolio Standard (EPS): Rulemaking to encourage an increasing percentage of renewable generation- biogas is one of the renewable categories
- The program name is being changed to Renewable Energy Standard Tariff (REST) from EPS
- REST is currently out for review by manufacturers, interest groups, utilities and others
- Upon review completion and comments incorporation, the program still needs funding approval

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REST Incentives

- Proposed Incentives for biogas are:
  - $0.054 per kWH, electricity generation only, or
  - $0.031 per kWH-elec and $0.016 per kWH-thermal for CHP
- There is no 'Upfront Incentive'
- The incentives, as proposed, are transferable
- Baseline for incentive calculation is 1996 biogas consumption for electricity or CHP generation

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REST Example

- Assume the biogas flared at Roger Road could be burned in the engines at Ina Road
- Since the baseline year approximately 140MCF are flared annually
- If this gas were consumed at Ina, the annual energy savings are $845,600 assuming only half the thermal output is used, $.08/kWH and $.80/Therm
- The REST incentive, based upon its Uniform Credit Purchase Plan table, is $355,460

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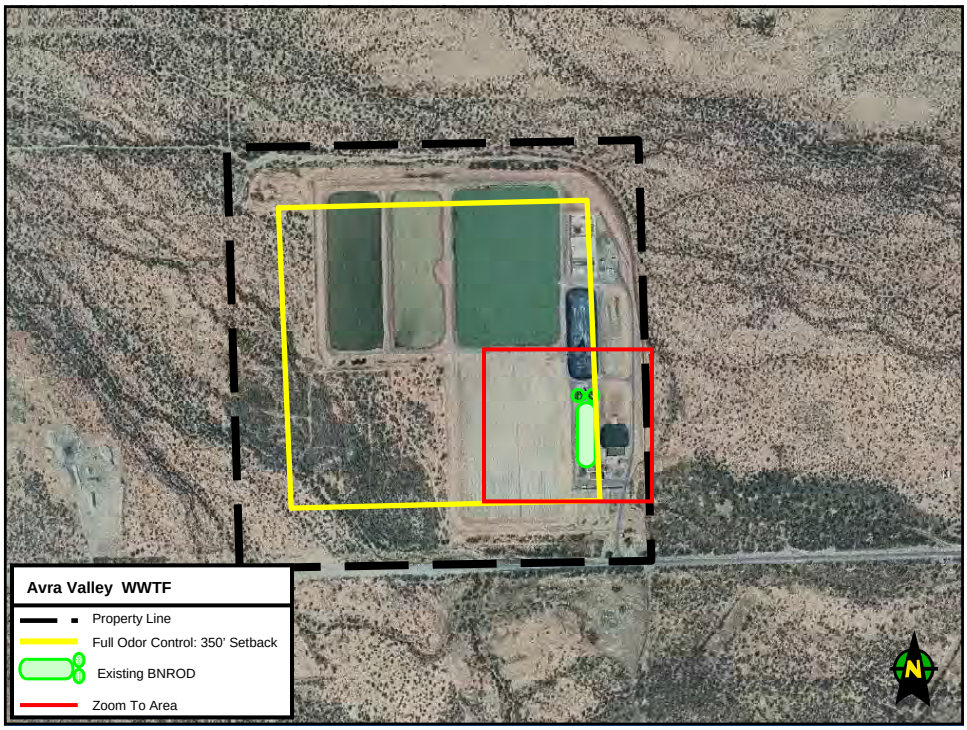
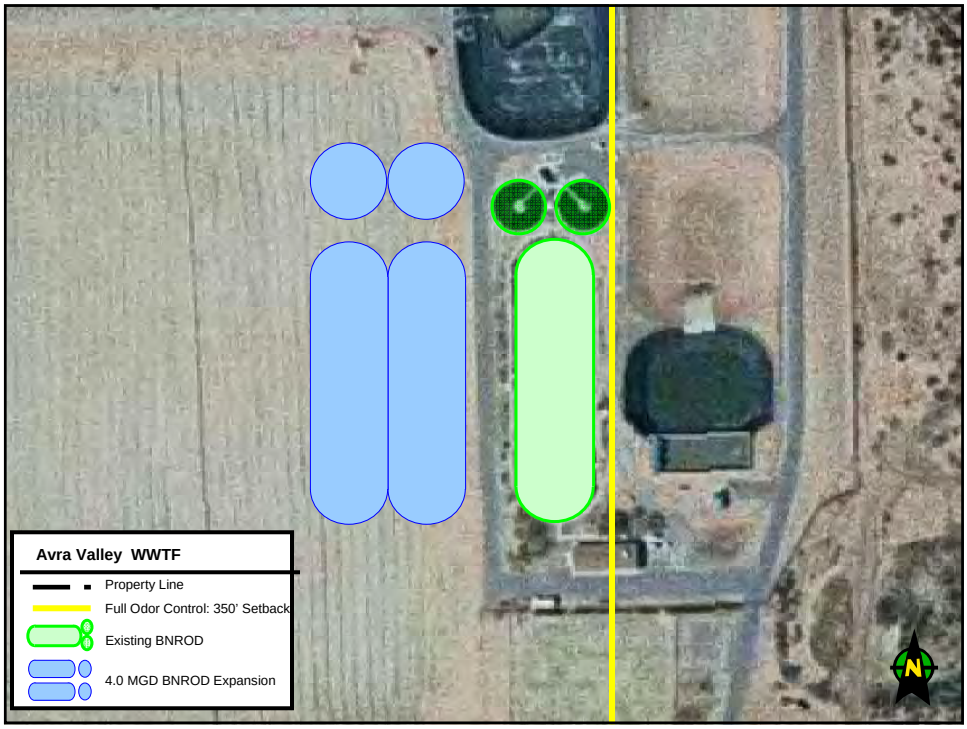
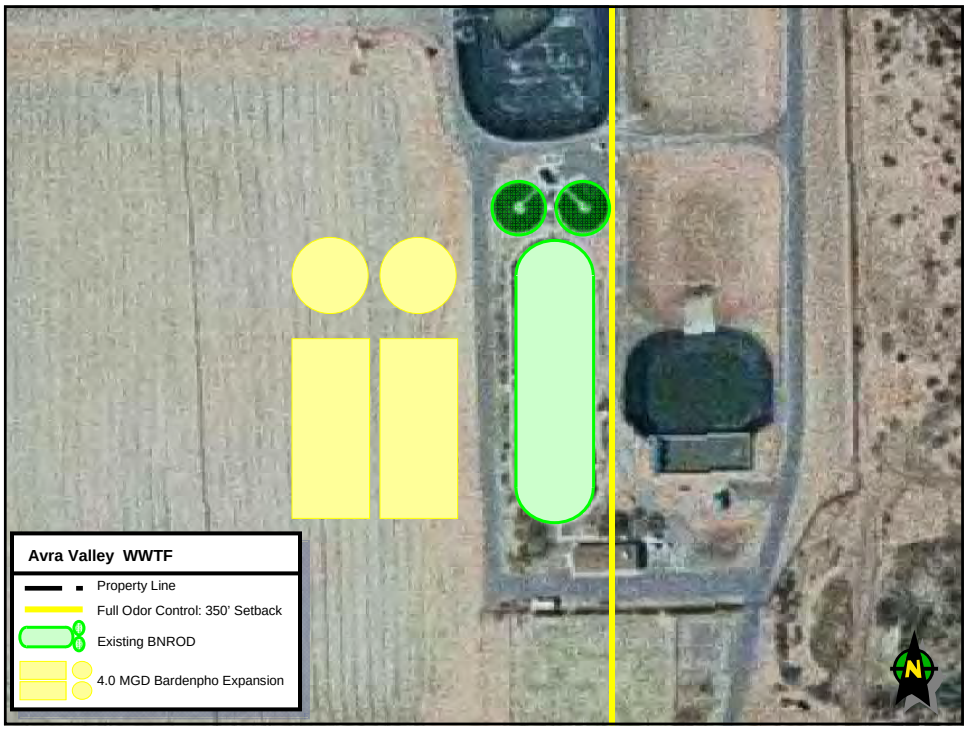
Non-Metro Treatment Facilities WW Process

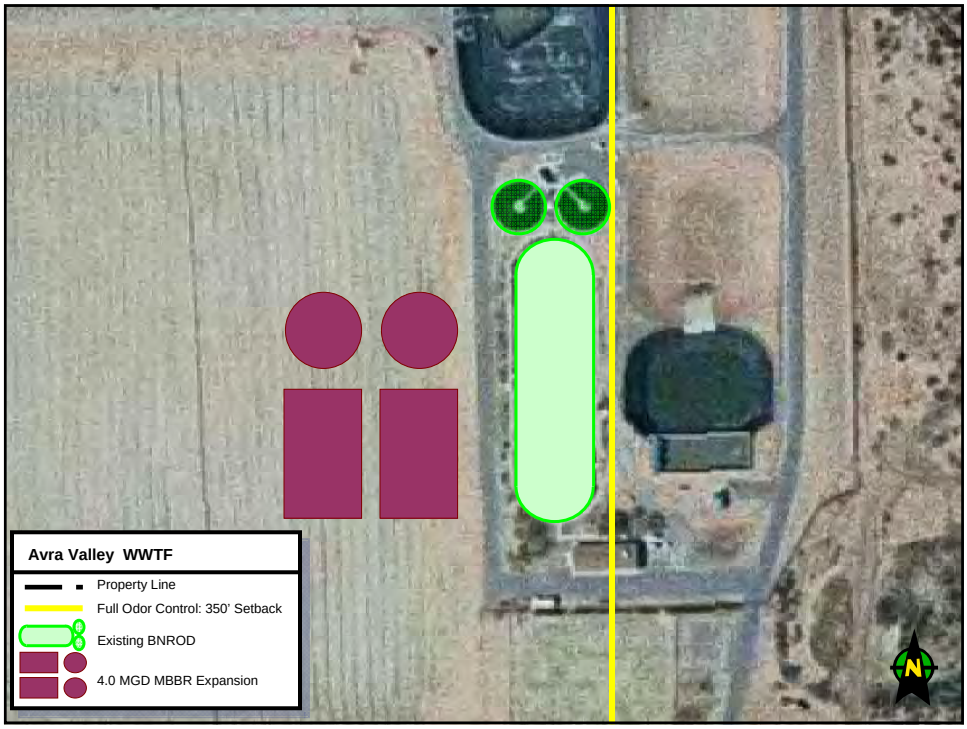
Gordon Culp

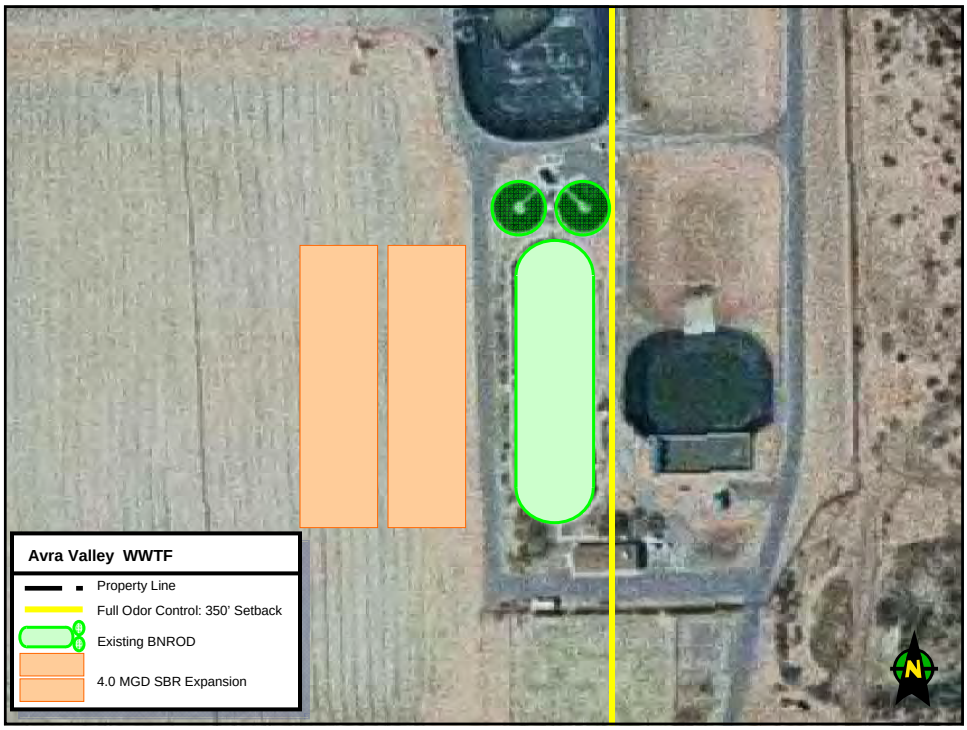
Avra Valley WWTF
Property Line
N

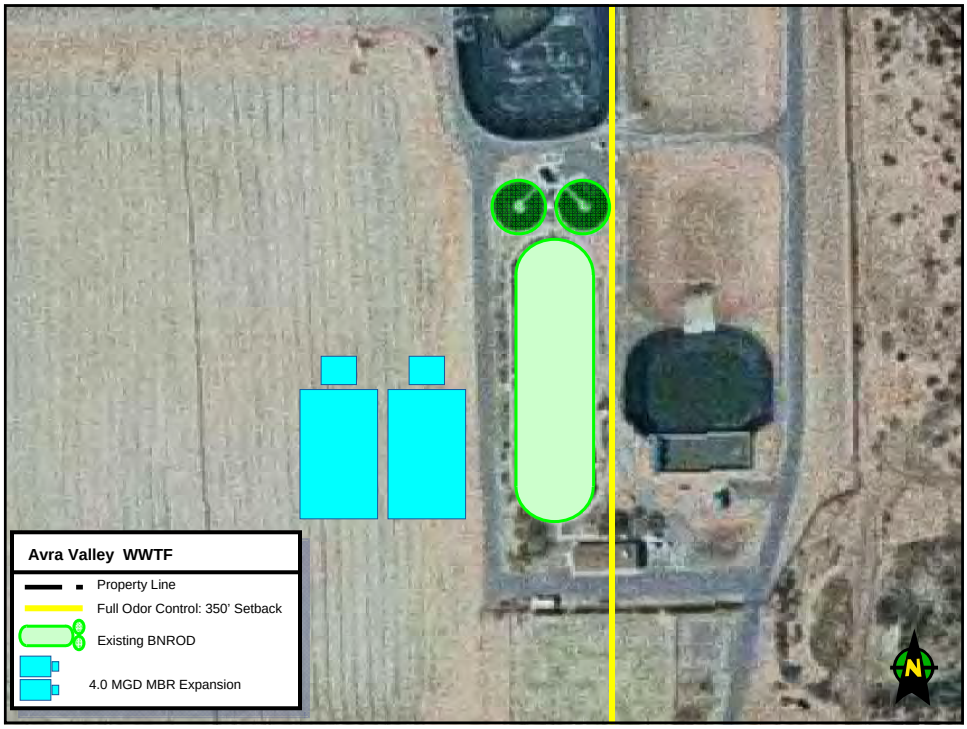

Avra Valley WWTF
Property Line
Full Odor Control: 350' Setback
Existing BNROD
Zoom To Area
N


Avra Valley WWTF
Property Line
Full Odor Control: 350' Setback
Existing BNROD
4.0 MGD BNROD Expansion
N


Avra Valley WWTF
Property Line
Full Odor Control: 350' Setback
Existing BNROD
4.0 MGD Bardenpho Expansion
N


Avra Valley WWTF
Property Line
Full Odor Control: 350' Setback
Existing BNROD
4.0 MGD MBBR Expansion
N


Avra Valley WWTF
Property Line
Full Odor Control: 350' Setback
Existing BNROD
4.0 MGD SBR Expansion
N



System Evaluation Matrix

Criteria	Rank				
	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	4	4	3	5	1
Environmental Impact	3	4	3	3	3
Feasibility	3	5	4	3	4
Operational Capability	4	4	3	2	4
Land Required	4	3	4	4	5
Maintenance	3	5	3	3	2
Public Acceptability	3	3	3	3	4
Reliability	3	4	3	3	2
Sludge Production	3	5	3	3	3
Water Reuse Potential	4	4	4	4	5

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Weighting Factors

Criteria	Weighting Factor
Cost	5
Environmental Impact	4
Feasibility	3
Operational Capability	4
Land Required	2
Maintenance	4
Public Acceptability	4
Reliability	4
Sludge Production	1
Water Reuse Potential	4

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Weighted System Evaluation Matrix

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBBR	SBR	MBR	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	5	4	4	3	5	1	20	20	15	25	5
Environmental Impact	4	3	4	3	3	3	12	16	12	12	12
Feasibility	3	3	5	4	3	4	9	15	12	9	12
Operational Capability	4	4	4	3	2	4	16	16	12	8	16
Land Required	2	4	3	4	4	5	8	6	8	8	10
Maintenance	4	3	5	3	3	2	12	20	12	12	8
Public Acceptability	4	3	3	3	3	4	12	12	12	12	16
Reliability	4	3	4	3	3	2	12	16	12	12	8
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	5	16	16	16	16	20
Sum of Weighted Ranks							120	142	114	117	110

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Covered Oxidation Ditch

- Cambridge, MN 1.84 mgd (ADWF)

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Biosolids

Jerry Bish

Major Issues/Concerns

- What are others in Southwest doing?
- Concerns about issues arising in California about land application
- Currently single land applicator controls majority of land around Pima County
- Can not produce Class A biosolids now if Class B became unacceptable to public

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Other AZ Utilities:

- Land application in AZ:
  - Approx. 65,000 tpy land applied in AZ from AZ
  - Approx. 35,000 tpy land applied in AZ from CA
- Phoenix Regional
  - 91st Street – landfill
  - 23rd Avenue – land application
- City of Tolleson (Peoria and Sun City) – land application
- Other major utilities that landfill biosolids:
  - Chandler
  - Flagstaff
  - Mesa
  - Avondale/Glendale
  - Lake Havasu City

202

Other Southwest Utilities Are:

- CA – Considerable land application
  - City of LA has land application and composting
  - LA County SD contracting for commercial biosolids to E-fuel to start in 2008
  - LA County currently landfilling and land application, much of it in NV and AZ
- NV – Las Vegas valley utilities landfill unstabilized solids

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California LA Example

- City of Los Angeles land applies Class A/EQ biosolids on own 4,688 acre farm in Kern County
- In 2003 Kern County required that land applied biosolids be Class A/EQ in unincorporated areas
- Kern County voted in a land application ban on all biosolids in unincorporated areas in June 2006 to start Jan. 2007 (85% voted yes)
- LA and partners suing in Federal Court to continue land application
  - Class A/EQ product did not safeguard land application

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California LA Example *(continued)*

- Review of news information indicates:
  - Ban supporters talk about LA dumping on them – urban vs. rural or powerful vs. marginalized issue
  - Kern County allows Class B solids from Kern County to be applied to land in incorporated areas
  - Emotional issue – not related to facts and inconsistently applied

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Land Application

- Current contractor does not foresee interest in Class A biosolids in area
  - Hauling of liquid is well contained so no mess or odors in populated areas
  - Current liquid (up to 10%) directly incorporated = low odors at sites
  - Hauling/incorporating cake = more odors
  - Class A more odorous in contractor's opinion

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Single Land Contractor Locally

- Current land application cost relatively low
- Other contractors have bid in the past
- Synagro and Solid Solutions are contractors working in the Phoenix area
- <u>County should have a backup plan</u>
  - Recommend ability to make cake that could be landfilled as backup
  - Explore future dedicated land application
  - Could install one thermophilic digester to see if product is more marketable and gain experience in operation

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Class A vs. Class B

- Opposition to land application does not appear limited to Class B
  - Converting to Class A may not help with this market
- Type of Class A process to use depends on available markets
  - Liquid (TPAD) best option if land applying
  - Drier product desired for mine reclamation, bagging/landscaping or energy generation

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Class A vs. Class B

- Class A processing is more expensive in capital cost and operation cost
- Stable market for Class A unknown at this time
- Do not want to invest significant $ before knowing viable market – market analysis
  - Arrange site to have space for a future Class A process
  - Could be a fit for future DBO project

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Composting at Los Reales

- Los Reales landfill currently performing pilot testing on composting operation
- Looking for good/consistent nitrogen source (trying manure)
- Could it be a fit for Pima County biosolids, maybe an outlying plant?
- Los Reales Concerns: don't want odors or metals from the biosolids
- Worth exploration by Pima County to further diversity future biosolids program

210

Dedication Land Application

- Requires significant land
  - Approx. 1,400 acres for main plants solids
  - Approx. 1,900 acres for all plants solids
- Line application site
- Must contain surface runoff
- Must monitor groundwater
- No agronomic limit to application rate
- Provides County with control over own destiny

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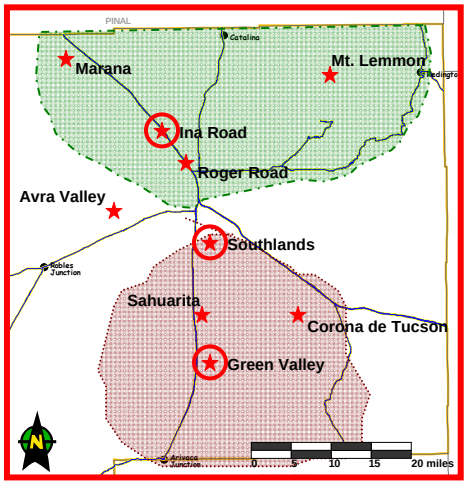
Regional Solids Processing



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UV vs. Enhanced Chlorination

Jerry Bish

UV Disinfection vs. Enhanced Chlorination – Systems

- UV Requirements
  - Lift pump station
  - Filtration
  - High Intensity UV
- Enhanced Chlorination
  - Contact Tank (longer retention)
  - Higher sodium hypochlorite dosages
  - Higher sodium bisulfite dosages

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UV Disinfection vs. Enhanced Chlorination – Cost Impacts

- UV Costs $91.0 million
  - Construction/Contingency/ Engineering
- Enhanced Chlorination $17.6 million
  - Construction/Contingency/ Engineering

215

Enhanced Chlorination Study/Investigation

- Identify/list critical success factors
- Research
  - Literature review
  - Conduct a facility survey
  - BADCT standards evaluation
  - On-site investigations/performance
- Chlorine-based Disinfection Alternative Evaluation
- Alternative Chlorine-Based Disinfection Evaluations

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Enhanced Chlorination Study/Investigation *(continued)*

- Develop a Regulatory Strategy
- Conduct a Cost/Affordability Analysis
- Facilitate Three (3) Workshops
- Facilitate One (1) Meeting with State Regulatory Authority

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Soil Aquifer Treatment

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SAT Features

- Percolation Rate = 0.064 ft/day
- Available Area = 179 acres + Sweetwater
- Required land = available + 49 acres

219

SAT – Issues of Concern

- Setback issues
- Floodplain issues
- Vector control issues
- Infiltration tests
- Appropriate wetting and drying cycles based on infiltration tests
- Hydrogeologic study on surrounding property and landfill areas
- Environmental disruptions
- Environmental permits
- Additional property procurement
- Cultural resource assessment/impacts
- Costs expensive as compared to other available technologies
- Costs for facilities proportionally similar at the Ina Road WPCF
- Loss of economic potential to use land for other purposes

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Roger Road – SAT Costs

Item	Total Cost ($mil)
Land Acquisition	-------
Soil Excavation (6.3 Million CY @$ 5/CY)	$ 32
Hauling and Grading ($40/CY)	$300
Pipes and Valves (Lump Sum)	$ 5
Engineering and Permits (15%)	$ 58
Contingency (30%)	$118
Total	$513

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Shallow Wells

222

Shallow Well Features

- Assume infiltration rate similar to SAT percolation rate
- Available Area = 179 acres + Sweetwater
- Required land = available + 49 acres

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Shallow Well – Issues of Concern

- Setback issues
- Floodplain issues
- Infiltration tests
- Biofouling/plugging issues
- Hydrogeologic study on surrounding property and landfill areas
- Environmental permits
- Additional property procurement
- Cultural resource assessment/impacts
- May be legal prohibitions/challenges
- Demonstration required
- Costs for facilities proportionally similar at the Ina Road WPCF

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Roger Road – Shallow Well Costs

Item	Total Cost ($mil)
Land Acquisition	------
Filtration ?	------
Shallow Wells ($ 100k/well)	$ 7
Pumping Station	$ 5
Pipes and Valves (Lump Sum)	$ 8
Engineering and Permits (15%)	$ 8
Contingency (30%)	$ 9
Total	$ 37

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Summary

Andy Richardson

GREELEY AND HANSEN

Workshop #15 Meeting Notes
Miscellaneous ROMP Issues Workshop

1. The Miscellaneous ROMP Issues Workshop for Pima County Regional Optimization Master Plan was held on March 21, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
PCWMD Staff
Dave Bartos
Gary Blomstrom
Ed Curley
Frank Gall
Dave Garrett
Mary Hamilton
Houssam Eljerdi
Marty Jones
Michael Kostrzewski
Mike Lueken
Byron McMillan
Jeff Prevatt
Helen Rhudy
Ron Riska, Project Manager
John Sherlock
Jack Van Riper
John Warner
Eric Wieduwilt
Legal
Harlan Agnew
Barbra McMurray
Chuck Wesselhoff

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Dennis Rule
Wally Wilson

GREELEY AND HANSEN PROJECT TEAM
Tim Bennett
Jerry Bish
Gordon Culp
Andy Richardson

2. Major topics of the workshop were:
   - Workshop #15: Miscellaneous ROMP Issues
     - Updates
       - Biogas Utilization
       - Enhanced Chlorination
       - Request for Expression of Interest

- Biosolids Handling at Outlying Facilities
- Wastewater Treatment Process at Outlying Facilities
- County-Wide Biosolids Disposal
- Preliminary Architectural Development for Roger Road WRF/Ina Road WPCF

A set of handouts were provided to each attendee at the workshop. Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be utilized by the project team while conducting the study. The flip chart notes are included at the end of the meeting notes.

3. Mike Gritzuk welcomed the attendees to the workshop and invited the workshop to begin.

4. Andy Richardson quickly outlined the meeting topics and objectives. He further elaborated on his role as facilitator and encouraged full participation by all. The primary workshop objective was to review miscellaneous open issues pertaining to the regional optimization master plan (ROMP) for wastewater facilities in Pima County. The goal is to provide closure on all issues where possible. Items to come include the financing plan, delivery method and implementation plan. Attendees were reminded to send their comments on the draft ROMP document as soon as possible to Ron Riska who will compile them and forward them to Greeley and Hansen. For unsettled issues the plan is to have several small group meetings in the next few weeks on topics, such as, outlying facilities wastewater treatment processes, biosolids handling/disposal, disinfection and delivery methods. It will be decided later who will be involved in each of these meetings and when they will be held.

   Overview, agenda, meeting objectives, and ground rules were covered on pages 1 through 4 of the handout.

5. Regarding updates Mike Gritzuk asked for an update on the upcoming meeting with ADEQ on BADCT requirements associated with the treatment plant upgrades. Issues to be considered in an agenda for the meeting are: the scientific bases for 4 non-detects of fecal or E. coli out of 7 grab samples, requirements for site specific standards, and enhanced chlorination approaches. Ron Riska opined that Pima County is not the first to deal with this situation. Other agencies in Arizona, such as Phoenix, are in the same predicament and are going through similar issues. California has similar strict requirements and what has been their experience. Other agencies in Arizona need to be contacted to learn what discussion they have had with ADEQ. Mike Gritzuk indicated that in talks last week with Phoenix that all the samples from their SAT are non-detect.

   The team to address the ADEQ BADCT requirements was identified as: Jeff Prevatt, Byron McMillan, Chuck Wesselhoff, Harlan Agnew, Ron Riska, and Jackson Jenkins.

   Mike Gritzuk stated that support by ADEQ on the disinfection approach was important. ADEQ was informed on January 26th that Pima County would be looking to save $76 million through enhanced chlorination/de-chlorination disinfection. Harlan Agnew indicated that a legal challenge to the disinfection standard is an approach, but a variance would take less time. Byron McMillan offered that a variance may need to be offered statewide, thereby ADEQ may be reluctant to issue a variance.

Also, to change BADCT requirements would take a long time under the rule making process in Arizona, and that ADEQ will not listen without supportive scientific information to make any change.

Jackson Jenkins wants the benchmarking within the enhanced chlorination investigation and study to find who is meeting BADCT standards and what technology they use. Jeff Prevatt indicated that Arizona, California and Florida have tough disinfection standards.

6. Jerry Bish reviewed the biogas issues. The biogas is a significant resource that is being underutilized. There are options for the future use of biogas, but improved gas conditioning could realize short term benefits. Plant operations are on the right track at looking for gas conditioning now – poor quality of gas limits use. Currently there is a band-aid approach to stop a hemorrhage in lost of energy production.

   One possible option in the future would be to have a third party take the biogas and operate a combined heat and power facility for Pima County. This would take Pima County out of the power business. The request for expression of interest (RFEI) will provide insight into that possibility. Regardless of the outcome of the RFEI, Pima County should proceed with improved gas cleaning.

   Byron McMillan provided a caution that adding more generators at Ina Road WPCF could trigger replacement of all generators. Chuck Wesselhoff offered that if additional generators are placed into a different building it may not trigger replacement of the generators. Jerry Bish indicated that the costs for electrical improvements at Ina Road WPCF included the change-out of all generators, and included a new permit process.

   The biogas issues were covered on pages 5 and 6 of the handout.

7. The next update was on the enhanced chlorination/de-chlorination investigation and study. Jerry Bish reviewed the purpose and goals of the investigation and study along with a schedule of activities. Mike Bunch asked that dates be placed on the schedule. It was indicated that Dr Larry Leong was looking at other plants for compliance with strict disinfection requirements. Harlan Agnew stated that actual performance data needs to be evaluated, not just permit requirements. Data suggests that methods of measurement are all over the place. Region 9 puts data on their site. Byron McMillan indicated that the rules need to be looked at as well.

   The enhanced chlorination/de-chlorination issues were covered on pages 6 and 7 of the handout.

8. The request for expression of interest (RFEI) purpose and status were presented by Jerry Bish. The RFEI document was in rough draft form and consists of 6 sections. The introduction section provides statements of general purpose and background, while subsequent sections become more detailed and specific with information, process and procedures. Mike Gritzuk asked that since there were no cost implications in the document, just information gathering, whether it needed to go through procurement. Ron Riska offered that procurement does not have a procedure for this type of document, although that they want to review the document and comment, but would not issue it. Therefore, the County Administrator or Mike Gritzuk will be signing the letter. A principal purpose of the letter is to create excitement about opportunities in Pima County within the marketplace at large. This should result in creative and cost effective methods and approaches to delivering the projects needed by the County over the next 25 years.

Ron Riska suggested that contractors are uneasy about performing large projects for Pima County and insert added contingences in their bids because they will be held to task. Therefore, jobs this large may be performed by unknown contractors (unfamiliar with Pima County procedures and processes). Recently, projects are receiving 2 to 3 bids when 5 or 6 are expected. This may be indicative of Pima County's relationship with contractors. Mike Bunch also indicated that many Pima County jobs end up in litigation. One task of a program manager will be to keep all parties within bounds of reasonableness.

Mary Hamilton asked if the projects will be broken down into small jobs. This is an issue to be sorted out through the RFEI activity. Mike Gritzuk observed that design-bid-build was not listed as a delivery method in the RFEI. This will be included into the final draft.

There is a question about private or what may appear to be private meetings with contractors or businesses. The concern is the appearance of collusion, that may create challenges to the procurement process later. Chuck Wesselhoff was assigned to research and review the issue of one-on-one meetings with contractors in parallel to refining the RFEI for issuance. Among a few other things the dates and schedule of events are required to complete the document. The RFEI is scheduled to be on the street in about 4 weeks. It was suggested that the RFEI be advertised nationally.

The RFEI scope and status were covered on pages 7 through 9 of the handout, and the current draft scope was provided as an appendix to the handout.

9. Gordon Culp presented the recommendations for handling biosolids at the outlying facilities. In a previous workshop there was a request that each outlying facility be evaluated on an independent economic basis to determine the solids handling approach most suitable for each location. For each facility five options were investigated. These included: 1) haul to interceptor, 2) pump to interceptor, 3) thicken - haul to Ina Road, 4) digest/dewater onsite and haul to landfill, and 5) digest/dewater onsite and haul to Ina Road. In broad terms the haul option is O&M intensive, pipeline is capital intensive, and thicken and haul are, more or less, O&M and capital intensive. From the evaluation of each plant individually, thicken and haul was generally the most cost effective approach to handle solids in the future. Therefore, it was recommended that thicken and haul be utilized at each facility.

   Frank Gall asked if costs were included for receiving solids at Ina Road WPCF. The answer was yes. John Warner indicated that non-cost issues such as additional traffic, safety and environmental issues are something else to be considered.

   Mike Gritzuk asked if biosolids disposal was included in the request for expression of interest. The answer is yes. Houssam Eljerdi asked if Green Valley should abandon the existing dewatering process. The answer is no, that there is capital invested that needs to be used and it supports the mine reclamation projects in that area. The thicken and haul approach is the recommended option based on the current biosolids disposal plan, but a closer look is needed in conjunction with a long term county-wide biosolids disposal plan.

   The outlying facility biosolids options, assumptions and recommendations were covered on pages 10 through 16 of the handout.

10. Tim Bennett followed with a presentation of the preliminary architectural design concepts at the new Roger Road WRF and the expanded and upgraded Ina Road WPCF. Design concepts were centered around the Leadership in Energy and Environment Design (LEED) silver requirements including site selection, energy use, energy production and materials. The preliminary developments have a strong emphasis on natural indigenous materials. At Roger Road WRF the design features a public friendly image with a water campus type environment that is inviting and accessible. At Ina Road WPCF a single landscape and architectural theme harmonizes and unifies the appearance of existing and new facilities.

    It was noted that the centralized laboratory and department headquarters were located on the site plan at Roger Road WRF, although they were shown on land owned by the City of Tucson. Mike Gritzuk indicated that space at Ina Road WPCF, as well as, Roger Road WRF should be allocated for the centralized laboratory and department headquarters.

    Frank Gall indicated that more laboratory work will be required at Ina Road WPCF than Roger Road WRF. Jeff Prevatt indicated that location does not matter from a laboratory function perspective. There is land adjacent to the existing Sport Park property adjacent Ina Road WPCF that would be suitable for the laboratory, whereas the facility would encroach on city property at Roger Road WRF. Perhaps, it would be a little more convenient at Ina Road. Most likely land issues will be the driver for the final site location. The architect commissioned for the laboratory services will address both locations.

    At Ina Road WPCF it was noted that the plant is currently well lit at night, which could impact the vision screen concept. Could landscaping with berms aid in or augment the design of the 22 foot high vision screens at Ina Road?

    Ina Road vision screens must be multi-purpose to improve likelihood of approval incorporating:

    - VISION
    - GREEN (energy production, material reuse/recycle, etc)
    - SECURITY

    PCWMD has a security consultant that needs to be consulted for potential review of the vision screen concept for security purposes. The amount of hard security at the site also needs to be defined. The Ina Road WPCF vision screen concept was discussed as a possible help with dispersal/dilution of odors and sound. At a minimum the vision screen materials must be impervious to plant air emissions. Harlan Agnew asked if plantings could provide the same effect as the screens. In response, the screens unify the Ina Road WPCF architecture to a greater degree than landscaping. Moreover, landscaping takes years to be effective.

    Need additional study to arrive at recommendation for screens at Ina Road WPCF regarding materials, locations, size(s) and quantity. Architectural characteristics of other Pima locations are needed to determine applicability of vision screens elsewhere to aid in development of a uniform PCWMD facility image and identification. Green Valley was mentioned as a facility that currently shows a strong and well received PCWMD image.

The department headquarters program requirements are mostly unknown, as well as, its preferred location (Roger Road vs. Ina Road). Mike Gritzuk advised to simply show a reasonable footprint at both locations, and the details will be determined as the design process evolves.

Program requirements may include space for additional staff from other locations and agencies. For example, the Roger Road structure may be required to house the County Parks and Recreation administration staff of an unknown quantity. Mike suggested a discussion should be held with the appropriate personnel at Parks and Recreation to obtain a better idea of this concept. Other functions that need to be housed at Roger Road WRF include a warehouse and a maintenance building, sizes to be determined.

Melodee Loyer noted that on the Roger Road WRF site plan that the locations of the trees are where Tucson Water's facilities reside. Jackson Jenkins expressed concern over placing a crane on site under the canopy at Roger Road WRF to access equipment. It was noted that holes were deliberately placed in the canopy to allow for some of the crane access maintenance. It was suggested that photovoltaic cells in the canopy could augment electric power at the plant.

Ed Curley suggested that vehicle access to Ina Road WPCF be re-established off of the Interstate I-10 frontage road.

The preliminary architectural themes, concepts and designs for Roger Road WRF and Ina Road WPCF were covered on pages 24 through 32 of the handout.

11. Melodee Loyer presented a preliminary layout of Tucson Water's water reclamation facilities at Ina Road. The facilities are for 20 mgd with expansion to 40 mgd. The facilities were sited along Ina Road west of the IWC unit facilities and north of the plant outfall. According to Jackson Jenkins, this site is currently being used by solid waste. The site layout provided requires more than 10 acres previously discussed by Tucson Water.

    Actual facilities depend upon receipt by Tucson Water of Class B+ versus Class A+ effluent, UV disinfection versus chlorination disinfection, and where effluent accessibility is located at the site. The layout is preliminary and needs to be refined, but illustrates the need for land at Ina Road for Class B+ effluent and future high water quality treatment. Timing will be the same as the Ina Road 50 mgd expansion because of the availability of less effluent water at Roger Road.

    Tucson Water's peak demand is 33 mgd in July, but they are still waiting to hear from Oro Valley about their plans for more golf courses. Initially 20 mgd is required from Ina Road WPCF for Tucson Water's needs – 10 mgd pumped north, 10 mgd pumped south.

    Gary Blomstrom asked if there were needs for setbacks for the water reclamation facilities. The only setbacks needs are for solids handling systems. Costs of the water reclamation facilities for processing Class B+ effluent were unknown, but would be more than the $25 million identified for a reservoir and booster pump station if a Class A + effluent is provided.

    Mike Gritzuk asked if both facilities could be combined to save costs. Tucson water would want guarantees on water quantity and quality in order to meet the water reuse standards, if systems were consolidated with Pima County. Tucson Water would at a minimum need a reservoir, booster pump

station and booster disinfection facilities. Jackson Jenkins asked if a reservoir was necessary with 50 mgd being processed at the plant. The recommendation was made to look for synergisms in consolidation.

Melodee Loyer provided a preliminary layout of the Tucson Water facilities, which is included at the end of the notes

12. Gordon Culp presented the recommended wastewater treatment processes at each of the outlying treatment facilities. The recommendations were developed based on the current and future situation at each site in accordance with a request at a previous workshop. Future flows, potential wastewater treatment processes and estimated plant expansion dates were evaluated for each site. Three of the current lagoon systems will be phased out during the 25-year planning period. These include Arivaca Junction, Rillito Vista and the Pima County Fairgrounds. Jackson Jenkins indicated that there were some issues with the Fairgrounds lagoons and that Paul Bennett should be contacted to obtain the latest information. At this time there is no change in the wastewater system process forecast for the Mt. Lemmon operation, although this could change if growth of the service area is permitted by the County and the U.S. Forest service.

    The wastewater processes recommended for the outlying facilities were:

    - Avra Valley BNROD
    - Corona de Tucson CLR (BNROD derivative)
    - Green Valley BNROD
    - Marana BNROD
    - Southlands Bardenpho

    Frank Gall asked what type of aeration system would be utilized with the BNROD. Brush aerators is the traditional approach, however, other aeration systems are available. The aeration system will be dependent on how the BNROD is configured to achieve the desired treatment performance and for odor considerations (submerged type aerators versus brush aerators). Eric Wieduwilt indicated that odor control is a key factor in the process selection. It was noted that with the long aeration times associated with BNROD systems that odors are generally not a significant issue. However, within a BNROD system the areas of concern can be covered economically and the odors treated before release to the atmosphere.

    Dennis Rule reported that Avra Valley is projecting a large population increase and that that plant may become much larger than projected. This may be occurring because flood control is changing the designation of the Black Wash area which will permit additional build-out. Ed Curley also indicated that the nearby tribal lands planning activities may have an impact on growth of the Avra Valley service area. The table on flows may need to be updated based on the latest growth information. If future flows are projected to be more that 8 to 10 mgd, then the wastewater process recommendation may change.

    Jackson Jenkins pointed out that the current flow at Corona de Tucson was not 1.3 mgd, but closer to 0.1 mgd and the flow associated with the facility needs to be changed.

Since the Southland wastewater facilities are non-existent at this time, wastewater treatment facilities will start out as a small developer constructed facility (0.3 mgd package plant) with growth rapidly advancing the facilities needs to 2.0 to 2.5 mgd. When wastewater flows approach one mgd, or less, the first module of a Bardenpho system should be constructed to handle 2.0 to 2.5 mgd. The projected flows at this facility are forecast to be over 10 mgd by the end of the 25-year planning period.

Frank Gall cautioned that the facilities at each of the outlying treatment plants need to have one approach to wastewater treatment and not be like Roger Road or Ina Road where multiple processes exist at one site.

The outlying wastewater treatment process considerations were covered on pages 16 through 21 of the handout.

13. The current biosolids disposal program and recommendation for future actions were presented by Jerry Bish. The current disposal program is land application through one contract. Some biosolids removed from the wastewater lagoon systems are periodically taken directly to landfill. The biosolids disposal approach by the County is very cost effective, but is vulnerable because of one source for disposal. A strong biosolids program has multiple disposal options and outlets. The biosolids recommendation is continue producing Class B biosolids using mesophilic digestion, continue to land apply (cost effective in the short term), be prepared to quickly produce a Class A biosolids when required by regulations or demands of the public, and develop a long term biosolids management plan. In addition, the request for expression of interest (RFEI) will seek out possible third party interest in a public-private partnership to disposal of biosolids with a cost effective approach.

    Elements of the long term biosolids management plan include analysis of the current program, identify quantity and quality of biosolids, address regulatory and social issues that may impact disposal, develop and evaluate alternatives (includes determining market size and product need evaluation, and technologies required to achieve the market desired product), costs related to the probable disposal options, and lastly an implementation plan. Ron Riska requested that the biosolids management plan scope of services and deliverables be spelled out in the report.

    Gary Blomstrom indicated that over 2 years ago the Pima County Parks and Recreation department had a need for all the biosolids produced at the wastewater treatment plants, if it were of Class A+ quality. Houssam Eljerdi indicated that Parks and Recreation currently would like to start with a one ton test pilot of a Class A biosolids to determine suitability of the product. Also, it was reported that other area farmers are expressing a desire for the biosolids (Class B). Harlan Agnew asked about composting, since the City of Tucson was interested in the biosolids. Composting can provide Class A biosolids, but is land intensive and has associated odors which makes it an unattractive consideration.

    Ed Curley asked about going to thermophilic digestion now. There would be additional costs to build additional tanks for the thermophilic batch process and heat exchangers. Also, the thermophilic biosolids have a greater odor potential than the mesophilic product. Jim Doyle offered that the biogas system would also need to be revised to accommodate biogas from thermophilic digestion. Furthermore, there is no market analysis to demonstrate that Class A biosolids is more acceptable in

the marketplace than Class B, or that Class A has a higher market value to offset the additional costs of thermophilic digestion.

Harlan Agnew asked if the sludge storage bladders are to be replaced. The answer was affirmative with a storage tank, and this project could be advanced prior to the plant upgrade. Dave Garrett indicated that two of the centrifuges were 20 years old. The master plan is to replace all the centrifuges and their replacement could be advanced, as well as, the storage tank, funding permitting.

The TPAD system was selected as a conservative approach to provide Class A biosolids for master planning, because it is the most expensive and most land intensive. Heat drying requires less space and would be utilized if there were a substantial market for dried products. John Warner asked about co-generation of the biosolids and accumulating green credits. The County is looking for interest in this approach through the request for expression of interest activity.

Houssam Eljerdi expressed that creating a partial stream of Class A biosolids for marketing purposes and developing a potential for a southern region biosolids processing facility were good features for a biosolids plan.

The biosolids disposal approach and recommendations were covered on pages 21 through 24 of the handout.

14. The open session of the workshop covered unsettled issues and discussed topics relevant to the master plan development. Jerry Bish led the discussion by reviewing the possible operating modes for Roger Road WWTP and Ina Road WPCF after the completion of the plant interconnect pipeline and before the new, or expanded and upgraded, facilities were placed into service. Paul Bennett asked if grit and screenings were going to be removed at Roger Road for the plant interconnect pipeline. The response was only the flow processed at Roger Road WRF will have grit and screenings removed. The remaining flow will receive preliminary treatment at Ina Road WPCF. This makes cost effective use of the existing headworks facilities at the Ina Road WPCF.

    The waste activated sludge from Roger Road WWTP will be transported to Ina Road WPCF through the existing dedicated sludge line. The backup service will be the plant interconnect pipeline.

    Jim Doyle offered that at the Ina Road WPCF 3 of 4 digesters are currently required, and 4 digesters would be needed for a flow of 37.5 mgd (but there would be no slack for cleaning). The plant could use another digester in the next 4 to 5 years to cover the increase in flows. Ina Road WPCF will complete the cleaning of 2 digesters in next 6 to 9 months so could it could go 4 to 5 years without cleaning another digester. Also, the disinfection contact tanks are serviceable for flows up to 37.5 mgd.

    The information available suggests that over the next seven to eight years that an additional digester, replacement of old centrifuges, and thickener upgrades are needed at the Ina Road WPCF. Jackson Jenkins also added the need for a fourth emergency overflow basin. Dave Garrett added that gas cleaning equipment is also needed to burn more of the available biogas.

At Roger Road WWTP a new gravity belt thickener is going into service. In addition Digester # 5 is being converted primary service, new backup aeration system is to be installed and electrical system upgrades will be constructed.

During the construction at the two plants, where flow is treated should be kept flexible, depending on the needs of each plant for operation and maintenance. In general, flows should be directed to the facility with the lowest operating costs and still meet permit requirements. At this time the lowest per unit treatment costs would be at the Roger Road WWTP. Jim Doyle reminded the group that Tucson Water has a reclaimed water need at Roger Road that must be satisfied. In addition, it needs to be recognized that Roger Road WWTP is out of wet weather capacity, which will need to be factored into the operating plan. Jackson Jenkins indicated that a schedule is needed for the transitional steps, beginning with the plant interconnect pipeline followed by next step and so forth.

Harlan Agnew offered that infiltration restrictions will be placed into new permits.

Houssam Eljerdi indicated that an upgraded sludge loading system at Ina Road WPCF was in design. Whether it had odor control features was unknown. Also, there is a need to pre-screen sludge before centrifuge dewatering.

Ed Curley stated the CIP for the wastewater department includes more than the facilities described in the Regional Optimization Master Plan (ROMP). The reason for smoothing the annual capital cost burden is to fit in the other project costs required to keep the infrastructure viable.

Smoothing the capital cost burden "hump" options were discussed in general terms. Paul Bennett suggested that maybe Ina Road WPCF is upgraded and expanded first, followed by the new Roger Road WRF. This would keep Roger Road WWTP running four years longer and would place that plant into possible non-compliance for approximately four years. This would reduce the annual capital cost burden.

Costs for odor control in the conveyance are assumed to be included in the conveyance system rehabilitation and replacement costs program in place for the County. No additional line item is provided for conveyance system odor control in the CIP. Odor control is to be mentioned in the ROMP report.

Helen Rhudy asked how the comments from the request for expression of interest (RFEI) are to be incorporated into the report. The comments are expected to be received before the final report is accepted and issued by the County and that pertinent comments will be incorporated where they fit into the document. Melodee Loyer asked by when were the comments needed on the RFEI. The response is as soon as possible, but within a week.

The open issues were covered on pages 33 through 35 of the handout.

15. From the meeting a list of actions items was identified and reviewed with the group. The actions were:

    - Action Items

- ADEQ agenda development (Harlan Agnew)
- CL_2/deCL_2 team – benchmarking data (Greeley and Hansen)
- RFEI – (Chuck Wesselhoff) – Need dates, steps
- Outlying plants – meetings to fill in steps (Ron Riska)
- Biosolids scope (Greeley and Hansen)
- Small group meeting with Tucson Water about merging facilities (Ron Riska)

16. The meeting was closed with a reminder that the next workshop is scheduled for May 9th at the public library downtown. In a response to a question from Melodee Loyer a copy of the final report would be available before the meeting..

Agenda
Workshop #15 – Miscellaneous ROMP Issues
March 21, 2006

Time	Topic	Presenter
8:00 am	*Tucson Main Library, Basement Meeting Room, 101 N. Stone*	
8:15 am	Opening Session	
	• Welcoming Remarks	Mike Gritzuk
	• Review Agenda	Andy Richardson
	• Workshop Goals	
8:30 am	Updates	Jerry Bish
	• Biogas Utilization	
	• Enhanced Chlorination	
	• Request for Expression of Interest	
9:00 am	Biosolids Handling at Outlying Facilities	Gordon Culp
10:00 am	Wastewater Treatment Process at Outlying Facilities	Gordon Culp
11:00 am	Break	
11:15 am	Biosolids Disposal	Jerry Bish
12:15 pm	Lunch	
1:00 pm	Site Layout at Roger Road WRF	Tim Bennett
1:30 pm	Site Layout at Ina Road WPCF	Tim Bennett
2:00 pm	Open Session	
3:15 pm	Summary Wrap-Up	Andy Richardson
	• Comments by Group	
	• Closing Remarks	Mike Gritzuk
3:30 pm	Adjourn	

Flip Chart Notes – March 21, 2007

ADEQ

- Develop agenda for BADCT meeting
  - Team to develop
  - Why 4 out of 7
  - Site Specific Standard
  - Discuss approach to CL_2/deCL_2
  - Testing problem – overdosing sodium bisulfite
  - Talk to other states & Phoenix on their approach
    1st task Go/No-Go "Can It Be Done"
  - Who is being held to the 4 of 7 non detect standard
  - Need to bring information to discuss rule

Jeff Prevatt
Byron McMillan
Chuck Wesselhoff
Harlan Agnew
Ron Riska
Jackson Jenkins

BIOGAS

- Need to do some gas conditioning now
- Will add final fix to Ina Road WPCF Project
- *Air permit is important
  - could trigger replacement of all engines
  - put in a different building does not trigger replace
  - Does gas need to be cleaned?
- Move forward as a transition project

CL_2-DECL_2

- If one agency could all of this be incorporated into one site answer - maybe
- Should we look at a consolidate concept
- Start Monday – end date 07-07-07
- For bench marking determine what are the permit requirements
- Need to know test methods and how tested
- Also, look at rules in each state when conducting the benchmarking.
- Coordinate dates for workshops

RFEI

- Add design-bid-build to list in section 4
- RFEI – final next two weeks
  - Meeting to review RFEI
  - Concern w/individual meetings after RFEI submitted
  - Need to think about how to design in "Private Meetings"
  - Chuck take lead on how process will unfold
  - Need to determine where and how to advertise
  - Get Chuck Lake Pleasant meeting information.

OUTLYING BIO SOLIDS

- Marana has growth around plant - may want to consider not hauling biosolids
- What is the cost of lost time for hauling, risk factors and growth in those areas.
- Have not looked at private hauling yet
- Pipeline from Marana- should this be looked at for bi-directional flow

ARCHITECTURAL PROGRAM

- Need Additional Information
  - Admin Bldg.
    - Provide a foot print.
    - HQ Dept.
  - Central Lab Bldg. – could be at Roger Road
  - Need to program Central Lab and HQ Dept. at both sites.
  - May also need space for Parks & Recreation staff.
  - Need to meet w/Parks & Rec.
  - Need space for noise & odor control
  - For Roger Road add maintenance shop & warehouse

INA ROAD WPCF

- May want to consider a theme for PCWMD facilities
  - At Ina Road WPCF consider the high mast lighting.
  - Use vegetation to achieve same affect
  - Screens need to be multi-purpose
    - Green & Security
- Tucson water site layout assumes 20 mgd with expansion to 40 mgd. $25 million does not include filters. If A + received by Tucson Water the need for filters, and backwash and solids handling go away.
- Facilities installed at same time as 50mgd at Ina Road

TUCSON WATER

- If one agency, could all of this be incorporated into one site? Answer - maybe
- Should we look at a consolidated concept
- Tucson Water – permit compliance
- Need to have meeting w/Tucson Water to develop consolidated site plan w/cost saving – coordinate w/Ron

OUTLYING AREA

- Need to address fairground issue – send email to Paul Bennett to get answer

OUTLYING PLANT PROCESS

- Avra Valley - Process BNROD
  - What type of aeration system
  - Pima Co. looking at 180,000 people for Avra Valley
  - At what size do we look at other WW processes
- Corona de Tucson WWTP Process - CLR
  - Current flow vs. future flow?
- Green Valley WWTP Process - BNROD

- Marana – Process BNROD – maybe bigger
- Southlands – Process Bardenpho
  - First size may be 300,000 gpd (package plant)
  - Next step 2 mgd
- Indicate how outlying plants can be expanded – first have a small group meeting to discuss each facility.
- Is there a policy needed to say at:
  - 0.5 mgd or 1 mgd it is a package plant - bigger than that is a decision.

BIO SOLIDS

- Suggested that Parks & Recreation will take all the solids at Class A
- Would like to ramp-up using a ton or less to pilot how it will work
- Now have a 2 year contract to continue disposal on agricultural lands
- Need to make sure we multi-disposal outlets – add to program – need a contingency plan
- Knowing if there a secondary market for a Class A Biosolids?
- Need to have in report – produce some Class A (thermophilic digestion) at Ina Road
- Need to have potential for outlying bio solids disposal concentrated in one spot.
- Place time limit on effort and how biosolids should be implemented. What are the "Triggers" that have PCWMD do something relative to biosolids.
- Pre-screen before centrifuge dewatering

OPEN ISSUES

- How to handle screening and grit removal at Roger? – Answer – Ina Road will handle
- WAS from Roger – put in sludge line to Ina Road
- Who should use sludge line if PCWMD does not use it?

TRANSITIONAL OPERATIONS

- Plant interconnect – Ina Road can handle 37.5 mgd of flow – but on the edge would be better to add a new digester
- Once back-up power is at Ina Road will stress system to see capacity.
- Additional digestion and centrifuges – Ina Road.
- Add 4th EOB at this time.
- Gas cleaning system on burning gas, gas condition system Roger Road/Ina Road
- Roger Road - convert number 5 digester to primary service
- Roger Road - clean all digesters and assess condition of # 3
- Provide back-up aeration system at Roger Road
- Plant capacity analysis – need to be flexible in how flows will be transferred – but look at baseline on how it should be operated based on "cost to transfer"
- Sludge loading facility being appraised - a fix is being done.
- Need to state rehab of pumping system

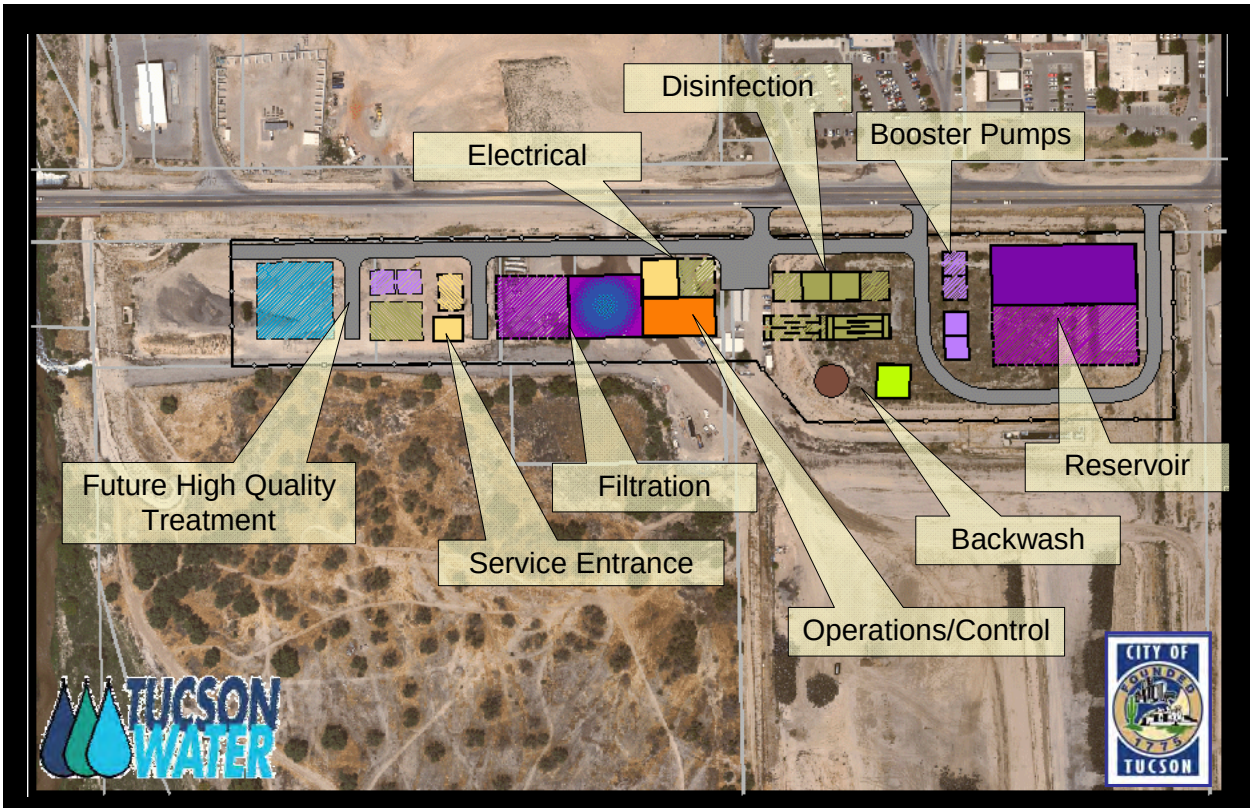
SMOOTHING THE HUMP

- 4 year delay on Roger to meet Tucson Water needs until Ina Road is up and running.
- What would we do without regulatory requirements
- Use bond financing instead of "pay as we go"

ACTION ITEMS

- ADEQ – Agenda develop team - Harlan
- Meeting with Tucson Water to review site plan consolidation.
- CL_2/deCL_2 – End 7-7-07 – want benchmarking
- RFEI – need dates for event – Chuck
- Outlying facilities small group meeting to deal with expansion program.
- Biosolids need scope of service in report
- Final Report – implementation plan

Tucson Water Facilities Layout at Ina Road WPCF



Pima County
Regional Optimization
Master Plan

Workshop #15 Miscellaneous ROMP Issues

March 21, 2007

Workshop Presenters

- Mike Gritzuk — Welcome / Closing
- Andy Richardson — Facilitator
- Jerry Bish — Updates / Biosolids Disposal
- Gordon Culp — Outlying Biosolids Handling / Processes
- Tim Bennett — Site Layouts

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- Updates
- Solids handling at outlying facilities
- Wastewater treatment process at outlying facilities
- Biosolids disposal
- Site layout at Roger WRF / Ina WPCF

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

6

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

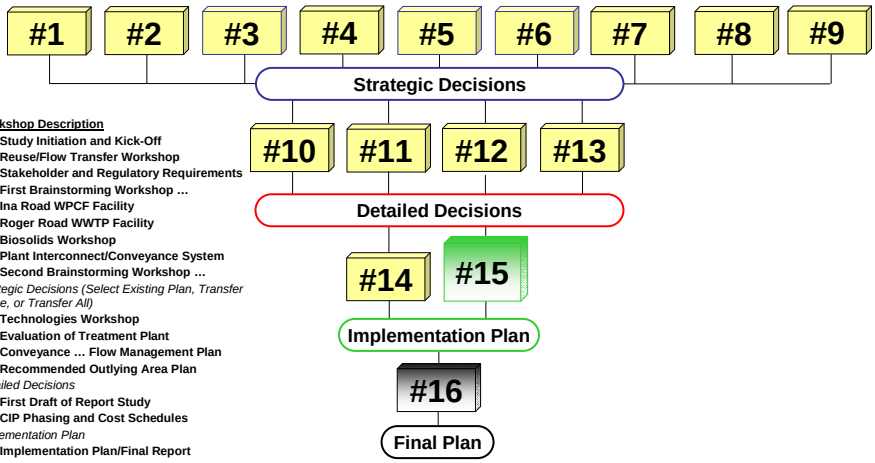
- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

Objective

- Review Project Elements
- Advance open / unsettled ROMP issues to closure
- Identify who, what and when necessary for issue closure

11

Pima County Wastewater Management Department

GREELEY AND HANSEN

Updates

Jerry Bish

Update Issues

- Biogas utilization
- Enhanced chlorination
- Expression of Interest

13

Biogas Use

- 500 million cubic feet per year
- Options
  - Continue biogas for power / heat generation with engine-driven equipment
  - Sell biogas to third party for commercial use
  - Purchase power from local utility and use biogas for heating and cooling functions

14

Biogas Utilization Economics

Biogas Utilization System	X $1,000			
	Capital Cost	Energy Savings	Operating Costs	Annual Savings
Combined Heat / Power	12,000 to 16,000	3,595	1,475	2,125

15

Engine Cost Considerations

- Capital costs
  - Value of existing power plant
    - Central cooling
    - Cooling distribution
    - Central process and space heating
    - Heating distribution
    - Engine heat rejection systems
    - General infrastructure
  - Changes needed
    - New generators and synchronization
    - New electrical addition and remodeling
    - Gas conditioning (hydrogen sulfide/siloxane)

16

UV Disinfection vs. Enhanced Chlorination – Systems

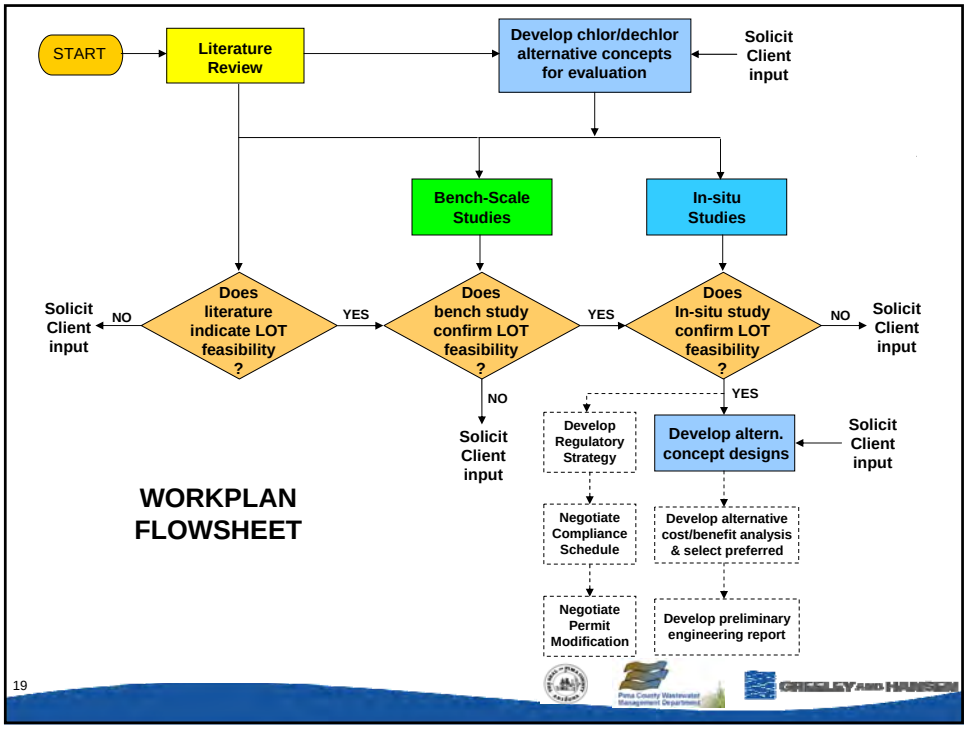
- UV requirements
  - Lift pump station
  - Filtration
  - High intensity UV
- Enhanced chlorination
  - Contact tank (longer retention)
  - Higher sodium hypochlorite dosages
  - Higher sodium bisulfite dosages

17

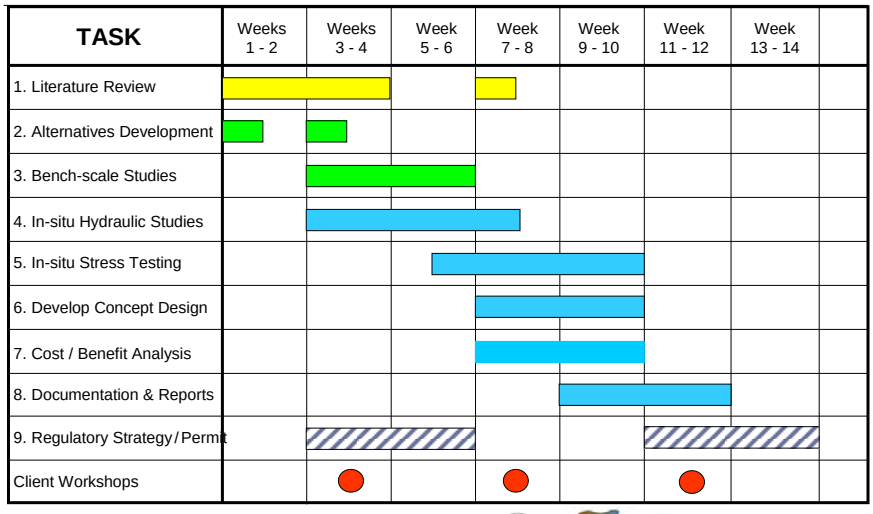
UV Disinfection vs. Enhanced Chlorination – Cost Impacts

- UV Costs $91.0 million
  - Construction/Contingency/ Engineering
- Enhanced Chlorination $17.6 million
  - Construction/Contingency/ Engineering

18



Study/Investigations Schedule



Request for Expression of Interest

- 1.0 Introduction
- 2.0 Facilities, Operations and Budget
- 3.0 Proposed Projects
- 4.0 Alternative Project Delivery Methods
- 5.0 Questions and Comments
- 6.0 RFEI Submittals

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RFEI Content – (1)

- 1.0 Introduction
  - 1.1. Overview
  - 1.2. RFEI Objectives
  - 1.3. Pima County Wastewater System
  - 1.4. Regional Optimization Master Plan (ROMP) Study
  - 1.5. ROMP Capital Improvement Plan
  - 1.6. County Retained Responsibilities
  - 1.7. Timetable
  - 1.8. Individual Meetings
  - 1.9. Communications
  - 1.10. Costs
  - 1.11. Respondents
  - 1.12. County Team

22

RFEI Content – (2)

- 2.0 Facilities, Operations and Budget
  - 2.1. Description of the Department and Its Responsibilities
  - 2.2. Existing Facilities and Practices
  - 2.3. Recent Improvements and Optimization Efforts
  - 2.4. Interface with City of Tucson Water Department
  - 2.5. Economic and Financial Matters
  - 2.6. Regulatory Matters

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RFEI Content – (3)

- 3.0 Proposed Projects
  - 3.1. New Roger Road WRF
  - 3.2. Ina Road WPCF Expansion/Upgrade
  - 3.3. Biogas/Power Facilities
  - 3.4. Biosolids Disposal Services
  - 3.5. Outlying Treatment Facilities

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RFEI Content – (4)

- 4.0 Alternative Project Delivery Methods
  - 4.1. Overview
  - 4.2. Requests for Qualifications
  - 4.3. Requests for Proposals
  - 4.4. Design-Build and Related Project Delivery Methods
  - 4.5. Construction-Manager-at-Risk

RFEI Content – (5)

- 5.0 Questions and Comments
  - 5.1. Preferred Project Delivery Method and Procurement Process
  - 5.2 Business Terms and Conditions Generally
  - 5.3. Construction-Manager-At-Risk
  - 5.4. Design-Build
  - 5.5. Design-Build-Operate
  - 5.6. Private Financing

RFEI Content – (6)

- 6.0 RFEI Submittals
  - 6.1. RFEI Response Format
  - 6.2. Respondent Information
  - 6.3. Projects of Interest
  - 6.4. Project Delivery Method Commentary
  - 6.5. Institutional, Contractual and Legal Considerations
  - 6.6. Economic and Financial Considerations
  - 6.7. Answers to Questions

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Outlying Facilities – Biosolids Handling

Gordon Culp

Biosolids Options

- Haul to interceptor
- Pump to interceptor
- Thicken – haul to Ina Road
- Digestion / dewater – haul to landfill
- Digestion / dewater – haul to Ina Road

29

Haul to Landfill or Interceptor

- Tanker truck
- Driver / operator ($35/hr)
- Operator intensive

30

Pump to Interceptor

- Pumping station
- Pipeline (6” minimum, $11/inch/foot)
- Capital intensive

31

Thicken and Haul to Ina Road

- Thickening facilities
- Tanker truck
- Driver / operator ($35/hr)
- Less capital intensive but more labor intensive than pipeline

32

Digestion / Dewater and Haul to Landfill or Ina Road

- Dewater / stabilize capabilities
- Dump truck
- Driver/operator
- Capital Intensive

33

Assumptions

- BOD_5 loading = 2,800 lbs of BOD_5 per 1 mgd per day
- 1 lb of total solids per lb of BOD_5 load
- 33,000 gal per day of 1% biosolids per mgd of wastewater treated

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Outlying Biosolids

Location	Current, tpd(1)	Future, tpd(1)	Current Processing, Disposal
Marana	0.28	6.16	storage, hauled ⇒ regional facility
Rillito Vista	0.014	0.00	---
Avra Valley	2.2	5.26	storage, hauled ⇒ regional facility
Green Valley	5.7	6.79	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction	0.09	0.00	---
Corona de Tucson	0.16	3.77	storage, hauled ⇒ regional facility
Pima Co. Fairgrounds	0.004	0.00	---
Mt. Lemmon	0.018	0.003	storage, hauled ⇒ regional facility
Southlands	0.0	14.7	separate processing and disposal
Total	8.47	36.68	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

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Biosolids Truck Trips

Biosolids	Truck Trips per Day in Year 2030				
	Avra Valley	Corona de Tucson	Green Valley	Marana	Southlands
Haul Liquid	18	12	26	26	36
Haul Thickened	4	3	5	5	12
Haul Dewatered	1	0.6	1.3	1.3	3

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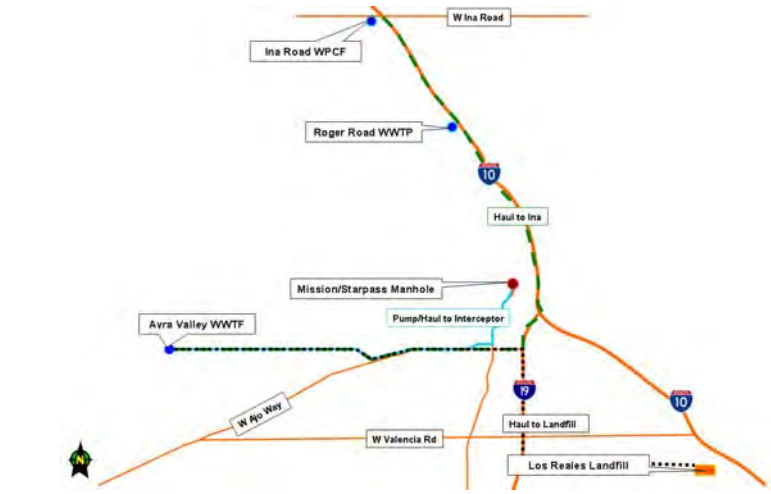
Handling Options – Avra Valley



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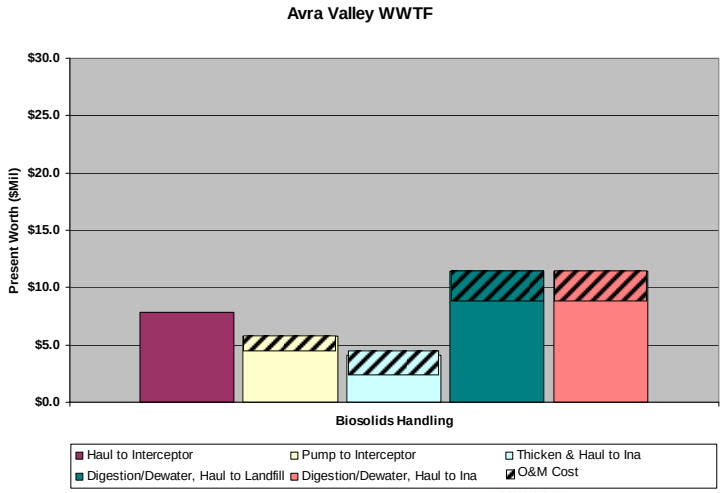
Avra Valley



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Handling Options – Corona de Tucson

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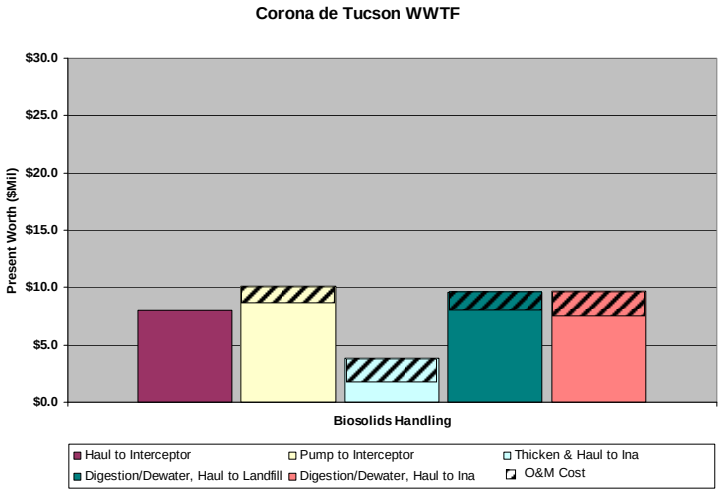
Corona de Tucson



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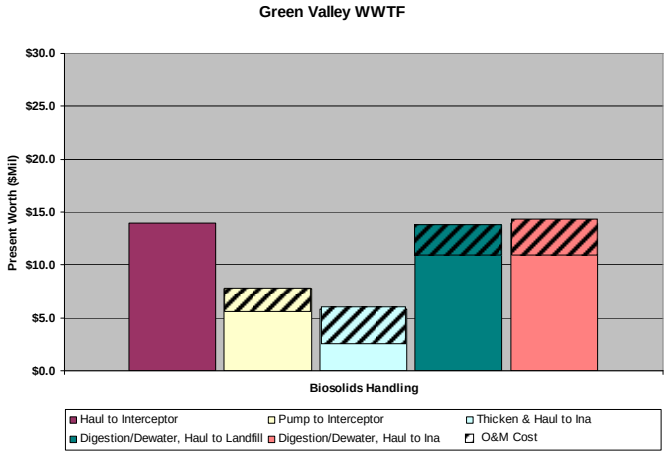
Handling Options – Green Valley

41

Green Valley



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Handling Options – Southlands

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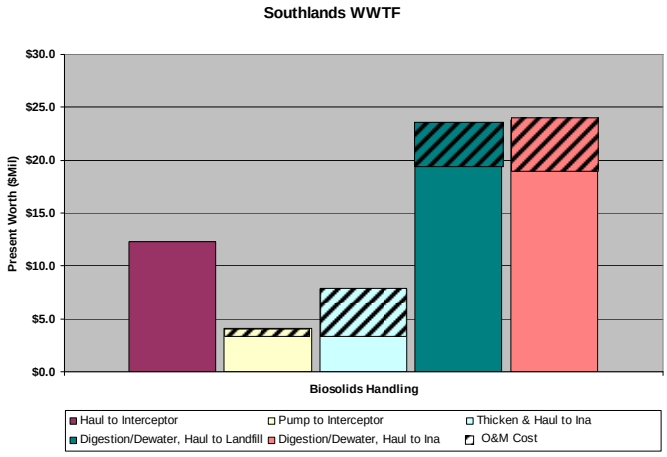
Southlands



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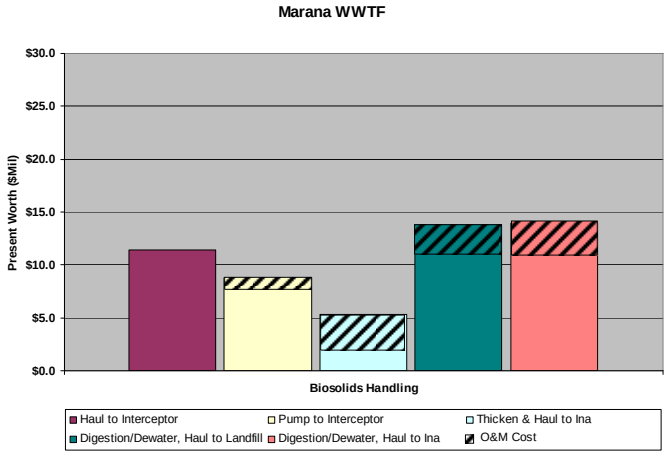
Handling Options – Marana

45

Marana



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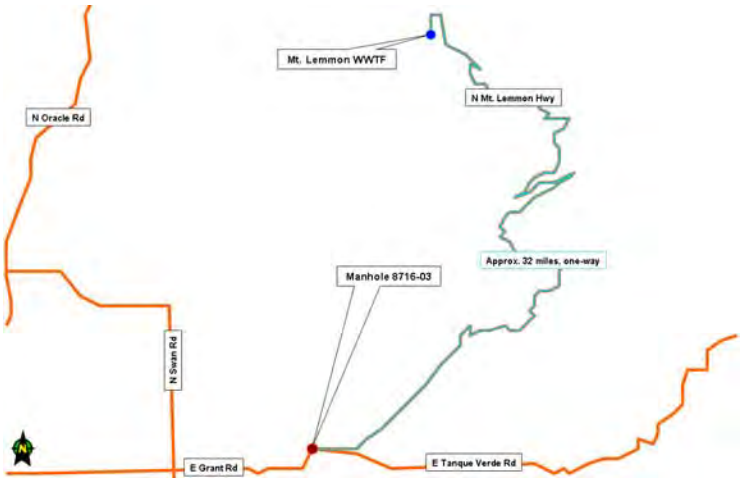
Handling Options – Mt. Lemmon



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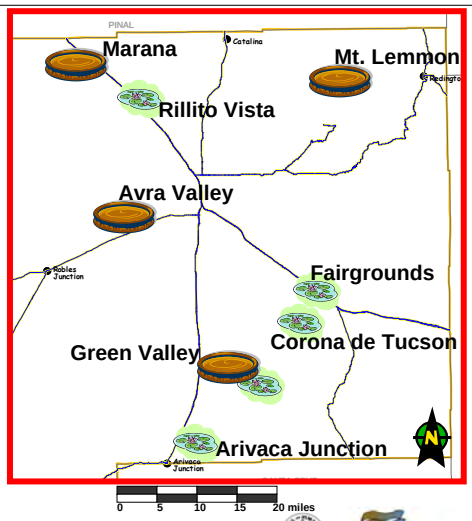
Wastewater Treatment Process at Outlying Facilities

Gordon Culp

Current Outlying Facilities



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Flow Projections

Facility	2006	2010	2015	2020	2025	2030
Avra Valley	1.1	1.4	1.8	2.2	2.6	3.0
Corona de Tucson	0.1	0.5	0.9	1.3	1.7	2.1
Green Valley	1.8	2.7	3.1	3.6	4.0	4.4
Marana	0.1	1.6	2.3	3.0	3.7	4.4
Mt. Lemmon	0.002	0.002	0.002	0.002	0.002	0.002
Southlands (excludes Corona)	-	1.2	3.6	6.0	8.2	10.5

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Weighted System Evaluation Matrix

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBBR	SBR	MBR	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	5	4	4	3	5	2	20	20	15	25	10
Environmental Impact	4	4	4	3	3	3	16	16	12	12	12
Feasibility	3	3	5	4	3	3	9	15	12	9	9
Operational Capability	4	4	4	3	2	4	16	16	12	8	16
Land Required	2	4	3	4	4	5	8	6	8	8	10
Maintenance	4	5	5	3	3	2	20	20	12	12	8
Public Acceptability	5	3	3	3	5	5	15	15	15	25	25
Reliability	4	3	4	3	3	2	12	16	12	12	8
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	4	16	16	16	16	16
Odor Control	5	4	3	4	3	4	20	15	20	15	20
Sum of Weighted Ranks							**155**	**160**	**137**	**145**	**137**

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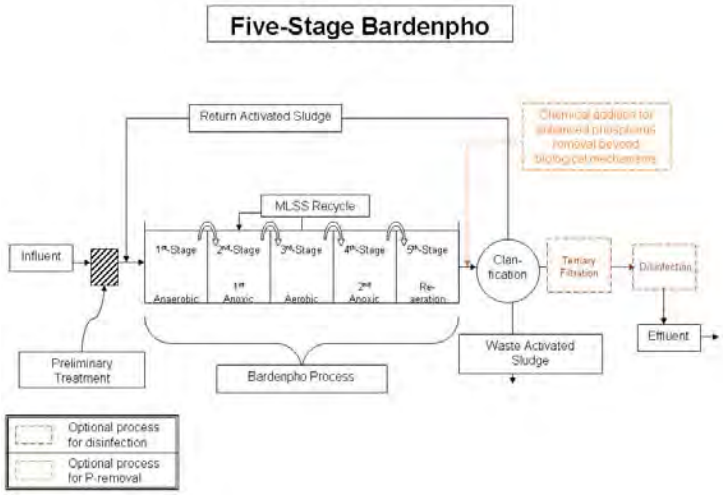
Bardenpho Process



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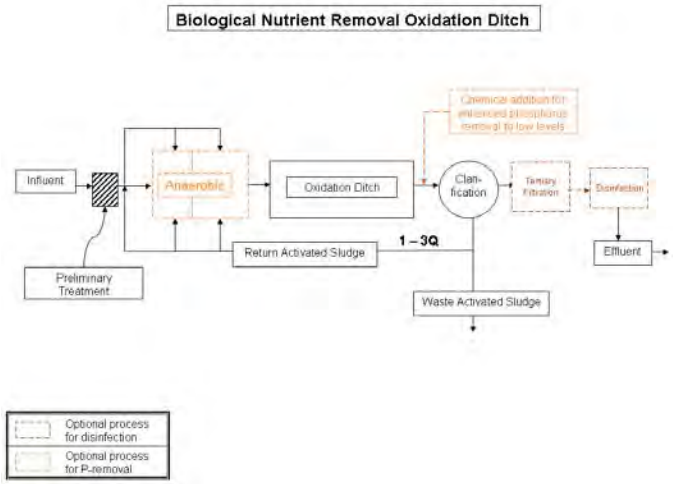
BNROD



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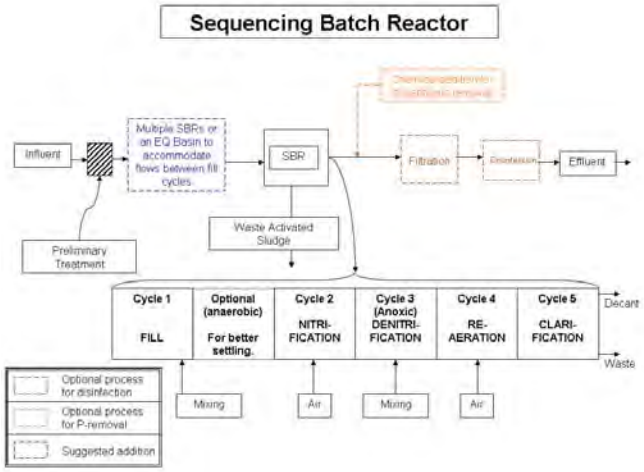
SBR



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Phase Out Lagoons (Clean Closure)

- Arivaca Junction
- Rillito Vista
- Pima County Fairgrounds

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Treatment Process Considerations

- Avra Valley
- Corona de Tucson
- Green Valley
- Marana
- Southlands

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Outlying Facility Expansion Completion Dates

Facility	Expansion 1	Expansion 2	Expansion 3
Arivaca Junction	To be decommissioned	-	-
Avra Valley	2006 / 2007	2008 / 2009	-
Corona de Tucson	2006 / 2007	2018 / 2019	2027 / 2028
Southlands	2008 / 2009(1)	2014 / 2015	2022 / 2023
Green Valley	2011 / 2012		-
Marana	2006 / 2007	2008 / 2009	2011 / 2012
Mt. Lemmon(2)	TBD	TBD	TBD
PC Fairgrounds	To be decommissioned	-	-
Rillito Vista	To be decommissioned	-	-

(1)To be completed by others
(2)Long range planning study in progress

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Avra Valley WW Process

- Currently BNROD
- BNROD expansion underway
- Selecting different process introduces complexity
- Loss of investment
- Avra Valley = BNROD
- Q_6 = 1.1 mgd; Q_{30} = 3.0 mgd

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Corona de Tucson WW Process

- Closed loop reactor nearly finished
- Selecting different process introduces complexity
- Corona de Tucson = CLR
- Q_6 = 1.3 mgd; Q_{30} = 2.1 mgd

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Green Valley WW Process

- Currently BNROD
- Plan to construct additional BNROD
- Selecting different process introduces complexity
- Green Valley = BNROD
- Q_6 = 1.8 mgd; Q_{30} = 4.4 mgd

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Marana WW Process

- BNROD system design complete, ready for bid
- Selecting different process requires additional investment
- Marana = BNROD
- Q_6 = 0.1 mgd; Q_{30} = 4.4 mgd

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Southlands WW Process

- Does not exist
- 2030 capacity above 10 mgd (upper bounds of BNROD and SBR)
- Southlands = Bardenpho
- Q_6 = 0.0 mgd; Q_{30} = 10.5 mgd

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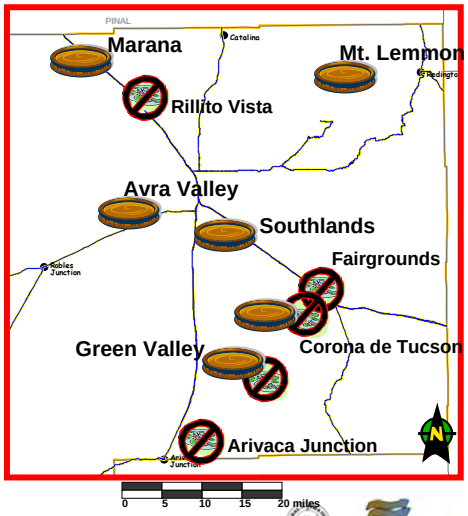
Future Outlying Facilities



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Biosolids Disposal

Jerry Bish

Biosolids Disposal Options

- Class B
  - Agricultural land (current operations)
  - Landfill
- Class A
  - Market requires study
    - Liquid / dry forms
  - D/B/O ?

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Future Solids Streams

- Roger Road WRF

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Waste Activated Sludge	1.72	0.7	100,600	76,400
Thickened WAS (to Ina Road Digestion)	0.36	3.0	90,500	68,800
Thickener Overflow	1.36	0.1	10,100	7,600

- Ina Road WPCF

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Primary Sludge	1.15	1.0	95,300	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

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Master Plan Recommendation

- Produce Class B biosolids using mesophilic digestion at Ina Road
- Continue to apply Class B biosolids to agricultural land (cost effective in short term)
- Modify process to produce Class A biosolids when required by regulatory agencies or public pressure
- Develop a long-term biosolids management plan (w/ multiple disposal options/outlets)

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Class A Processes

Process	Requirements
Thermophilic Aerobic Digestion 1	MCRT of 10 days @ 55-60°C
Heat Drying 1	Direct or Indirect Gas Drying to ≤ 10% moisture content and solids temperature of 80°C
Heat Treatment 1	MCRT of 30 minutes @ 180°C
Composting 1	3 days @ 55°C for in-vessel or static pile 15 days @ 55°C for windrow
Pasteurization 1	30 minutes @ 70°C
Alkaline Stabilization 2	pH 12 and maintained for 72 hours with biosolids ≥ 52°C for 12 hours, followed by air drying to 50% TS
Time/temperature 3	Process meets detention time at temperature requirements by solids concentrations given in 503 regulations or has been given equivalency by USEPA (TPAD and batch thermophilic digestion for example)

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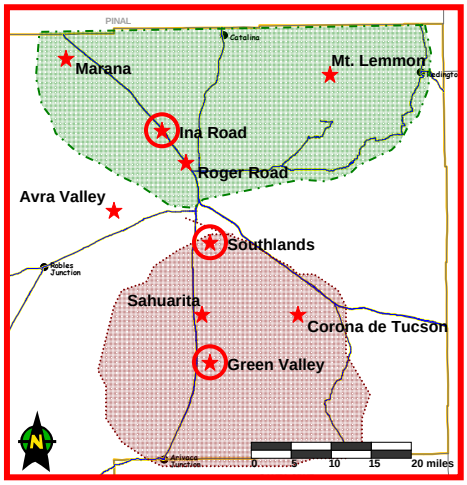
Regional Solids Processing



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Elements of Long-Term Biosolids Management Plan

- Analysis of current program
  - Establish baseline conditions
- Projected quantity and quality of biosolids
  - Effects of liquid treatment process changes
- Regulatory and social issues
  - Regulatory pressures
  - Public concerns
  - Increased urbanization
  - National trends

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Elements of Long-Term Biosolids Management Plan

- Development and evaluation of alternatives
  - Market assessment for biosolids
  - Technology identification and screening
  - Development of preliminary alternatives
  - Screening of preliminary alternatives using economic and non-economic criteria
  - Evaluation of shortlisted alternatives
  - Recommended long-term plan

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Elements of Long-Term Biosolids Management Plan

- Cost summary
- Implementation plan

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Site Layouts –
Preliminary Architectural Design Concepts

Tim Bennett

Preliminary Architectural Design Concepts: Roger Road

- Architectural basis of design
  - Cost effective
  - Friendly public image
  - "Water Campus" concept
  - Unconstrained by existing designs
  - Inviting and accessible
  - Use of indigenous materials
  - Energy consumption
  - Environmental impact

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PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD

SIGNIFICANT LOCAL ORGANIC AND STRUCTURAL FORMS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD

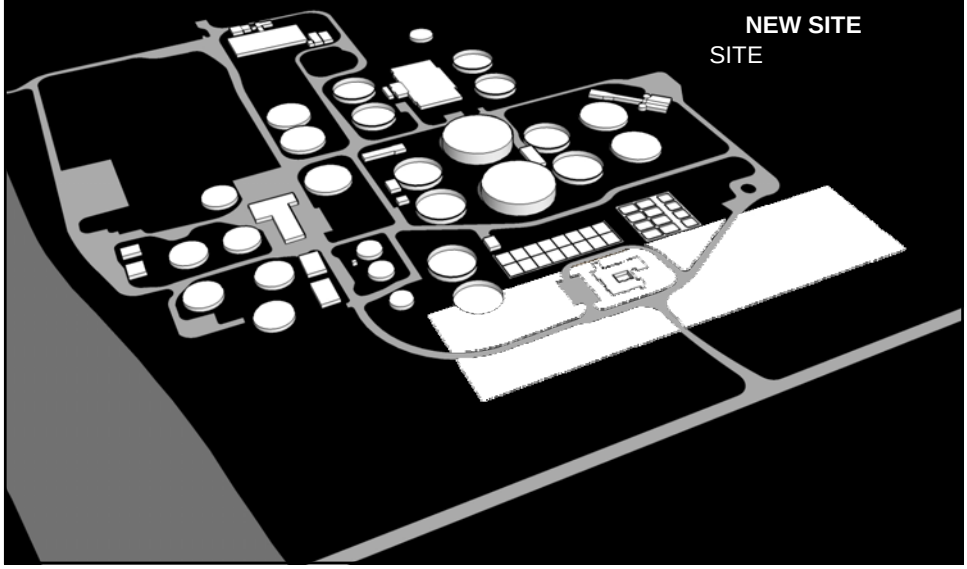
SIGNIFICANT LOCAL ORGANIC AND STRUCTURAL FORMS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD

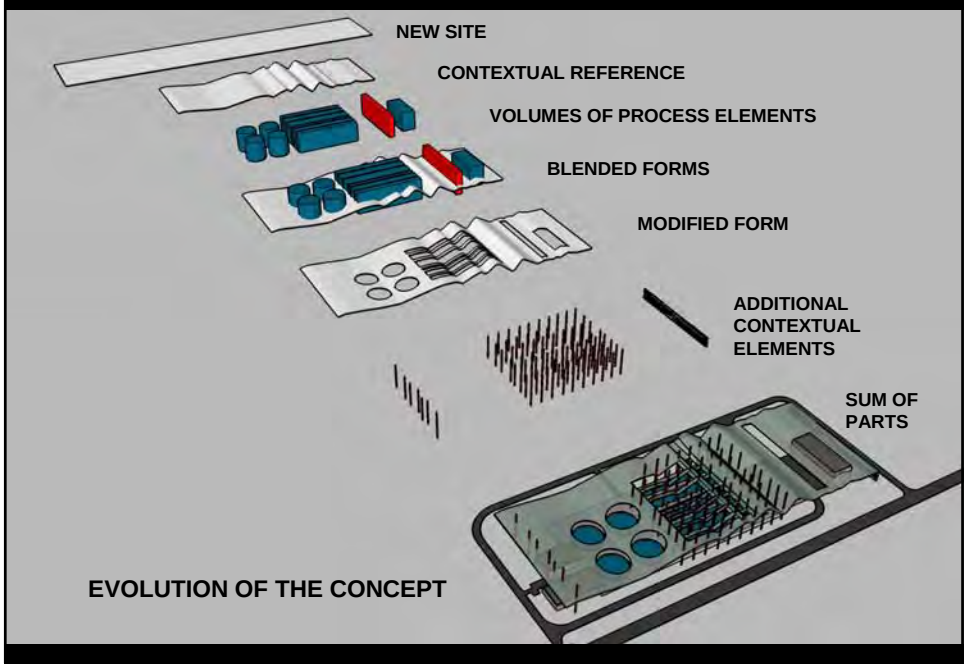
- CONCEPTUAL SKETCH

- CONTEXTUAL RELATIONSHIP OBJECTIVE

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



EVOLUTION OF THE CONCEPT

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD

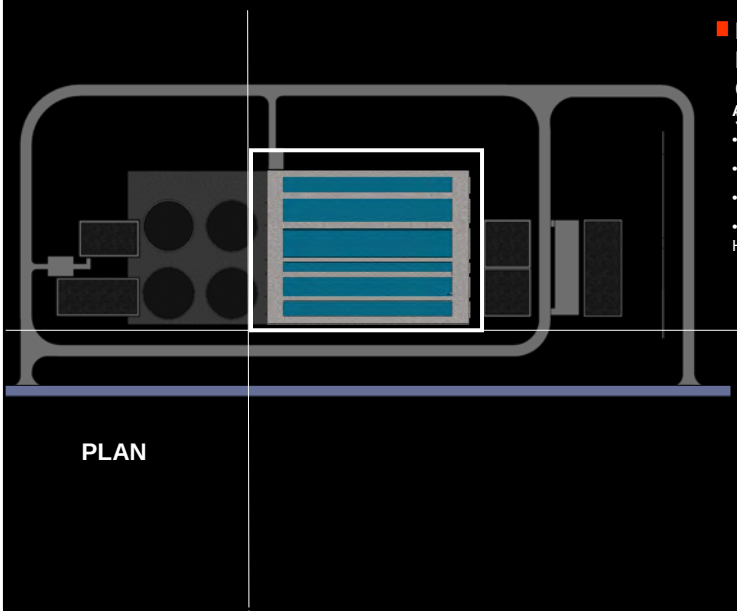
CANOPY PLAN

- **CONTEXTUAL ELEMENTS CHARACTERISTICS**

CANOPY:

- CLEAR REFERENCE TO MOUNTAINOUS HORIZONS
- METAL FABRIC TENSILE STRUCTURE SUPPORTED ON MASTS
- SHADE PRODUCING, WITH ACCESS VOIDS AS SHOWN
- POSSIBLE SOLAR AND WIND ENERGY HARVESTING CAPABILITY
- PROJECTS THE IMAGE OF TUCSON

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



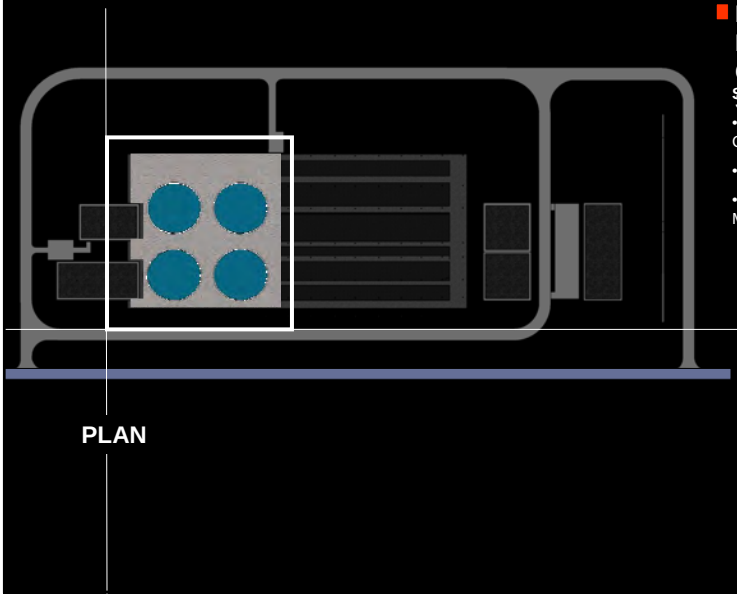
PLAN

- **PROCESS ELEMENTS CHARACTERISTICS**

AERATION TANKS:

- CORE OF THE PROCESS
- CENTRALIZED LOCATION
- LOW VERTICAL MASS
- VERY SIGNIFICANT HORIZONTAL MASS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



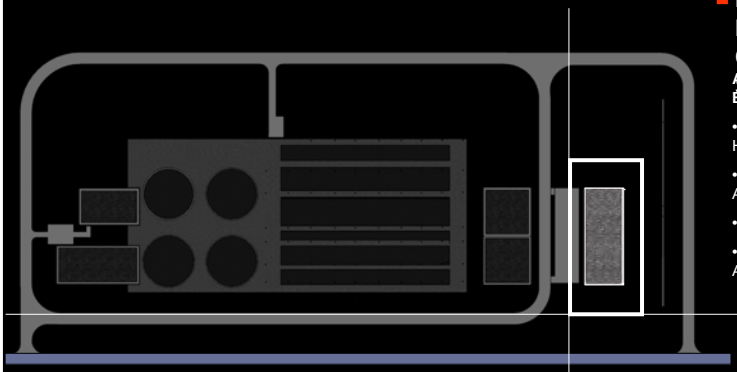
PLAN

- **PROCESS ELEMENTS CHARACTERISTICS**

SEDIMENTATION TANKS:

- PRECISE GEOMETRIC CIRCULAR ARRAY
- LOW VERTICAL MASS
- SIGNIFICANT HORZONTAL MASS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



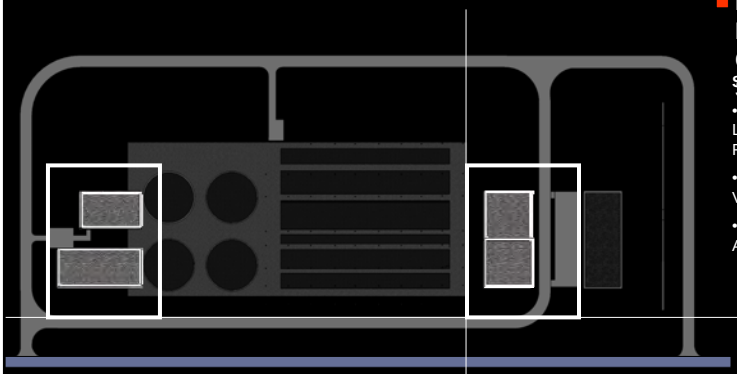
PLAN

- **PROCESS ELEMENTS CHARACTERISTICS**

ADMINISTRATION BUILDING:

- PERSONNEL AND VISITOR HOME BASE
- VEHICULAR TRAFFIC ACCOMMODATIONS
- MAJOR VISUAL ELEMENT
- SIGNIFICANT HORIZONTAL AND VERTICAL MASS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



PLAN

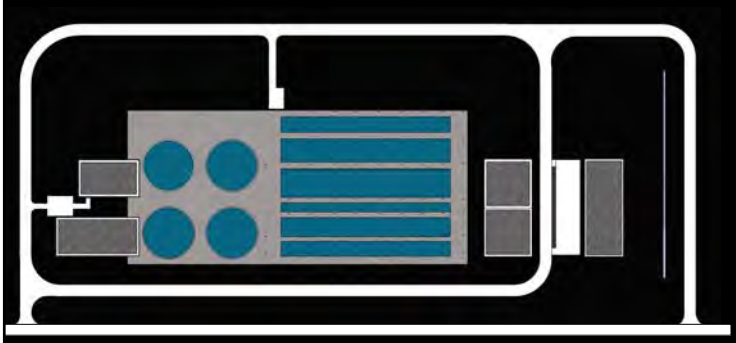
- **PROCESS ELEMENTS CHARACTERISTICS**

SUPPORT STRUCTURES:

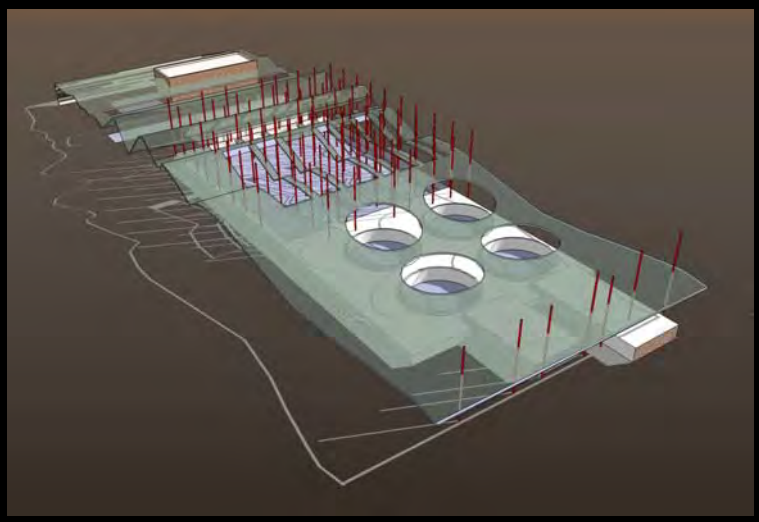
- RANDOM VARIATIONS IN LOCATIONS AND FOOTPRINTS
- STRONG REPEATING VISUAL ELEMENTS
- VARYING HORIZONTAL AND VERTICAL MASS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD

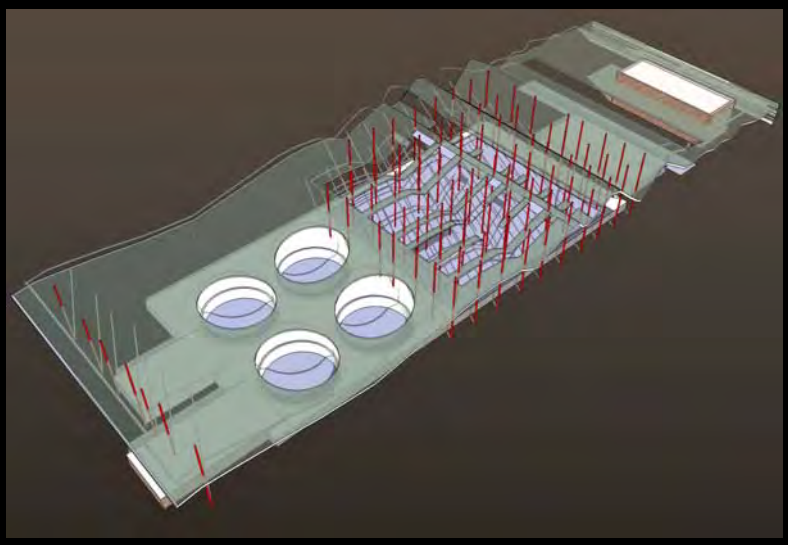
PLAN VIEW



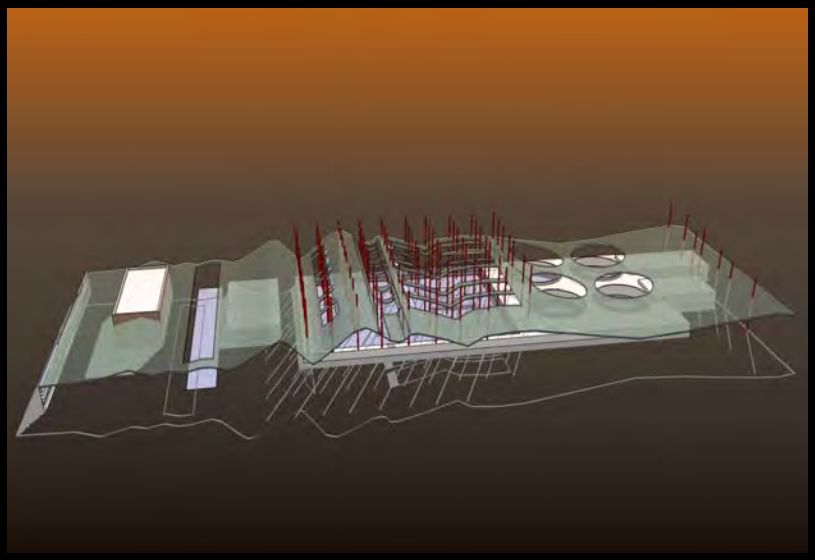
PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



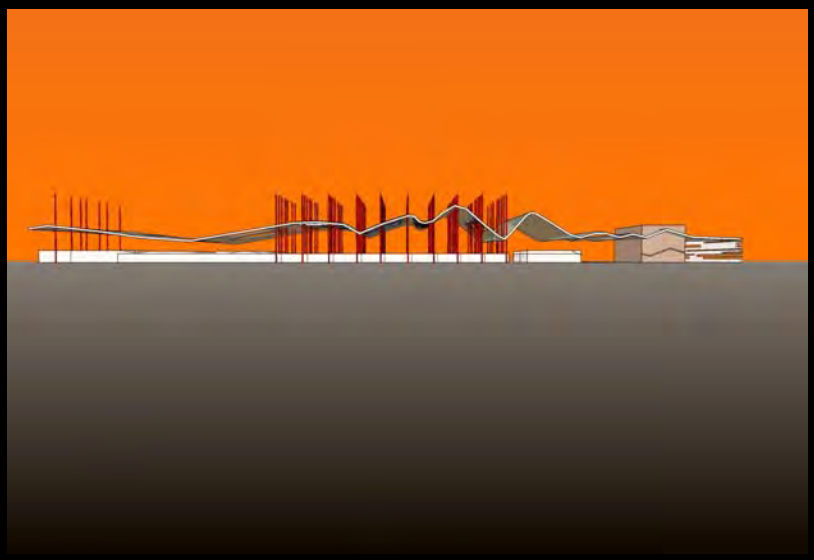
PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: ROGER ROAD



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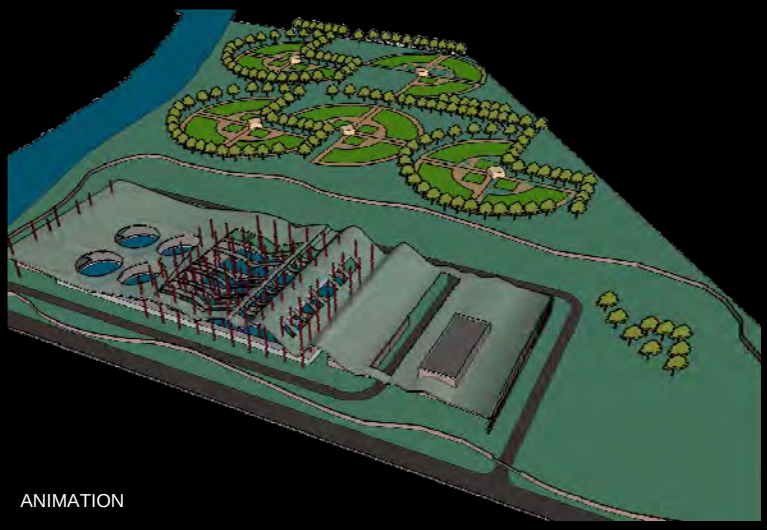

ANIMATION

Preliminary Architectural Design Concepts: Ina Road

- Architectural basis of design
  - Single landscape and architectural theme to harmonize existing and new facilities
  - Cost effective
  - Relationships to other plants
  - Unifying appearance overall
  - Use of indigenous materials
  - Energy consumption
  - Environmental impact

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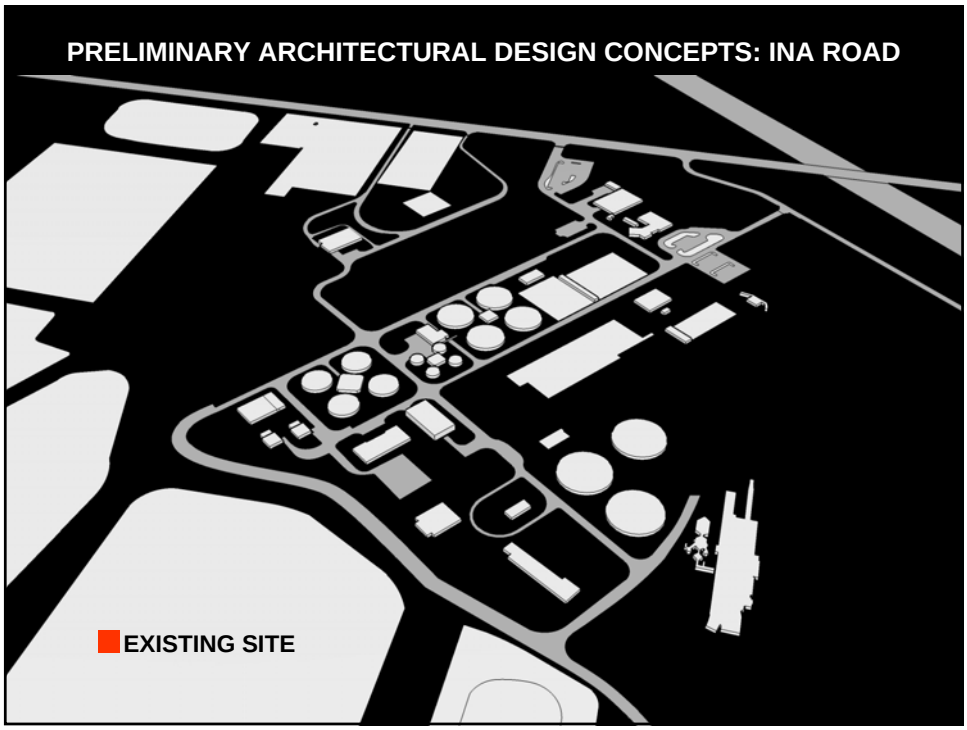

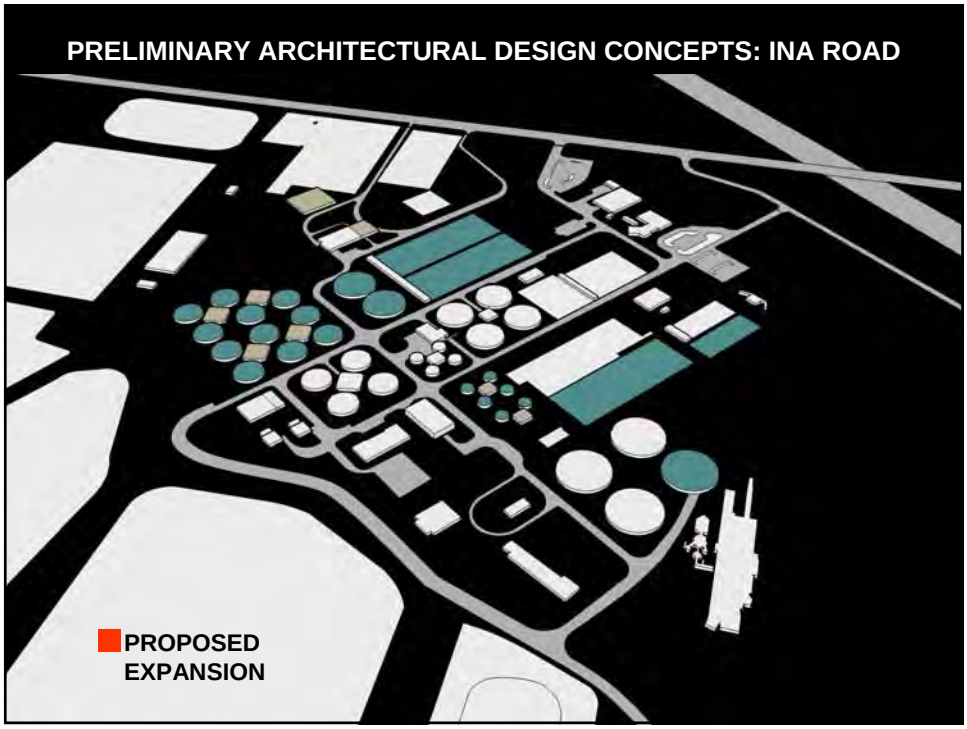
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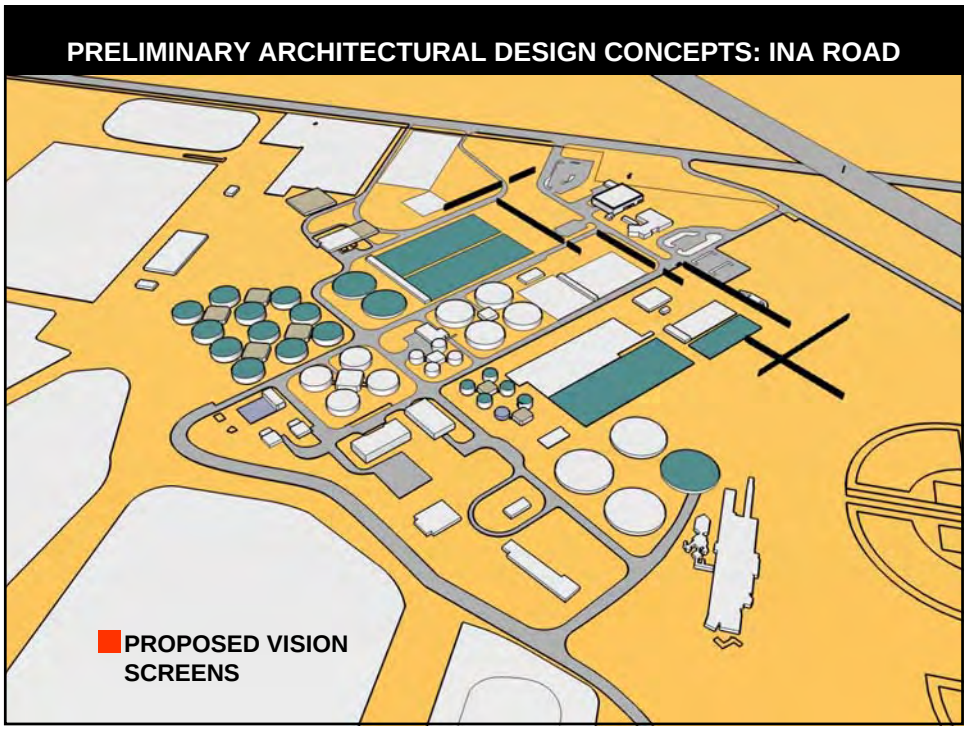
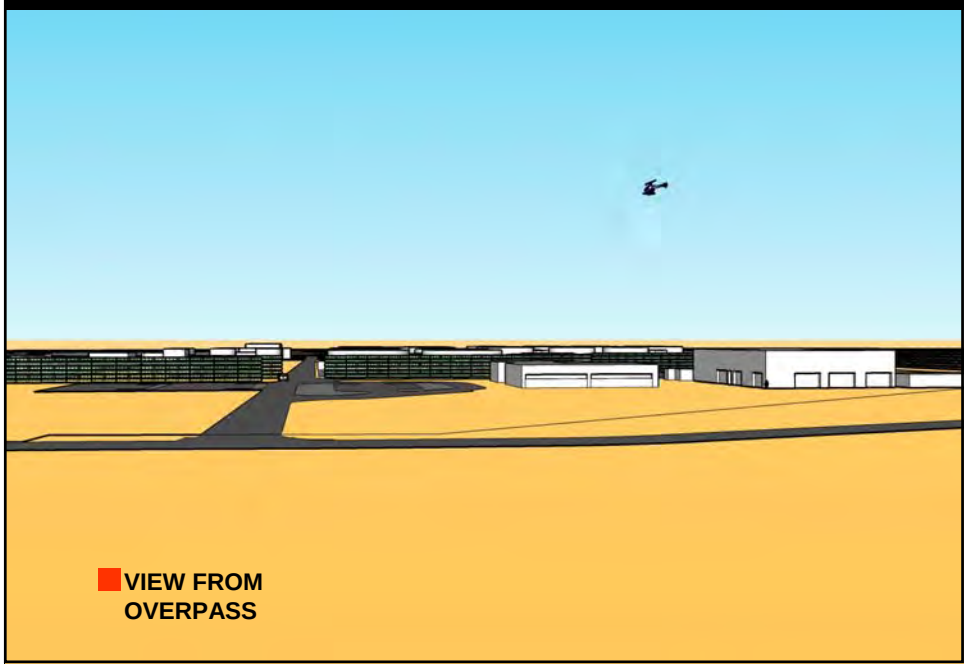
PROPOSED EXPANSION

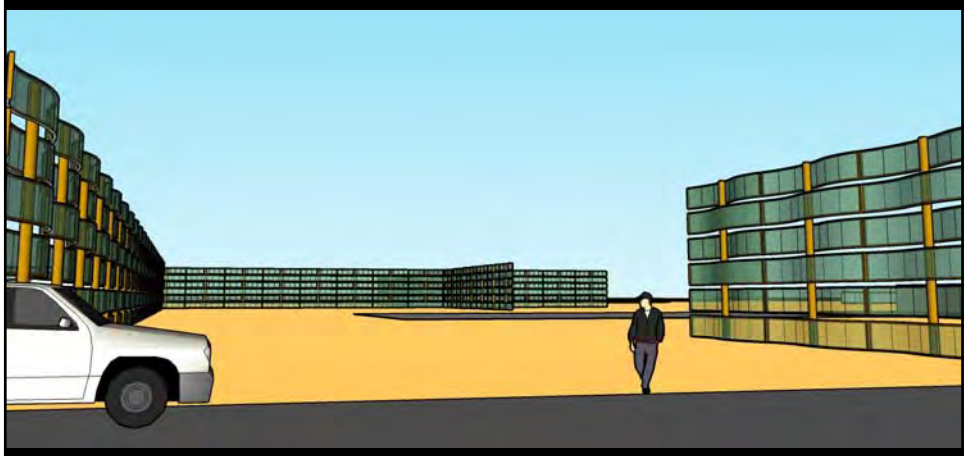

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: INA ROAD
PROPOSED VISION SCREENS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: INA ROAD



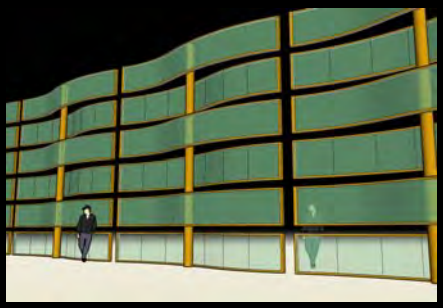
VIEW FROM OVERPASS

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: INA ROAD



VIEW ONSITE

PRELIMINARY ARCHITECTURAL DESIGN CONCEPTS: INA ROAD



- VISION SCREEN DETAIL

Pima County Wastewater Management Department

GREELEY AND HANSEN

Open Session

Jerry Bish

Transitional Operations

- Construction of plant interconnect by 2010
- 2010 to 2015 flows at Ina Road
- 2010 to 2015 flows at Roger Road

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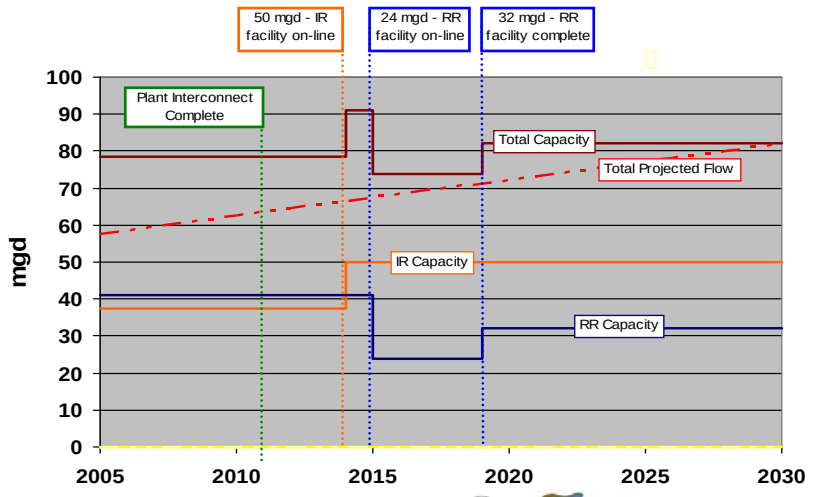
Plant Capacity Analysis



100

Transitional Operations

- Digester at Ina Road
- Thickener upgrades
- Centrifuge upgrades
- Sludge storage upgrade
- Sludge loading facility upgrade

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Transitional Operations

- Power Supply – Ina Road WPCF
  - Plant is served from two utility sources with multiple service drops and on site generators
  - Original treatment plant constructed during the 1970's and Centrifuge Building added in the 1980's is powered by generators at the plant power generation facility
  - Plant expansion is powered from three separate Tucson Electric Power (TEP) incoming utility electric services

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Transitional Operations

- Power Supply – Ina Road WPCF *(continued)*
  - A unified power distribution system will be implemented as plant is expanded
  - Unified system will feature redundant power sources; this will consist of dual utility sources, on site generators or combinations of both

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Other Issues

- Program management
- Smoothing CIP "hump" scenarios
  - Finance over different periods 15, 20, 30 years
  - Existing program – defer more project elements
  - Extend time for compliance
  - What is the ideal "sweet spot" financing plan
- Odor control – conveyance system

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Summary and Wrap-Up

Andy Richardson

Pima County Wastewater Management Department

GREELEY AND HANSEN

Closing Remarks

Mike Gritzuk

GREELEY AND HANSEN

Workshop #16 Meeting Notes
Implementation Plan / Pre-Final Draft of ROMP Report Workshop

1. The Implementation Plan and Pre-Final Draft of the ROMP Report Workshop for Pima County Regional Optimization Master Plan was held on May 9, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
Jeff Nichols
PCWMD Staff
Ed Curley
Laura Fairbanks
Jim Doyle
Frank Gall
Mary Hamilton
Michael Kostrzewski
Byron McMillan
Jeff Prevatt
Karen Ramage
Helen Rhudy
Ron Riska, Project Manager
Prakash Rao
Mandley Rust
John Sherlock
Jack Van Riper
John Warner
Eric Wieduwilt
Legal
Chuck Wesselhoff

TUCSON WATER
Tucson Water Staff
Pat Eisenbach
Melodee Loyer
Ralph Marra
Tim Thomure

BUREAU OF RECLAMATION
Deborah Tosline

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Joe Popeck

2. Major topics of the workshop were:
   - Workshop #16: Implementation Plan / Pre-Final Romp Report Review
     - Review of Chapters – 1 through 13 + Executive Summary
     - Updates
       - Enhanced Chlorination
       - Request for Expression of Interest

A set of handouts were provided to each attendee at the workshop. Throughout the workshop one comment was recorded on a "flip-chart." That comment is incorporated into the summary provide below.

3. Mike Gritzuk welcomed the attendees to the workshop. He stated a job well done by all of those in the Pima County Wastewater Management Department who have participated in the Regional Optimization Master Plan process. Tucson Water was recognized as contributor and major stakeholder in all the workshops. Also, it was requested that the department collectively review every page of the Report to make sure it reflects the needs of PCWMD.

4. Jerry Bish outlined the meeting topics and objectives. All were encouraged to fully participate with comments or questions on the ROMP Report as it was reviewed chapter-by-chapter during the workshop. The primary workshop objective was to review the draft of the ROMP Report, including the financing plan, delivery methods, implementation plan and executive summary which were only outlined in the previous draft of the Report. Attendees were reminded to send their comments to Ron Riska who will compile and forward them to Greeley and Hansen. Comments are due to Ron by May 21, 2007.

   Overview, agenda, meeting objectives, and ground rules were covered on pages 1 through 4 of the handout.

5. The meeting began with a review of an open and unsettled issue with Tucson Water regarding filtration of the plant effluent at the new Roger Road Water Reclamation Facility and the upgraded and expanded Ina Road WPCF. If PCWMD is required to filter the effluent, Tucson Water will recognize this as A+ water and will receive, disinfect and distribute as reclaimed water. This is similar to the Randolph Park WRF operation, where the effluent is A+ water. However, at Randolph Park WRF PCWMD also disinfects and delivers that water to the reclaimed water distribution system. If Class B+ is provided by PCWMD and filtration is provided by PCWMD, Tucson Water wants a guarantee of water quality. It was agreed that this would be discussed further in a future meeting with Tucson Water.

6. Jerry Bish reviewed the purpose and summarized the contents of the Executive Summary and Chapter 1. For the Executive Summary if was stated that while brief, that this will serve as a stand alone document that summarizes the master plan purpose and recommendations. It is important that this reflect the future planning needs of the Department. For example, it was suggested that unresolved issues that were identified under ROMP be listed in the Executive Summary. Since this was the first presentation of this section, it is important that everyone review it and provide comments on whether it correctly states with clarity the future needs of the Department.

   Chapter 1 sets forth the purpose of the Regional Optimization Master Plan and establishes the basis of the report. This chapter sets the stage for the chapters to follow. The purpose of the report is to provide the 25-year road map for the department to follow in its continued mission and stewardship of the environment in Pima County.

   Summaries of the Executive Summary and Chapter 1 were covered on pages 5 and 6 of the handout.

7. Chapter 2 was reviewed by Jerry Bish. This chapter covers regulatory requirements and customer issues. It is recognized that the permits required by the State environmental agencies are not static, but are periodically being renewed. For example, the APP permit summarized in the chapter is outdated and has been replaced with a new permit. Based on this fact, tables in the chapter which summarizes the permits will be moved to the appendix, as previously requested by Byron McMillan. In addition, it was indicated that ADEQ is considering new and more stringent rules on ammonia removal in the discharges from wastewater treatment plants, which should be referenced in the Chapter. Further the chapter needs to stress the impacts of cultural resources at the sites along the Santa Cruz River, where ancient cultures once inhabited.

   Jack Van Riper asked if the report identifies how the riparian habitat downstream of Roger Road will be maintained. The response is that the report does not explicitly state how to maintain the riparian habitat, but addresses it in general terms by providing up to 7 mgd of effluent into the river. There are other entities in the County that are addressing the riparian habitat issue along the Santa Cruz River, such as the Tres Rios del Norte study by the Corps of Engineers. Mike Gritzuk commented that no firm commitment has been made to how much water is allotted for riparian habitat. Further, it was stated that the ownership of the effluent from the treatment facilities should be addressed, but an exact amount of effluent ownership need not be included in the Report. In addition, there is no known regulatory requirement that any amount of effluent be discharged to the Santa Cruz River.

   John Warner asked if CMOM was included in Chapter 2. It was affirmed that CMOM was included in this section of the report. It was also suggested that the future Corps of Engineers river restoration study project between Prince and Congress should be referenced in the report along with the current Tres Rio del Norte project. Finally, the possible presence of asbestos at the existing Roger Road WWTP should be noted as a clean closure issue at the site. It was noted that there is a report on asbestos issues at the site that should be referenced.

   The Board of Supervisors has adopted new County sustainability initiatives that will need to be utilized in future facilities. The date of the resolution is dated May 1, 2007 and supports sustainable development and the continual emphasis on sustaining a livable community. A copy of the County resolution is attached at the end of the notes.

   Summary of Chapter 2 was covered on page 7 of the handout.

8. The treatment plant evaluation is covered in Chapter 3 and was reviewed by Joe Popeck. The chapter addresses existing treatment capacity, facility condition and assessment of processes and systems at the existing Roger Road WWTP and Ina Road WPCF. At Roger Road WWTP due to age, condition and functional risk of future operations, the existing facilities are deemed marginal for conversion to BNR service. Since Ina Road WPCF is a much newer facility, much of the existing systems and can be utilized in the future nitrification and denitrification (BNR) operation. At both Roger Road WWTP and Ina Road WPCF near-term planned improvements are necessary to maintain wastewater treatment effectiveness until the modifications are completed to upgrade the plants for ammonia (nitrogen) removal.

   It was requested that an additional section be added to Chapter 3 to address the evaluation of the plants via the risk factors, such as contractual, unforeseen/unknown, etc. As stated above ADEQ is

considering new proposed rules for ammonia limits which are more stringent. The new rules will be pH dependent. The proposed new rule should be addressed in the development of the future treatment processes.

Summary of Chapter 3 was covered on pages 8 through 10 of the handout.

9. Overall wastewater treatment strategy is developed in Chapter 4. The chapter was summarized by Joe Popeck and includes: information on future flows, wastewater characteristics, future treatment requirements, flow split options, treatment process alternatives, and reclaimed water considerations. An initial screening of system alternatives was developed, which reduced the candidate wastewater systems to three. Through application of technical, financial, risk and non-cost criteria a wastewater treatment system recommendation was provided for the Roger Road and Ina Road facilities. The final recommendation is to use Bardenpho process at both plants, use a flow split arrangement of 32 mgd at Roger Road and 50 mgd at Ina Road. All new facilities would be located at Roger Road, while Ina Road WPCF will be expanded and upgraded to meet the future requirements.

   The chapter should state that the treatment plant design is set to achieve a nitrogen limit of less than 8 mg/L and a phosphorus limit of less than 2 mg/L. Jackson Jenkins indicated that Randolph Park WRF is a nominal 3 mgd facility. Its actual capacity is less than that. Also, if thicken biosolids from the outlying facilities are to be received at Ina Road, they should be discharged directly to the digesters.

   Frank Gall asked about diurnal flows at Roger Road. The Roger Road WRF will be able to operate in a steady-state or on diurnal flow mode. The final operational mode is a strategic operational decision based a number of factors. This will be evaluated at the time of startup, or early operation of the new, and expanded and upgraded facilities.

   As a site location consideration, moving the new Roger Road Water Reclamation Campus to along the Santa Cruz River needs to be evaluated. This relocation may better suit the environmental and park themes considered for the surrounding area.

   Summary of Chapter 4 was covered on pages 11 through 17 of the handout.

10. Biosolids handling and treatment for the County wastewater treatment facilities were covered in Chapter 5. The summary was provided by Jerry Bish and included a review/assessment of current practices, review of biosolids regulations, projection of future biosolids quantities and a recommendation to deal with near-term and future biosolids challenges. In addition, the recommendation for the use of biogas from current and future digesters at Ina Road is to generate electricity and heat to satisfy the energy needs of the plant, or to sell the biogas for green credits and purchase utility power. This is being addressed through the request for expression of interest process currently underway. The recommendation for biosolids handling and disposal is to take the current biosolids assessment and recommendation in the Report as a base, and develop a long term biosolids management plan. The plan needs to include a comprehensive biosolids market study and economic feasibility analysis of Class A biosolids. It was noted that biosolids handling and disposal was one of the items in the request for expression of interest. It was further noted that prospective biosolids management firms need to be informed of the expression of interest process.

Comments of the Chapter 5 content include the following. Since new gravity belt filters have been recently installed and placed into service at Roger Road, they should be included in the process diagram. In the Ina Road WPCF process diagram, dissolved air flotation thickeners should be shown in parallel with the gravity thickener tanks. For Mt. Lemmon show biosolids as stored and hauled to an interceptor of the Ina Road WPCF. Also, since the new facilities at Corona de Tucson WWTP will be in service soon, show biosolids as stored and hauled. Also, it was offered that the sludge quantities at each site needs to be checked for correctness.

Prakash Rao stated that the biosolids from Green Valley will continue to be disposed of at the mines for two more years. At that time a decision will be made as to whether to continue the program on a permanent basis.

Further, Byron McMillan indicated that the County Board if Supervisors have passed a resolution on "green power – renewable energy" which should be referenced in the report.

Summary of Chapter 5 was covered on pages 17 through 25 of the handout.

11. Chapter 6 reviews and makes an assessment of the conveyance interceptor systems within the Roger Road WWTP and Ina Road WPDF service areas. Jerry Bish summarized the chapter contents. The contents include a hydraulic capacity analysis of future flows, wet weather impacts, CMOM considerations, Roger Road WRF and Ina Road WPCF service interconnect and a listing of interceptor capacity projects over the next 25 years. John Warner suggested and the group accepted that the pipeline interconnecting Roger Road WRF to Ina Road WPCF be called the Santa Cruz Interceptor Phase IV.

    Summary of Chapter 6 was covered on pages 25 through 28 of the handout.

12. The recommended treatment plant is described in Chapter 7. Joe Popeck summarized the features of both the new Roger Road WRF and the expanded and upgraded Ina Road WPCF. The chapter covers land use and area development, and location and configuration of future treatment facilities and associated utilities. It was noted that the future facilities at Roger Road will be identified as the Roger Road Water Reclamation Facility. Melodee Loyer stated that the reclaimed water volumes indicated in the presentation (30 mgd at Roger Road WRF and 20 mgd at Ina Road WPCF) were estimated for the year 2030. Actual effluent quantities allotted to Tucson Water for reclaim water use is prescribed in IGAs.

    Jackson Jenkins asked if a fourth emergency overflow basin was shown at Ina Road WPCF. Since Roger Road can use the new Santa Cruz Interceptor Phase IV (plant interconnect pipeline) to transfer flow under emergency conditions, it will not be necessary to provide emergency overflow basins there in the future. But since that additional flow will be transferred to Ina Road additional storage may be required there. The conclusion is to provide an allocated space for a fourth basin, but to improve standby power capabilities and not include an additional basin in the expansion and upgrade program at Ina Road WPCF at this time.

    Summary of Chapter 7 was covered on pages 28 through 33 of the handout.

13. Existing outlying wastewater facilities permits, capacities, service areas and operations are described in Chapter 8 and were reviewed by Jerry Bish. Pima County operates eight outlying treatment facilities. A ninth facility is the Randolph Park WRF which is included within the Roger Road Service Area. Comments on the chapter include: combine Figures 8-10 and 8-11into one figure, check capacity at Marana WWTP (current capacity is 200,000 gpd), check capacity at Pima County Fairgrounds WWTP, and change Corona de Tucson WWTP's biosolids handling to store and haul. Pima County growth has recently slowed and flows are not increasing as rapidly as predicted using the PAG and TAZ population data. PCWMD planning group tracks the growth and flows separately to provide timely services.

    Where biosolids are thickened and hauled at the outlying facilities, indicate that those thickened biosolids are transported to Ina Road WPCF and fed directly into digesters.

    Summary of Chapter 8 was covered on pages 34 through 36 of the handout

14. The strategic wastewater management plan for the outlying facilities is described in Chapter 9. A summary of the chapter contents was provided by Jerry Bish. The chapter examines future needs, treatment plant capacities and facilities consolidation potential. From an evaluation of the future needs and population growth patterns, it is recommended that the current eight facilities be organized into six future facilities. One of the future facilities, Southlands, does not currently exist. In the consolidation process three lagoon facilities will be phased out of operation. Each of the future facilities will be an oxidation ditch system, or a variant thereof, except for the Southlands. The Southlands facility is recommended to be a Bardenpho process, because that facility is expected to grow at a rapid pace to a capacity over 10 mgd within the 25-year planning horizon of the master plan. The Bardenpho process is a more cost effective treatment choice at higher flows.

    Comments on Chapter 9 include: change the effluent TN requirement to less than 8 mg/L, change plant expansion dates to one year (e.g. 2008 not a fiscal year designation - 2007/2008), and on Table 9-1, footnote 2 add /TAZ.

    Since the Board of Supervisors has approved the Canoa Ranch facility, it needs to be added to the listing of outlying facilities.

    All outlying facilities are to be identified in the future as sub-regional facilities. For example, slide 119 of the handout should read "Future Arrangement of Sub-Regional Facilities."

    Summary of Chapter 9 was covered on pages 36 through 40 of the handout

15. Chapter 10 identifies the ROMP CIP elements by plant. In addition, the Santa Cruz Interceptor Phase IV (plant interconnect pipeline) and support facilities are identified as ROMP CIP elements. Other CIP items identified were the conveyance system augmentation and outlying facilities expansions. Jerry Bish reviewed the contents of the chapter. A comment was made to include text regarding the integration of the ROMP CIP with other PCWMD CIP elements.

    Summary of Chapter 10 was covered on pages 40 through 42 of the handout.

16. Chapter 11 addresses available methods of project delivery methods in the State of Arizona. There were no comments on this chapter. Chapter was reviewed by Jerry Bish.

    Summary of Chapter 11 was covered on pages 42 and 43 of the handout.

17. Chapter 12 addresses the financing methods and plan for the ROMP CIP elements and other PCWMD CIP elements. No substantive comments were received on this chapter. Chapter was reviewed by Jerry Bish.

    The summary of Chapter 12 was covered on pages 43 and 44 of the handout

18. Chapter 13 is the implementation plan for the ROMP CIP. This chapter covers the CIP elements, implementation schedule, project delivery approach, funding source and rate impacts. Contents of the chapter were reviewed by Jerry Bish. Comments on the chapter include: there is a bust in Tables 13-3 and 13-4 on the Pima County rates, to the engineering for Roger Road WRF projects add D/B, change all D/B/O to D/B, place presentation slides 137, 138 and 139 into the Chapter 13 text, on slide 139 add turnkey to procurement method, on slide 139 biogas generation add D/B/O to procurement method, and Figure 13-3 is not the most recent information (see Ed Curley for the latest information).

    Summary of Chapter 13 was covered on pages 45 and 50 of the handout

19. Several appendices will be included with the report to support the master plan development. Jerry Bish reviewed the appendices planned for the report. Comments on the appendices include: how will the public meetings be addressed in the report, how will he enhanced chlorination study be addressed, add a basis of design section to the appendices, and place the specific permit summaries from Chapter 2 in the appendices.

    Listing of appendices is provided on page 51 of the handout.

20. Update on the enhanced chlorination investigations/study and status of the requests for expression of interest were provided by Jerry Bish. Enhanced chlorination can provide considerable savings to Pima County, if effective. Initial investigations look promising. A workshop is scheduled for May 23, 2007 to review the initial findings.

    The request for expression of interest from the private sector marketplace has been advertised by Pima County. The information received will assist in public policy decisions regarding project delivery, private financing, green power and biosolids disposal. The pre-submittal meeting date is May 23, 2007 with submissions due on June 22, 2007.

    Summary of the updates was covered on pages 51 through 55 of the handout

21. Mike Gritzuk again thanked all the participants, including Tucson Water for their involvement throughout the master planning process. Based on the comments received the Report will be finalized over the next month or two. The project team thanked the County and Tucson Water for their assistance, counsel and advice in development of the master plan. The workshop ended with a request to send comments on the pre-final chapters to Ron Riska.

Agenda
Workshop # 16 – Implementation Plan / Pre-Final Draft of ROMP Report
May 9, 2007

Time	Topic	Presenter
8:45 am	*Tucson Main Library, Basement Meeting Room, 101 N. Stone*	
9:00 am	Opening Session • Welcoming Remarks • Review Agenda • Workshop Goals	 Mike Gritzuk Jerry Bish
9:15 am	Chapters 0 - 4 Review (Strategic Development) 0. Executive Summary 1. Introduction 2. Regulatory and Customer Requirements 3. Treatment Plant Evaluation 4. Overall Treatment Strategy	Joe Popeck/Jerry Bish
10:45 am	Break	
11:00 am	Chapters 5 -9 Review (Strategic Development) 5. Biosolids/Biogas 6. Conveyance 7. Recommended Treatment Plant Plan 8. Outlying Facilities Overview 9. Outlying Facilities' Strategic Management Plan	Jerry Bish/Joe Popeck
12:30 pm	Lunch	
1:00 pm	Chapters 10-13 Review (CIP Development) 10. CIP Elements 11. Alternative Project Delivery Methods 12. Financing Methods / Plan 13. Implementation Plan	Jerry Bish
2:30 pm	Updates • Enhanced Chlorination Investigation/Study • Request for Expression of Interest Update	Jerry Bish
2:45 pm	Summary Wrap-Up • Comments by Group • Closing Remarks	Jerry Bish Mike Gritzuk
3:00 pm	Adjourn	

Board of Supervisors Memorandum

May 1, 2007

Resolution In Support of New County Sustainability Initiatives

Background

The current drought, rising fuel prices, and climate change, are topics discussed daily in our news. Without action, all three have the ability to dramatically change our current lifestyles. That said, our community is known for rising to the occasion and supporting progressive changes. Whether it be coming together to finally pass a regional transportation plan that contains significant funding for transit improvements, or showing great conservation ethic and leadership by supporting the Sonoran Desert Conservation Plan. Many in this community enjoy a high quality of life, and we continue to implement initiatives in the areas of health, safety, education, job assistance, affordable housing, and neighborhood reinvestment, to assist those in need.

We need to continue to sustain and improve the quality of life of this community, without jeopardizing the ability for future generations to do the same. A sustainable and livable community requires investments in the environment, the economy, and the social fabric. We can continue this ethic by focusing efforts on the built environment, lessening our impact on non-renewable resources, and joining forces with other communities confronting global climate change.

As one of the largest employers in Southern Arizona, Pima County can be a leader in this effort. The County designs and constructs buildings as part of our voter-approved bond programs, and is therefore also one of the largest builders in Southern Arizona. This includes facilities like community centers and libraries within our cities and towns. In addition, through our development approval process, the County has the ability, through incentives, education, and regulation, to impact the private development process in unincorporated Pima County.

As you know, the topic of this year's State of the County event on May 4, 2007, is "Sustaining a Livable Community". In preparation for this event, I've placed the attached resolution on the Board's addendum for May 1, 2007. If approved, the resolution would commit Pima County to new initiatives in the areas of alternative fuel vehicles for our County fleet, energy conservation, water conservation, waste reduction, and green purchasing. This memorandum describes these new initiatives and how the County can continue its commitment to fostering sustainability.

The Honorable Chairman and Members, Pima County Board of Supervisors
Resolution In Support of New County Sustainability Initiatives
May 1,2007
Page 2

Water, Energy, and Climate Change

Water resources are inextricably related to other resources such as energy. Each kWh of thermoelectric generation requires approximately 25 gallons of water with additional amounts used for operating pollution control devices. The United States Geological Survey estimates that in 2000, 346 billion gallons of freshwater were used per day for energy production in the United States accounting for approximately 39 percent of total freshwater withdrawals. While only 9 percent of these withdrawals are actually consumed by the generation process, they still account for approximately 38 billion gallons per day in 2006. Hence buildings with inefficient energy use, and the manufacture of building materials requiring large amounts of energy, contribute indirectly to taxing our water resources.

In addition, the built environment has complex and potentially devastating impacts on the biosphere. While only representing 8 percent of the United States gross domestic product, the construction industry consumes 40 percent of raw materials extracted or harvested in this country and generates about half a ton of waste per person each year. Regarding impacts on greenhouse gases, buildings account for 40 percent of global carbon dioxide emissions, with transportation accounting for another 33 percent. Expansion of the built environment has resulted in: lower land carrying capacity, loss of biodiversity, rise in air quality toxicity, water supply shortages, and greater energy requirements. Our long-term survival in the Sonoran Desert depends upon our ability to reduce transportation emissions and move toward green or sustainable building.

Alternative Fuel Vehicles

Motor vehicle use is a major contributor to air pollution and global climate change. At the same time, we are facing higher and higher fuel prices at the gas pump. The County has over a thousand vehicles in its fleet, excluding patrol vehicles and heavy trucks. By approving this resolution, the County would be committing to an aggressive timetable to phase those vehicles to alternative fuel vehicles.

Waste Reduction and Green Purchasing

Emphasis will also be placed on moving the County toward waste reduction and green purchasing to include Energy Star equipment and materials of low embodied energy and of recyclable content whenever possible. Energy Star is a joint program of the Environmental Protection Agency (EPA) and the Department of Energy, which certifies appliances, office equipment, light fixtures, home electronics, and other products as meeting certain energy efficiency standards. The EPA estimates that in 2006 alone, the Energy Star program has saved Americans $14 billion on their utility bills and has avoided greenhouse gas emission equivalent to that generated by 25 million automobiles. Materials of low embodied energy are those that require little energy to produce, manufacture, and transport to their destination.

The Honorable Chairman and Members, Pima County Board of Supervisors
Resolution In Support of New County Sustainability Initiatives
May 1, 2007
Page 3

Water Conservation

Through implementation of the riparian element of the Sonoran Desert Conservation Plan, and amendments underway to the Water Resources Element of our Comprehensive Plan, the County is already making significant efforts to conserve our limited water resources. Approval of this resolution would take these efforts further by making commitments to reduce water consumption in County facilities, increase our use of effluent, and maximize the water resources we do have to protect our natural environment.

Green Building and LEED Standards

The most prominent green building standard in use today is produced by the United States Green Building Council under the name of LEED (Leadership in Energy and Environmental Design). The LEED rating system provides obtainable points in six distinct categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation & design process. Depending on the number of points obtained, buildings can be built and maintained meeting LEED certified, silver, gold, and platinum in escalating levels of performance.

Approval of this resolution means that Pima County will adopt LEED silver, already adopted by the City of Tucson and the State of Arizona. Since the County builds many facilities for other jurisdictions through voter-approved bond programs, this is a very significant commitment region wide.

Building to LEED has seen capital cost increases of over 10 percent a decade ago recently drop to below 0 percent in certain projects as designers and builders have become savvy in taking an integrative approach to sustainable construction. A 2003 study by Gregory Kats reported that the average construction premium for 33 LEED buildings across the country was 1.84 percent. The following year, Matthiessen and Morris of Davis Langdon Consulting compared 45 buildings attempting LEED certification to 93 conventional buildings, finding that there was no difference in costs per square foot. The United States General Services Administration reported that LEED silver federal courthouses cost premiums range from a negative 0.03 percent to 4.4 percent compared to their conventional counterparts. The low numbers are typically attributable to larger buildings and the high ones to small ones. While it is clear that there will be some initial capital cost increases to the County until such time that greater expertise in green building is obtained, these will be quickly offset through energy savings, and increases in productivity.

The United States Department of Energy's Pacific Northwest National Laboratory (PNNL), the National Renewable Energy Laboratory (NREL) and other organizations have compared the cost/benefit of investing in high performance commercial buildings. Although a few years old, and therefore capital cost increases have since dropped, findings generally reflect the following patterns:

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- While capital costs increase in the order of 2 percent or $2 to $5 per square foot for silver/gold rated LEED buildings, the total net present value (TNPV) of the energy savings over a 20-year life cycle is $5.79 per square foot.

- Additional per square foot savings for reduced emissions ($1.18), water ($0.51), and operations and maintenance savings from proper building commissioning ($8.47) bring the aggregate TNPV to $15.95 per square foot. Added to this number are yet further potential savings gleaned from improvement of interior environments.

- More efficient and healthy interiors reduce medical costs and produce a gain in productivity estimated by researchers as high as $36.89 TNPV per square foot for a certified/silver and $55.33 for a gold/platinum rated buildings.

It is in the best interest of the County to adopt LEED silver for its facilities. While initial capital costs may increase slightly, this amount would be rapidly recovered simply in terms of energy saved, not counting the large savings resulting from increased productivity, quality of life, and environmental benefits.

Additional Energy Conservation Commitments

In addition to committing to a LEED silver standard for County built facilities, adoption of this resolution will also commit the County to constructing one medium size building with a net zero energy consumption, to ensuring that 15 percent of County facilities' electrical energy consumption come from renewable resources, and that the County maximize renewable resources from the production of methane in County wastewater treatment land landfill operations.

Green Building, Energy and Water Conservation and the Private Sector

The County has the ability to pursue strategies to further conservation practices on private property in unincorporated Pima County through the County's development approval processes. Among these strategies is the development of green building programs currently in the planning stage. Pima County proposes to endorse green building standards by providing incentives to builders who select to build to recognized standards.

Opportunities will also be sought to incorporate solar elements into County planning to take advantage of our greatest local energy resource. These will include requiring that a minimum of 50 percent of homes constructed after 2010 include direct solar assisted energy through solar hot water or photovoltaic elements. Adoption of the resolution will also commit the County to amending land use regulations to require all new housing discharging to septic systems also be provided with a grey water reuse system.

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In addition, a draft memorandum of understanding is being negotiated with the United States Green Building Council whereby the County would be one of three national pilot jurisdictions with authority to certify structures to LEED within both the County and its incorporated jurisdictions. LEED certification could thus be provided to the community at lower cost by reducing the paperwork documentation effort through field verification of construction conformance to the target design. The pilot program would also provide an opportunity for large-scale educational promotion of sustainable development to designers, builders and the public at large by way of the building permitting process. Finally, this effort would allow the County as well as regional American Institute of Architects and United States Green Building Council groups to play a critical role in establishing procedures and methods to be deployed at a national level.

Organizational Approach

In conclusion, departments and organizational units within Pima County will be identified to contribute to these efforts and an organizational structure facilitating the coordination of efforts established. This group will seek opportunities to further sustainable goals, while looking to resolve current procedural and code requirements which conflict with sustainable practices. Pima County will also continue to work with other jurisdictions to strive for consistent policies and programs so as to maximize the potential for success, which can only be truly realized on a regional level.

Recommendation

It is recommended that the Board adopt the attached resolution in support of these new County sustainability initiatives.

Respectfully submitted,

C

C.H. Huckelberry
County Administrator
(April 26, 2007)

Attachments

Pima County
Regional Optimization
Master Plan

Workshop #16
Implementation Plan/
Pre-Final Draft of ROMP Report

May 9, 2007

Workshop Presenters

- Mike Gritzuk…… Welcome/Closing
- Jerry Bish…….....Facilitator/ Chapters 0,1, 2, 5, 6, 8-13 Updates
- Joe Popeck…….. Chapters 3, 4, 7
- Jerry Bish…….. Wrap-Up

2

GREELEY AND HANSEN

Welcoming Remarks

Mike Gritzuk

GREELEY AND HANSEN

Overview

Jerry Bish

Agenda

- Review Pre-Final Draft ROMP Report
- Topics update
  - Enhanced chlorination investigation/study
  - Request for Expression of Interest

5

Objective

- Receive critical comments on Pre-Final Draft Report
- Identify open/unsettled issues
- Identify who, what and when necessary for issue closure

6

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extent of their expertise
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

7

Groundrules *(continued)*

- Listen attentively and respectfully to others
- Participate conscientiously and read material prior to workshops
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

8

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

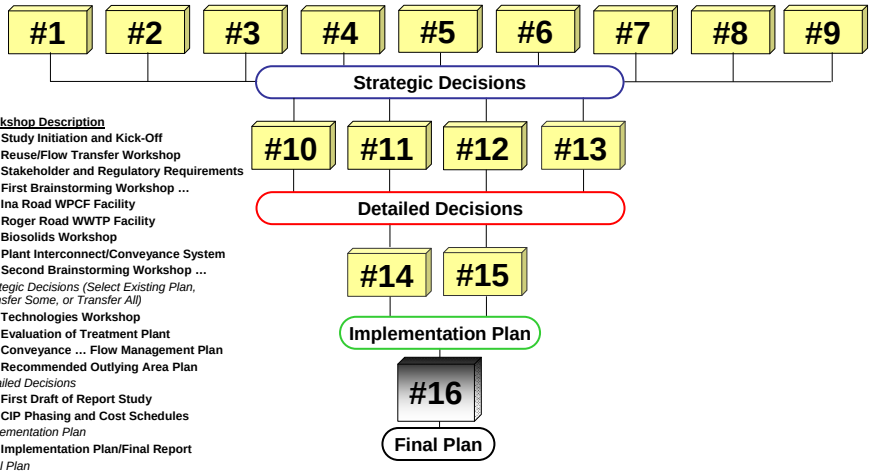
9

Role of Facilitator *(continued)*

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

10

Study Process



Workshop Description

1 Study Initiation and Kick-Off
2 Reuse/Flow Transfer Workshop
3 Stakeholder and Regulatory Requirements
4 First Brainstorming Workshop …
5 Ina Road WPCF Facility
6 Roger Road WWTP Facility
7 Biosolids Workshop
8 Plant Interconnect/Conveyance System
9 Second Brainstorming Workshop …

Strategic Decisions (Select Existing Plan, Transfer Some, or Transfer All)

10 Technologies Workshop
11 Evaluation of Treatment Plant
12 Conveyance … Flow Management Plan
13 Recommended Outlying Area Plan

Detailed Decisions

14 First Draft of Report Study
15 CIP Phasing and Cost Schedules

Implementation Plan

16 Implementation Plan/Final Report

Final Plan

11

GREELEY AND HANSEN

GREELEY AND HANSEN

Pre-Final Draft of Regional Optimization Master Plan

Jerry Bish/Joe Popeck

GREELEY AND HANSEN

Executive Summary

Jerry Bish

Executive Summary

- Provides overview
- Brief summary of purpose and recommendations
- Highlights key elements
- Can serve as stand alone document.

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GREELEY AND HANSEN

GREELEY AND HANSEN

Chapter 1 – Introduction

Jerry Bish

Chapter 1 – Introduction

- Sets forth purpose of master plan and establishes basis for report
- Identifies strategic issues / sets strategic direction
- Integrates Capital Improvement Plan

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Purpose

- Identify optimal strategy for wastewater treatment
- Identify optimal biosolids treatment / disposal
- Identifies conveyance capacity needs
- Sets outlying facilities strategic plan

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Purpose *(continued)*

- Develop key decisions through consensus process
- Outlines CIP program and funding methodology
- Provides 25-year road map

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Chapter 2 – Regulatory and Customer Requirements

Jerry Bish

Regulatory and Customer Requirements

- Governing agencies
  - US EPA
  - ADEQ
  - Pima County Department of Environmental Quality
- Permit summaries (go to Appendix)
  - AZPDES
  - APP (new for Marana)
  - Air quality
  - Reclaimed water

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Regulatory and Customer Requirements *(continued)*

- Water reuse
  - Intergovernmental agreements
  - Underground storage recharge / recovery
- Cultural / historic preservation
- Regulatory closure requirements at Roger Road

21

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Chapter 3 – Treatment Plant Evaluation

Joe Popeck

Existing Treatment Capacity

- Roger Road WWTP
  - Permitted capacity = 41 mgd
    - Preliminary and primary treatment
    - Biotowers with Activated sludge, final clarifiers
    - Chlorine disinfection
    - Anaerobic digestion

23

Condition Assessment – RR WWTP

- Summary of condition assessment
  - Most major structures appear in generally good condition
    - However, clarifiers and aeration tanks are not functionally optimal for conversion to BNR process
    - Flow distribution is marginal and cannot be readily improved
  - Most major equipment appear in generally good condition
    - However, major equipment may not be of required capacity for BNR process

24

Condition Assessment – RR WWTP

- Summary of condition assessment
  - Most major electrical components appear in generally good condition
    - However, system is ungrounded Delta – not optimal for equipment such as VFD's
  - Significant lack of I&C

25

Condition Assessment – RR WWTP

- Summary of condition assessment
  - Roger Road facilities, due to condition and functional risk are deemed marginal for conversion to BNR
  - Planned improvements for several areas of the plant are necessary to maintain treatment effectiveness regardless of the final decision on the long-term continued use of Roger Road WWTP

26

Existing Treatment Capacity

- Ina Road WPCF
  - Permitted capacity = 37.5 mgd
    - Preliminary and primary treatment
    - 25-mgd HPO activated sludge, final clarifiers
    - 12.5-mgd BNRAS, final clarifiers
    - Chlorine disinfection
    - Anaerobic digestion

27

Background / Condition Assessments

- Summary of condition assessment
  - Most Major Structures appear in generally good condition
  - Most Major Equipment appear in generally good condition
  - Most Major Electrical Components appear in generally good condition
  - Significant lack of I & C

28

Background / Condition Assessments

- Summary of condition assessment
  - Much of the Ina Road Facility that would be used either as a NdeN process component or support process is viable.
    - However, HPO tanks are not functionally optimal for conversion to BNR process

29

Condition Assessment – IR WPCF

- Summary of condition assessment
  - Planned Improvements for several areas of the plant are necessary to maintain treatment effectiveness prior to modifications for plant-wide NdeN.

30

Chapter 4 - Overall Treatment Strategy

Joe Popeck

Overall Treatment Strategy

- Future wastewater flows and characteristics
- Treatment strategy alternatives with three flow-split options
- Reclaimed water program
- Biological nutrient removal (BNR) treatment alternatives
- Alternative evaluation criteria
- Evaluation of alternatives
- Selection of recommended alternative
- Preliminary sizing facilities
- Summary

32

Future Wastewater Flows

Wastewater Flow Split Options Used for Plant Evaluations

Flow Split Options *	Flow to Roger Road, mgd			Flow to Ina Road, mgd		
	Current	Future	Total	Current	Future	Total
Existing Plan	22.6	9.4	32.0	36.5	13.5	50.0

* Randolph Park WRF capacity of 3.0 mgd is not included.

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Future Wastewater Flows and Characteristics

Selected Year 2030 Wastewater Characteristics

Based on Complete Mass Balance

Parameter	Units	RRWWTP		IRWPCF	
		Primary Influent	Primary Effluent	Primary Influent	Primary Effluent
Flow	mgd	33.2	32.6	52.6	51.4
COD	mg/L	659	443	689	456
BOD_5	mg/L	301	214	324	229
$sBOD_5$	mg/L	121	123	123	126
TSS	mg/L	310	126	358	146
VSS	mg/L	243	104	282	123
TKN	mg/L	47	46	63	61
TP	mg/L	10	10	15	14

34

Treatment Strategy Alternatives with Three Flow-Split Options

- Existing Plan
  - At both Roger Road and Ina Road, continue to follow present long-range CIP project schedule to address capacity and regulatory needs of both RRWWTP and IRWPCF
- Transfer Some
  - Maintain a facility at the RRWWTP to continue to provide effluent to the adjacent Tucson Reclaimed Water Treatment Plant (TWTP), and direct remainder of influent flows to IRWPCF
- Transfer All
  - Transfer all wastewater flow from the RRWWTP service area to IRWPCF and decommission RRWWTP

35

Reclaimed Water Program

- Reclaimed water program
  - Effluent water will be made available to Tucson Water for reclaimed water service at the future RRWRF and IRWPCF. Plan allows for approximately 30 mgd at RRWRF and approximately 20 mgd at IRWPCF based on allocated effluent water shares.
  - Up to 7 mgd would be made available for discharge into the Santa Cruz River at the RRWRF site.
  - This may require that up to 5 mgd (existing plan) and as of the IRWPCF effluent be transferred to the RRWRF site via a pumping station/force main system.

36

Biological Nutrient Removal (BNR) Treatment Alternatives

- Treatment process alternatives were developed to meet the goal of future effluent limits for nutrients with the following criteria:
  - Ammonia nitrogen concentration of 2 mg/L or less
  - Total nitrogen concentration of 8 mg/L or less
  - Total phosphorus concentration of 1 mg/L or less

37

Biological Nutrient Removal (BNR) Treatment Alternatives

- Initial screening of BNR process alternatives
  - Modified Ludzack-Ettinger (MLE)
  - Bardenpho
  - Step-feed nitrification and denitrification (NDN)
  - Integrated fixed-film activated sludge (IFAS)
  - Membranes (MBR)
  - Biostyr and Biofor systems
  - Activated sludge/nitrifying trickling filter (AS/NTF)
  - Biotowers/nitrifying activated sludge (BT/NAS)
  - Moving bed bioreactor (MBBR)

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Biological Nutrient Removal (BNR) Treatment Alternatives

- Processes carried forward for detailed evaluation:
  - Bardenpho
  - MLE
  - IFAS
  - BT/NAS for RRWWTP and Bardenpho for IRWPCF

39

Alternative Evaluation Criteria

- Technical criteria
  - Operability
  - Proven process
  - Life cycle cost
  - Site compatibility
  - Resource consumption
  - Ease of operation and maintenance during construction

40

Alternative Evaluation Criteria

- Financial criteria
  - Capital costs
  - Operation and maintenance (O&M) costs
  - Present worth of capital and O&M costs

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Selection of Recommended Alternative

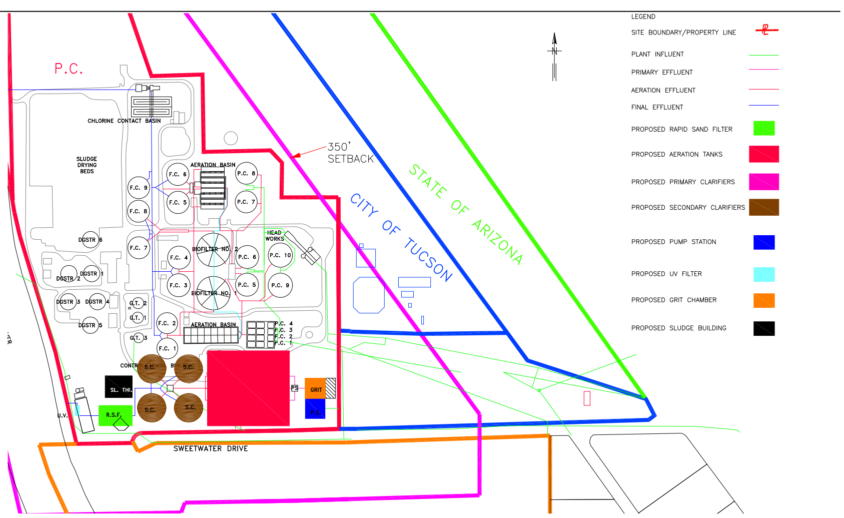
- Recommendation
  - Use Bardenpho process at both plant locations
  - Flow split of 32 mgd for RRWRF and 50 mgd for IRWPCF
  - New facilities design for RRWRF plant and rehabilitation for the IRWPCF facilities
  - New facilities design at RRWRF without primary treatment

42

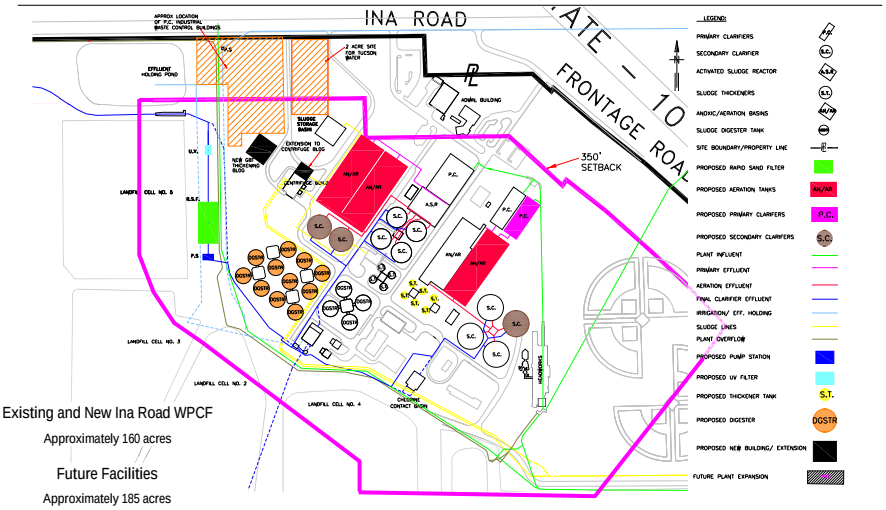
Preliminary Sizing Facilities

- Preliminary sizing of facilities
  - Facilities for RRWRF and IRWPCF were sized to adequately treat the future wastewater loads and to consistently meet the future effluent requirements meeting the treatment goals.
  - Hydraulic capacity for the RRWRF and IRWPCF is based on a peak hourly flow rate of 2.0 Average Daily Flow.

Roger Road – 32-mgd NdeN Facility



50-mgd Ina Road WPCF



45

Summary

- 2030 wastewater flows in the Roger Road and Ina Road service areas were estimated based on population projections and flow estimates. The year 2030 total flow is approximately 85 mgd.
- Wastewater characteristics were determined based on information contained in 2004-2005 GPS-X modeling, future loadings predicated on water conservation, and mass balance with recycle flows from expected future biosolids operation. Because of higher recycle contribution, nutrient concentrations in IRWPCF influent were substantially higher than RRWRF influent.

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Summary

- High degree of treatment is required - effluent goals were set at:
  - Ammonia nitrogen concentration of 2 mg/L or lower
  - Total nitrogen concentration of 8 mg/L or lower
  - Total phosphorus concentration of 1 mg/L or lower (when required)
- Combination of biological nitrogen removal processes and biological phosphorus (Bio-P) removal was found to be most cost effective.
- A review of biological nutrient removal (BNR) processes for nitrogen and phosphorus removal resulted in consideration of nine processes which were screened based on economic and non-economic criteria.

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Summary

- Bardenpho process was determined as most reliable and cost effective process for both treatment plants.
- Using Bardenpho, flow split options were analyzed based of technical and economic criteria. Flow-split of 32 mgd to RRWRF and 50 mgd to IRWPCF was determined as most cost effective.
- New facility option for replacing the existing RRWWTP with a new treatment plant at Roger Road was evaluated. Considering cost uncertainties involved in rehabilitating and modifying the RRWWTP and considering non-economic factors, the new facility was determined to be most viable option for Roger Road.

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Summary

- Preliminary sizing was made for both treatment plants. No chemical use is required for new RRWRF, but some amount of alum (or ferric chloride) will be required at the IRWPCF when phosphorus removal becomes a requirement in the future. This is due to relatively high nutrient concentration in the IRWPCF influent and insufficient carbon source to support both denitrification and Bio-P. After Bio-P removal, chemical will remove additional P to meet future effluent requirement.

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Chapter 5 – Biosolids

Jerry Bish

Chapter 5 – Biosolids

- Existing Class B facilities
- Mesophilic digesters at Roger Road
  - Sludge transfer pipeline to Ina Road
- Mesophilic digesters at Ina Road
- Centralized sludge loading operation

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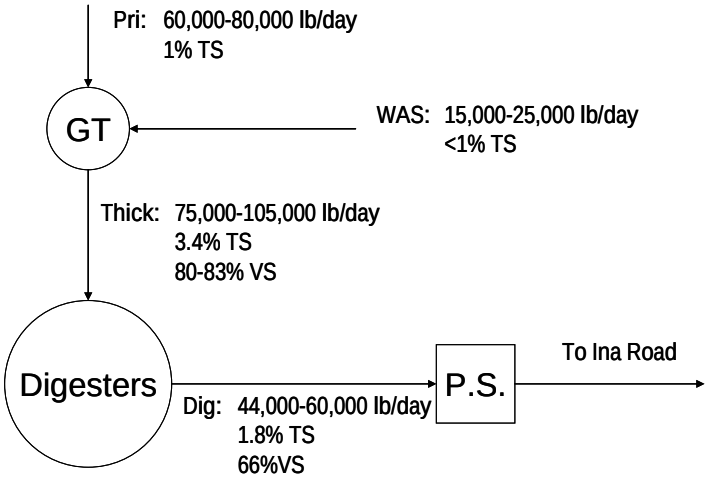
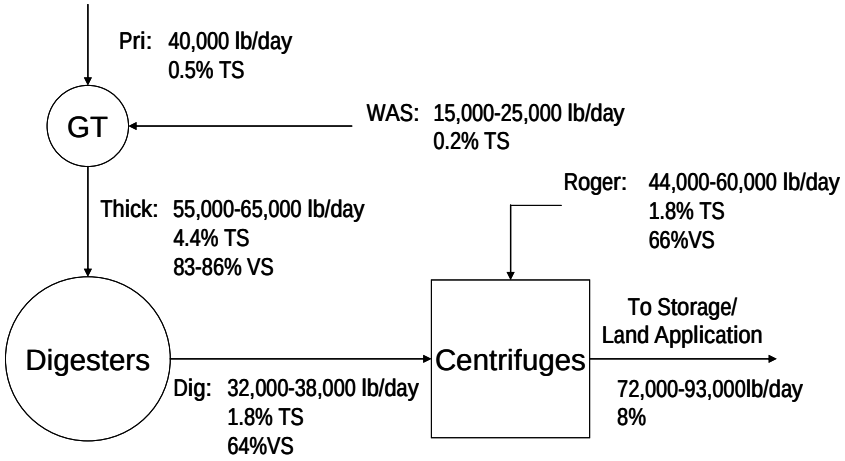
Existing Roger Road WWTP Biosolids Diagram (at 38.3 mgd)



52

Existing Ina Road WWTP Biosolids Diagram (at 23.4 mgd)



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Outlying Facilities

Location	Current, tpd(1)	Processing, Disposal
Marana	0.28	storage, hauled ⇒ Ina
Rillito Vista	0.014	---
Avra Valley	2.2	storage, hauled ⇒ Roger Road
Green Valley	5.7	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction	0.09	---
Corona de Tucson	0.16	Evaporation, hauled to landfill when pond is cleaned
Pima Co. Fairgrounds	0.004	Evaporation, hauled to landfill when pond is cleaned
Mt. Lemmon	0.018	storage, hauled ⇒ Ina
Southlands	0.0	---
Total	8.47	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated.

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Future Solids Streams

- Roger Road WWTP

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Waste Activated Sludge	1.72	0.7	100,600	76,400
Thickened WAS (to Ina Road Digestion)	0.36	3.0	90,500	68,800
Thickener Overflow	1.36	0.1	10,100	7,600

- Ina Road WPCF

Solids Stream	Flow, mgd	% Solids	Solids Mass, lb/day	VSS Mass, lb/day
Primary Sludge	1.15	1.0	95,300	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

Outlying Facilities - Biosolids

Location	Future, tpd(1)	Processing, Disposal
Marana	6.16	storage, hauled ⇒ regional facility
Rillito Vista		---
Avra Valley	5.26	storage, hauled ⇒ regional facility
Green Valley	6.79	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Arivaca Junction		---
Corona de Tucson	3.77	storage, hauled ⇒ regional facility
Pima Co. Fairgrounds		---
Mt. Lemmon	0.003	storage, hauled ⇒ regional facility
Southlands	14.7	separate processing and disposal
Total	36.68	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

Class B Processes

Process	Requirements
Aerobic Digestion	MCRT of 40 days at 20°C or MCRT of 60 days at 15°C
Air Drying	Dry on beds for 3 months, with 2 months ≥ 0°C
Anaerobic Digestion	MCRT of 15 days at 35-55°C or MCRT of 60 days at 20°C
Composting	5 days at 40°C and 4 hours of the 5 days at 55°C
Lime Stabilization	Lime addition to pH 12 and maintained for 2 hours

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Class A Processes

Process	Requirements
Thermophilic Aerobic Digestion 1	MCRT of 10 days at 55-60°C
Heat Drying 1	Direct or Indirect Gas Drying to ≤ 10% moisture content and solids temperature of 80°C
Heat Treatment 1	MCRT of 30 minutes at 180°C
Composting 1	3 days at 55°C for in-vessel or static pile 15 days at 55°C for windrow
Pasteurization 1	30 minutes at 70°C
Alkaline Stabilization 2	pH 12 and maintained for 72 hours with biosolids ≥ 52°C for 12 hours, followed by air drying to 50% TS
Time/temperature 3	Process meets detention time at temperature requirements by solids concentrations given in 503 regulations or has been given equivalency by USEPA (TPAD and batch thermophilic digestion for example)

58

Available Markets

- Agricultural land application
- Landfilling
- Mine tailing reclamation
- Dedicated land disposal
- Alternative land application option (Class A) – landscaping products
- Feed as fertilizer (Class A with amendments)
- Waste-to-energy

59

Class A Drivers

- Regulations (state/federal)
- National biosolids partnership – environmental management system participation
- Local community pressure

60

Class A Facilities Arrangement

- Temperature phased anaerobic digestion
- Heat drying
- Cambi process

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Recommendations

- Centralize biosolids handling / treatment
- Continue with Class B / land apply
- Develop additional product outlets
- Develop long-term biosolids management plan
- Be ready to adapt to changes in disposal market

62

Major Issues/Concerns

- Concerns about California spillover issues for land application
- Currently single land applicator controls majority of land around Pima County
- Can not produce Class A biosolids now if Class B became unacceptable to public

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Elements of Long-Term Biosolids Management Plan

- Analysis of current program
  - Establish baseline conditions
- Projected quantity and quality of biosolids
  - Effects of liquid treatment process changes
- Regulatory and social issues
  - Regulatory pressures
  - Public concerns
  - Increased urbanization
  - National trends

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Elements of Long-Term Biosolids Management Plan

- Development and evaluation of alternatives
  - Market assessment for biosolids
  - Technology identification and screening
  - Development of preliminary alternatives
  - Screening of preliminary alternatives using economic and non-economic criteria
  - Evaluation of shortlisted alternatives
  - Recommended long-term plan

65

Elements of Long-Term Biosolids Management Plan

- Cost summary
- Implementation plan

66

Land Application

- Current contractor does not foresee interest in Class A biosolids in area
  - Hauling of liquid is well contained so no mess or odors in populated areas
  - Current liquid (up to 10%) directly incorporated = low odors at sites
  - Hauling/incorporating cake = more odors
  - Class A more odorous in contractor's opinion

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Single Land Contractor Locally

- Current land application cost relatively low
- Other contractors have bid in the past
- Synagro and Solid Solutions are contractors working in the Phoenix area
- <u>County should have a backup plan</u>
  - Recommend ability to make cake that could be landfilled as backup
  - Explore future dedicated land application
  - Could install one thermophilic digester to see if product is more marketable and gain experience in operation

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Class A vs. Class B

- Opposition to land application does not appear limited to Class B
  - Converting to Class A may not help with this market
- Type of Class A process to use depends on available markets
  - Liquid (TPAD) best option if land applying
  - Drier product desired for mine reclamation, bagging/landscaping or energy generation

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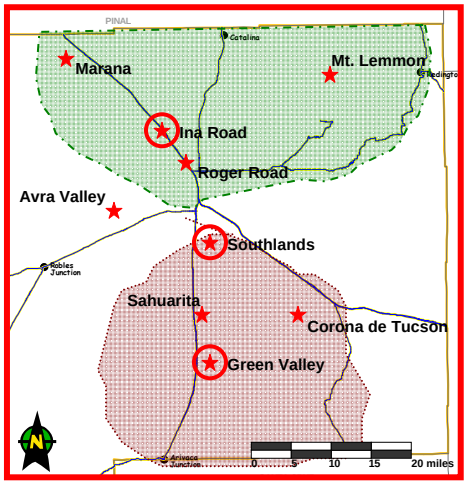
Class A vs. Class B

- Class A processing is more expensive in capital cost and O&M cost
- Stable market for Class A unknown at this time
- Do not want to invest significant $ before knowing viable market – market analysis
  - Arrange site to have space for a future Class A process
  - Could be a fit for future DBO project

70

Regional Solids Processing



71

Biogas Use

- 500 million cubic feet per year
- Options
  - Continue biogas for power generation / engine-driven equipment
  - Sell biogas to third party for commercial use
  - Purchase power from local utility and use biogas for heating and cooling functions

72

Biogas Recommendation

- Operate power generation for electricity and heating load needs,

  or

- Sell biogas for green credits – purchase power (RFEI process)

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Chapter 6 – Conveyance System Evaluation

Jerry Bish

Chapter 6 – Conveyance System Evaluation

- Comprehensive system review
- Hydraulic capacity analysis
  - Existing
  - Future
- Wet weather capacity impacts
- Plant interconnect pipeline
- CIP capacity projects

75

Regulatory Standards – CMOM

- Convey peak dry and wet weather flows
- Convey 10-year-24-hour rain event
- Upgrade deficient system elements within 10 years
- Prevent SSOs
- Capital Improvement Plan

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Regulatory Standards – Other

- Max Dry Weather d/D = 0.75
- Appropriate peaking factor
- Wet weather allowance based on:
  - Percentage of peak dry weather flow
  - Gallons per acre
- Minimum depth of cover = 3 feet
- V_d = 2 – 10 feet/second

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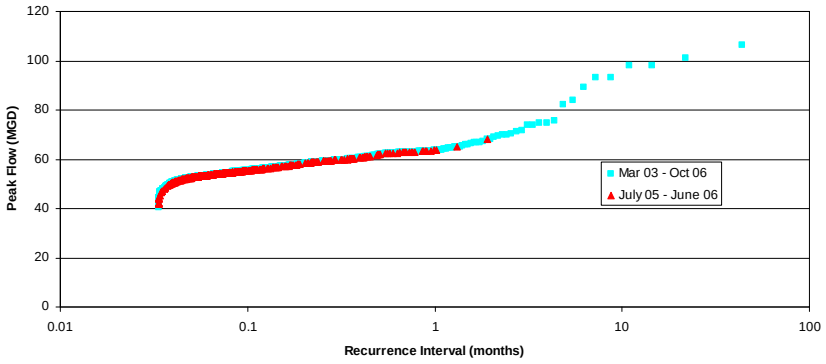
Roger Road Peak Flow Analysis

Results in 264 gpd/acre



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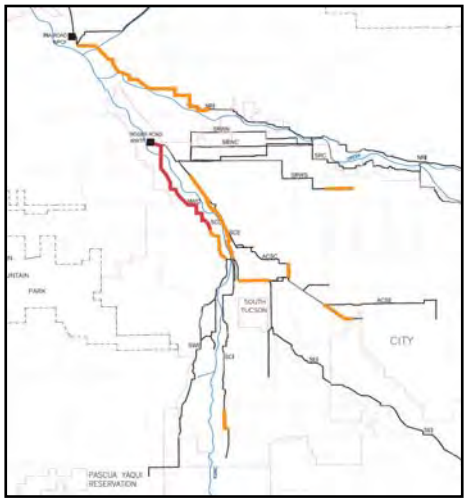
Existing Capacity Issues



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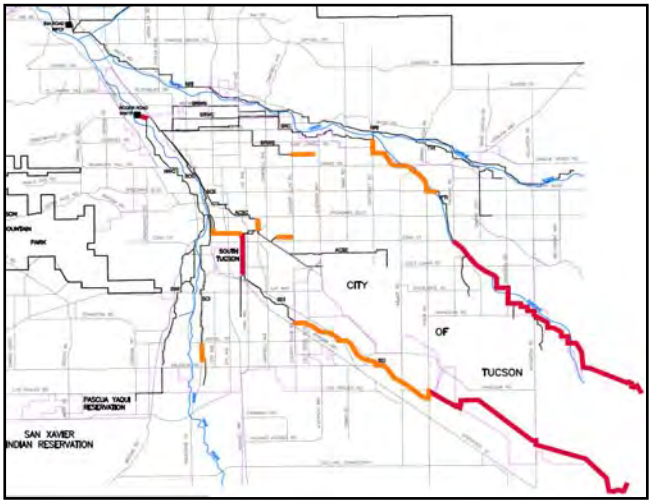
2030 Capacity Issues



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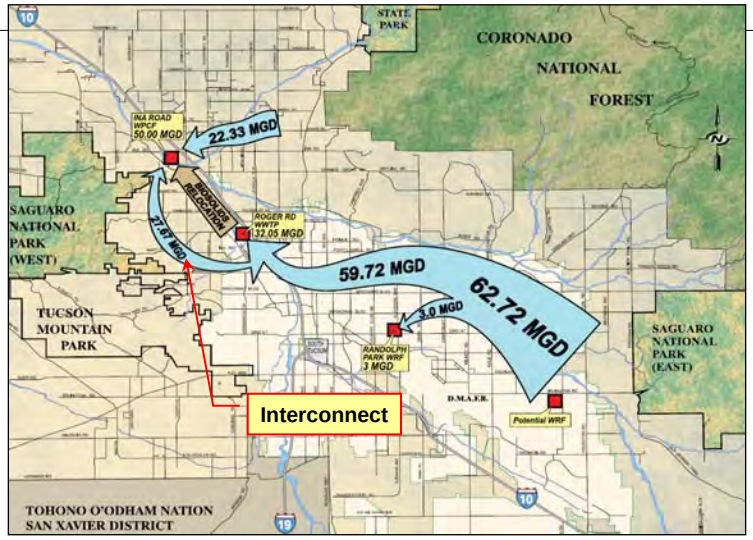
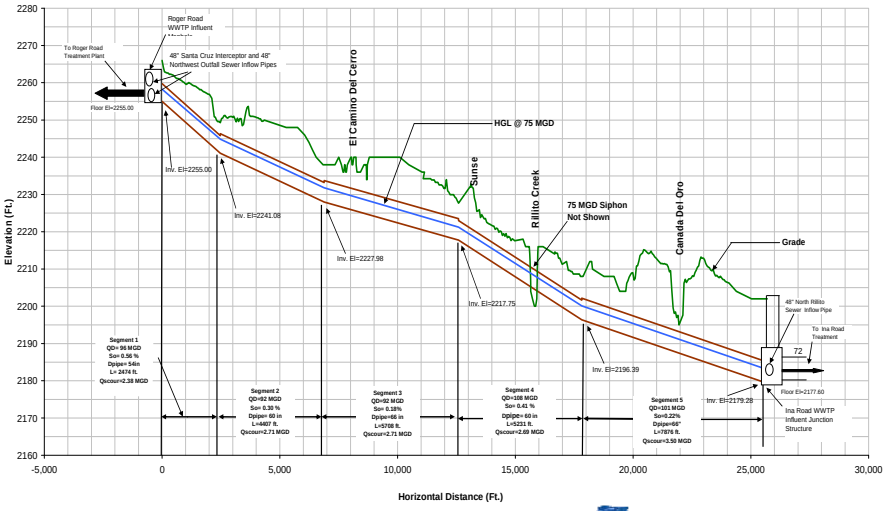
CIP Projects

Project	MH Start	MH End	Year	Item	Qty.	Units
1	4636-30A	4190-05A	2020	Replace 18" pipe with 21"	10,336	FT
				Project 1 Subtotal		
2	6036-21	3979-101	2015	Replace 18" pipe with 24"	1,183	FT
	3919-01	8031-01		Replace 18" pipe with 24"	5,486	FT
				Project 2 Subtotal	*6,669*	
3	8635-11	8635-10	2020	Replace 18" pipe with 21"	620	FT
				Project 3 Subtotal	*620*	
4	5627-08A	9907-49	2010	Replace 18" pipe with 21"	5,050	FT
				Project 4 Subtotal	*5,050*	
5	8130-01	1779-02	2015	Replace 30" pipe with 42"	1,153	FT
	9917-20	9910-21		Replace 33" pipe with 36"	5,402	FT
	5667-01	5662-01		Replace 30" pipe with 42"	3,875	FT
	1779-02	5667-01		Replace 30" pipe with 42"	1,415	FT
	9910-21	9910-19		Replace 36" pipe with 42"	550	FT
				Project 5 Subtotal	*12,395*	
6	8149-05	1726-29	2010	Replace 15" pipe with 21"	3,943	FT
	3983-05	8149-05		Replace 15" pipe with 24"	887	FT
	1726-29	1726-26		Replace 18" pipe with 24"	1,388	FT
	1726-26	1726-19		Replace 24" pipe with 30"	3,776	FT
				Project 6 Subtotal	*9,994*	
7	4630-09	4630-02	2015	Replace 21" pipe with 24"	3,013	FT
				Project 7 Subtotal	*9,994*	
8	1751-09	1751-01	2010	Replace 18" pipe with 24"	4,712	FT
				Project 8 Subtotal	*4,712*	
9	8626-01	6804-15A	2010	Replace 8" pipe with 15"	100	FT
				Project 9 Subtotal	*100*	
10	9521-02	9549-05	2020	Replace 15" pipe with 18"	1,006	FT
				Project 10 Subtotal	*1,006*	
11			2010	Fully Open Gate at Manhole 9910-21 Diversion		
	1708-22	6804-15A		36" Reverse Sewer	2,150	FT

Plant Interconnect



Plant Interconnect – Route 1



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Chapter 7 – Recommended Treatment Plant Plan

Joe Popeck

Recommended Treatment Plant Plan

- Land use and area development
- Location of future treatment expansions
- Expansion of treatment utilities and utility corridors
- Year 2030 master plan layout for selected alternative

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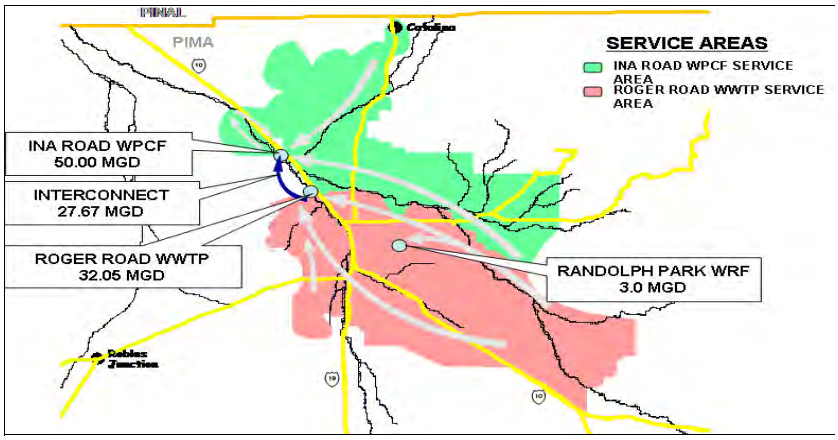
Recommended Treatment Plant Plan

Year 2030 Location of Major WWTPs Relative to the Metropolitan Tucson Service Area



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Land Use and Area Development

- Current Land Use
  - Current land use is limited to existing treatment facilities at both treatment plant locations, except sports complex with baseball diamonds at the southeast side of Ina Road WPCF facilities

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Land Use and Area Development

Future Area Development Site Plan for RRWWTP

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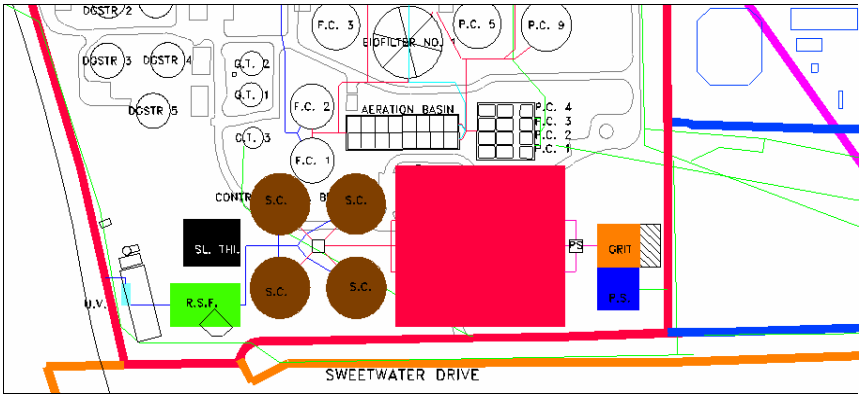
Location of Future Treatment RRWWTP

Roger Road – 32 MGD Facility



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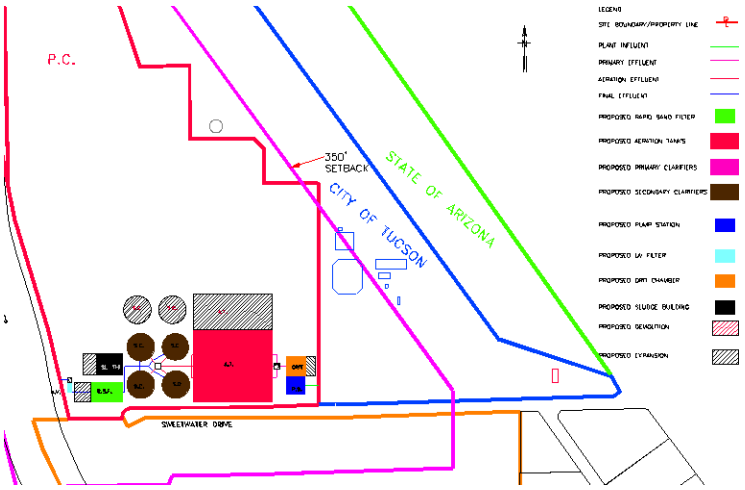
Roger Road WRF Future Expansion Beyond Year 2030



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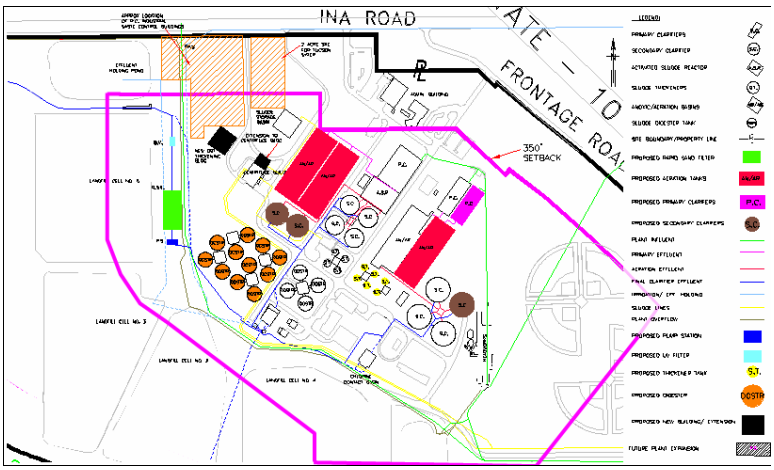
Location of Future Treatment IRWPCF

Ina Road WPCF 50 MGD Site Plan for Year 2030



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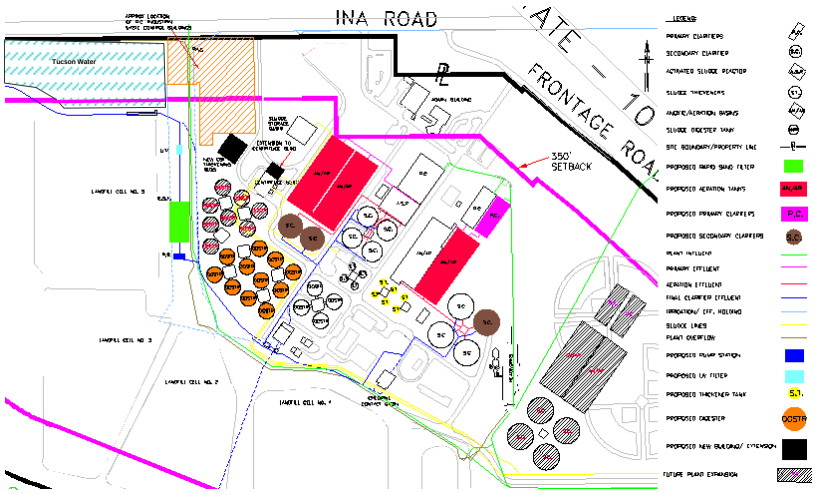
Ina Road WPCF 50-mgd Site Plan with Future Expansion Beyond Year 2030



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Water Reuse

- Reuse Water Supply
  - At RRWRF up to 30 mgd of plant effluent will be available to Tucson Water from new Plant
  - At IRWPCF up to 20 mgd of plant effluent will be made available to Tucson Water
    - New supply, (filtration), reservoir system, distribution disinfection system and distribution piping will be constructed by Tucson Water on a parcel of land at IRWPCF, provided by Pima County

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Architecture and Landscape

- Existing facilities consist of a wide variety of architectural styles and landscape types, reflecting independent decisions made at each plant expansion
- Through the year 2030 planning horizon, architectural and landscaping design will be guided by architectural and landscape themes to harmonize existing and new facilities consistent with new land use plan

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Support Facilities

- Odor Control
  - Year 2030 plan will provide a long-term solution for potential odors from both collection system and wastewater treatment plants. Odor control measures will include:
    - Minimize odor potential in collection system with pH adjustment, chemical addition and vapor treatment
    - Cover openings and channels
    - Collect and treat odorous air
    - Disperse treated air into atmosphere in a manner to minimize odor impact to surrounding communities

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Support Facilities

- Personnel Facilities
- Maintenance Facilities
- Laboratory Facilities
- Parking
- Support Facilities
- SCADA
- Chemical Handling
- Security
- Plant Stormwater Plan

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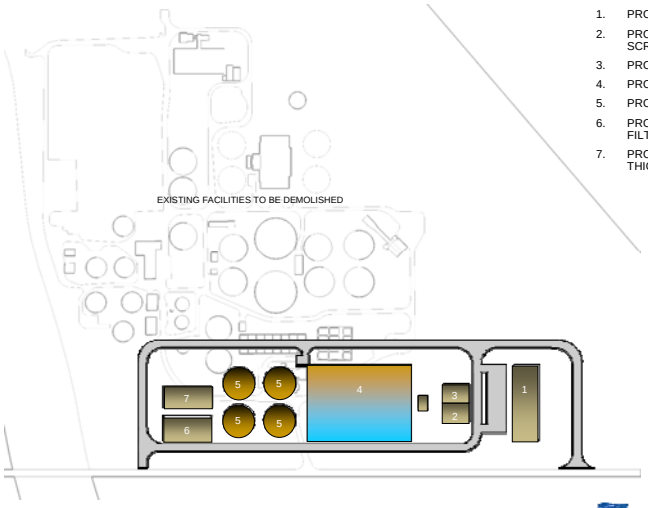
Roger Road WRF – Year 2030 Master Plan Layout



1. PROPOSED ADMINISTRATION FACILITY
2. PROPOSED HEADWORKS (INFLUENT PS, SCREENS)
3. PROPOSED GRIT REMOVAL FACILITY
4. PROPOSED BARDENPHO AERATION TANKS
5. PROPOSED FINAL CLARIFIERS
6. PROPOSED EFFLUENT FILTERS/DISINFECTION FACILITIES
7. PROPOSED SLUDGE THICKENING/TRANSFER FACILITY

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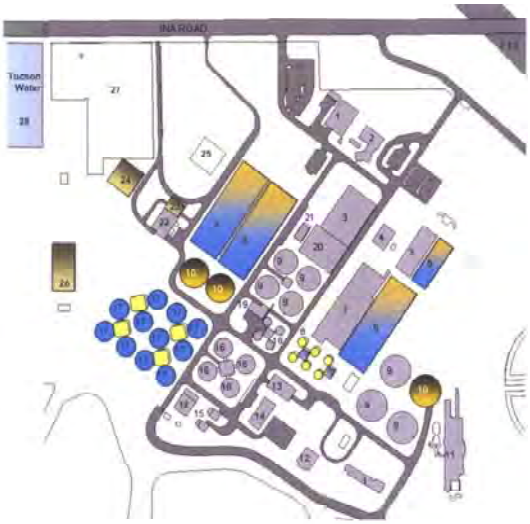
Ina Road WPCF – Year 2030 Master Plan Layout



1. WAREHOUSE
2. ADMINISTRATION BUILDING
3. EXISTING PRIMARY CLARIFIERS
4. NEW BLOWER BUILDING
5. NEW PRIMARY CLARIFIERS
6. NEW AERATION TANKS
7. EXISTING AERATION TANKS
8. NEW SLUDGE THICKENERS
9. EXISTING SECONDARY CLARIFIERS
10. NEW SECONDARY CLARIFIER
11. HEADWORKS
12. CHLORINE CONTACT BASIN
13. ENERGY RECOVERY BUILDING
14. TRAINING CENTER
15. CHLORINATION BUILDINGS
16. EXISTING DIGESTORS
17. NEW DIGESTORS
18. EXISTING SLUDGE THICKENERS
19. EXISTING VACUUM FILTRATION BUILDING
20. EXISTING ACTIVATED SLUDGE REACTOR
21. OXYGEN PRODUCTION
22. EXISTING CENTRIFUGE BUILDING
23. EXTENSION TO CENTRIFUGE BUILDING
24. NEW GBT THICKENING BUILDING
25. SLUDGE STORAGE BASIN
26. FILTER / DISINFECTION
27. PIMA COUNTY INDUSTRIAL WASTE
28. TUCSON WATER

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Summary

- Recommended treatment plant plan for the year 2030 provides a new plant at Roger Road and expansion of existing plant at Ina Road WPCF
  - New multi-faceted recreational, commercial and ecological development adjacent to the RR WWTP
  - Provision for future expansion beyond the year 2030 at both treatment facilities
  - Existing infrastructure to be expanded, upgraded or demolished
  - Expansion of infrastructure to accommodate the increased flows to be handled at both plant locations
  - Provision for new and/or expansion of the utilities including power, potable water, reuse water and plant air supply.
  - Architecture and landscape amenable to provide public friendly image
  - Complete plant-wide odor control at each facility and the conveyance system

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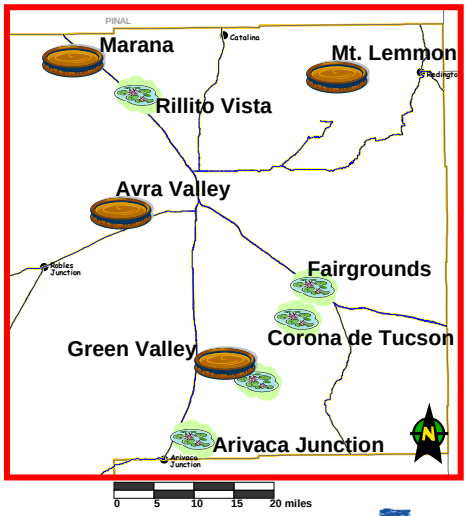
Chapter 8 – Outlying Facilities' Overview

Jerry Bish

Outlying Facilities



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Reclaimed Water Permits

Facility	Permit
Arivaca Junction	Class C
Avra Valley	Class B+
Green Valley	Class A+ (BNROD) Class B (lagoon)
Marana	Class B+
Mt. Lemmon	Permit (AZPDES)

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Summary of Outlying Facilities

Facility	Facility Parcel Area (acres)	Design Capacity (mgd)	Current Treatment Technology	Current Effluent Utilization
Arivaca Junction	10.5	0.1	Partially mixed, aerated lagoon	Percolation/evaporation. Class C delivered to Reventone Ranch.
Avra Valley	139*	1.2	BNROD	Plant irrigation (Class B+). Percolation/evaporation.
Corona de Tucson	200	0.3	Partially mixed aerated lagoons	Evaporation, SAT.
Green Valley	68	2.0 BNROD 2.1 lagoon	Primarily BNROD. Excess inflow sent to aerated lagoons.	Delivered to Quail Creek for irrigation (Class A+). Plant irrigation (Class B). Percolation.
Marana	156	0.2	Smith & Loveless BNR package plants. Interim Parkson Biolac.	Plant irrigation (Class B+). Possible riparian restoration.
Mt. Lemmon	1.7	0.015	Enclosed extended air package plant.	Spray field irrigation.
PC Fairgrounds	8.8	0.035	Stabilization ponds.	Percolation/evaporation.
Rillito Vista	-	0.02	Stabilization ponds.	Percolation/evaporation.

*Additional 140-acres of land adjacent to facility parcel.

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Flow Projections

Facility	2010	2015	2020	2025	2030
Avra Valley	1.4	1.8	2.2	2.6	3.0
Corona de Tucson	0.5	0.9	1.3	1.7	2.1
Green Valley	2.7	3.1	3.6	4.0	4.4
Marana	1.6	2.3	3.0	3.7	4.4
Mt. Lemmon	0.002	0.002	0.002	0.002	0.002
Southlands (excludes Corona)	1.2	3.6	6.0	8.2	10.5

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Current Water Reuse

Current Water Reuse		
Facility	**Permit**	**Use**
Arivaca Junction	Class C	Reventone Ranch (Agriculture)
Avra Valley	Class B+	Spray Field Disposal
Green Valley	Class A+	Robson/Quail Creek, Inc. (Turf Irrigation)
Marana	Class B+	Plant Turf Irrigation
Mt. Lemmon	AZPDES	Spray Field Disposal

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Current Biosolids Production

Current Biosolids Production		
Location	**Produced (tpd)**	**Processing, Disposal**
Arivaca Junction	0.09	Dry, scrape and haul to landfill
Avra Valley	2.2	Store and haul to conveyance system
Corona de Tucson	0.16	Dry, scrape and haul to landfill
Green Valley	5.7	GBTs, Aerobic Digesters, BFPs, Drying, Sent to Asarco Mines
Marana	0.28	Store and haul to conveyance system
Mt. Lemmon	0.018	Store and haul to conveyance system
PC Fairgrounds	0.004	Dry, scrape and haul to landfill
Rillito Vista	0.014	Dry, scrape and haul to landfill
Total	**8.47**	

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Future Biosolids Production

Future Biosolids Production		
Location	**Produced (tpd)**	**Processing, Disposal**
Arivaca Junction	-	-
Avra Valley	4.20	Thicken and haul to conveyance system
Corona de Tucson	2.94	Thicken and haul to conveyance system
Green Valley	6.16	GBTs, Aerobic Digesters, BFPs, dry and send to mine reclamation
Marana	6.16	Thicken and haul to Ina Road
Mt. Lemmon	0.003	Store and haul conveyance system
PC Fairgrounds	-	-
Rillito Vista	-	-
Southlands	14.70	Master plan is under development
Total	**34.16**	

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Chapter 9 – Outlying Facilities' Strategic Management Plan

Jerry Bish

Influent Wastewater Characteristics

Characteristic	Outlying Facility Influent Concentrations (mg/L)
BOD_5	300
$SBOD_5$	125
COD	590
TSS	270
VSS	220
TKN	57
TP	10

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Probable Effluent Quality

Parameter	Effluent Quality
BODs	< 6 mg/L
TSS	< 10 mg/L
NH4-N	< 1 mg/L
TN	< 10 mg/L
TP	< 1 mg/L
Pathogen removal	No detect in 4 of 7 samples/week. None exceeding 23cfu/100ml
pH	6.8 – 7.2

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Weighted System Evaluation Matrix

Criteria	WF	Rank					Weighted Rank				
		Bardenpho	BNROD	MBBR	SBR	MBR	Bardenpho	BNROD	MBBR	SBR	MBR
Cost	5	4	4	3	5	2	20	20	15	25	10
Environmental Impact	4	4	4	3	3	3	16	16	12	12	12
Feasibility	3	3	5	4	3	3	9	15	12	9	9
Operational Capability	4	4	4	3	2	4	16	16	12	8	16
Land Required	2	4	3	4	4	5	8	6	8	8	10
Maintenance	4	5	5	3	3	2	20	20	12	12	8
Public Acceptability	5	3	3	3	5	5	15	15	15	25	25
Reliability	4	3	4	3	3	2	12	16	12	12	8
Sludge Production	1	3	5	3	3	3	3	5	3	3	3
Water Reuse Potential	4	4	4	4	4	4	16	16	16	16	16
Odor Control	5	4	3	4	3	4	20	15	20	15	20
Sum of Weighted Ranks							**155**	**160**	**137**	**145**	**137**

Treatment Process Considerations

- Avra Valley
- Corona de Tucson
- Green Valley
- Marana
- Southlands

Outlying Facility Expansion Completion Dates

Facility	Expansion 1	Expansion 2	Expansion 3	Expansion 4
Arivaca Junction	-	-	-	-
Avra Valley	2006 / 2007	2008 / 2009	-	-
Corona de Tucson	2006 / 2007	2018 / 2019	2027 / 2028	-
Southlands(1)	2009 / 2010(2)	2010 / 2011	2012 / 2013	2014 / 2015
Green Valley	2011 / 2012		-	-
Marana	2006 / 2007	2008 / 2009	2018 / 2019	2027 / 2028
Mt. Lemmon(3)	TBD	TBD	TBD	TBD
PC Fairgrounds	-	-	-	-
Rillito Vista	-	-	-	-

(1)Additional expansion in 2022/2023
(2)By others
(3)Long range planning study in progress

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Avra Valley WW Process

- Currently BNROD
- BNROD expansion underway
- Selecting different process introduces complexity
- Loss of investment
- Avra Valley = BNROD

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Corona de Tucson WW Process

- Closed loop reactor nearly finished
- Selecting different process introduces complexity
- Corona de Tucson = CLR

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Green Valley WW Process

- Currently BNROD
- Plan to construct additional BNROD
- Selecting different process introduces complexity
- Green Valley = BNROD

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Marana WW Process

- BNROD system design complete, ready for bid
- Selecting different process requires additional investment
- Marana = BNROD

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Southlands WW Process

- Does not exist
- 2030 capacity above 10 mgd (upper bounds of BNROD and SBR)
- Southlands = Bardenpho

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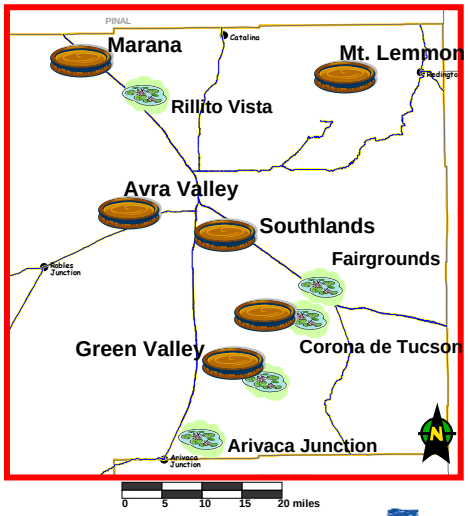
Future Outlying Facilities



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Chapter 10 – CIP Elements

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CIP Elements

- Plant interconnect
- Roger Road
- Ina Road
- Support Facilities
- Outlying Facilities Expansions

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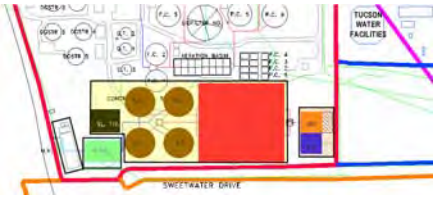
Roger Road WWTP

- Site preparation (temporary administration building)
- Headworks
- Bardenpho treatment (including clarifiers, solids thickening/pumping)
- Disinfection
- Administration/control building
- Standby power generation
- Future 8-mgd Bardenpho system (including clarifier)
- Future gravity belt thickeners
- Existing Roger Road Facility demolition



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Ina Road WPCF

- Site preparation
- Primary clarifier
- Bardenpho treatment (including clarifiers)
- Demolish HPO and oxygen system
- Mesophilic digestion (4 new, 4 existing)
- Gravity thickening (primary sludge)
- Gravity belt thickening (WAS sludge)
- Centrifuge dewatering
- Sludge storage
- Disinfection
- Centralized laboratory
- Power unification/biogas power generation
- Future mesophilic digester
- Future centrifuge thickener
- Future thermophilic digesters

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Outlying Facilities Expansion

- Southwest Region
  - Avra Valley WWTF
    - Expansion 1 (from 1.2 to 2.2 mgd)
    - Expansion 2 (from 2.2 to 4.0 mgd)
- Southeast Region
  - Corona de Tucson WWTF
    - Expansion 1 (from 0.3 to 1.3 mgd)
    - Expansion 2 (from 1.3 to 2.3 mgd)
    - Expansion 3 (from 2.3 to 3.3 mgd)
- Southland WWTF
  - Expansion 1 (from 0 to 2.0 mgd)
  - Expansion 2 (from 2.0 to 3.0 mgd)
  - Expansion 3 (from 3.0 to 4.0 mgd)
  - Expansion 4 (from 4.0 to 8.0 mgd)
  - Expansion 5 (from 8.0 to 12.0 mgd)

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Outlying Facilities Expansion

- South Region
  - Green Valley WWTF
    - Expansion 1 (from 4.1 MGD to 6.1 MGD)
- Northwest Region
  - Marana WWTF
    - Expansion 1 (from 0.5 to 1.5 MGD)
    - Expansion 2 (from 1.5 to 3.0 MGD)
    - Expansion 3 (from 3.0 to 4.5 MGD)
    - Expansion 4 (from 4.5 to 6.0 MGD)
- Mt. Lemmon WWTF
  - No change unless changes in area restrictions

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Chapter 11 – Alternative Project Delivery Methods

Jerry Bish

Alternative Delivery Methods

- Design-Build
- Design-Build-Operate
- Construction-Manager-At-Risk
- Design-Bid-Build

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Procurement Method Selection Considerations

- Procurement process
- Design and construction
- Operation and maintenance

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Chapter 12 – Financing Methods / Plan

Jerry Bish

CIP Components

- Capital Projects
  (ROMP projects and costs)
- Other Capital Projects
  (Include 15-year CIP information)
- Total Capital Plan
  (Include 15 year CIP information)

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Financing Options

- Baseline Financing Plan
  - Revenue Bonds
  - Current revenue/reserve funds

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Recommendations

- Use alternative charges to increase revenue
- Optimize current rates/charges
- Issue bonds – terms consistent with life of assets
- Investigate use of WIFA funds
- Use short term instruments…
- Explore private financing (RFEI process)

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Chapter 13 – Implementation Plan

Jerry Bish

Implementation Details

- Scheduled implementation
- Project delivery
- List of CIP projects
  - Treatment Facilities
  - Conveyance
- Funding source
- Rate impacts

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Implementation Schedule

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Interconnect	**$22,300,000**															
Design																
		$1,338,000														
Construct																
				$20,962,000												
Ina Rd	**$243,900,000**															
Design 50 mgd																
		$14,634,000														
Construct 50 mgd																
					$212,193,000											
Construct Thermophilic Digestion																
														$17,073,000		
Roger Rd	**$234,800,000**															
Design 32 mgd																
			$12,660,000													
Construct 24 mgd																
							$148,755,000									
Demo Existing Plant																
									$23,800,000							
Construct 8 mgd																
											$49,585,000					

Total ROMP Projects Cost $501,000,000

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Project Delivery

- Benefits / Challenges
  - Design - Bid - Build
  - Construction Manager at Risk
  - Design / Build
  - Design / Bid / Operate

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Roger Road Projects

Phase	Scope	Start	Complete	Project Delivery
1	Engineering – 24-mgd + 8-mgd Facilities	2007/08	2010	Professional
2	Construct – 24-mgd Facility	2011	2015	CMAR or D/B/O
3	Engineering – Demolition Existing Facilities	2014	2015	Professional
4	Demolition – Existing Facilities	2015	2017	CMAR or D-B-B
5	Construct – 8-mgd Facility	2017	2020	CMAR or D-B-B

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Ina Road Projects

Phase	Scope	Start	Complete	Project Delivery
1	Engineering – 50-mgd + Biosolids + Future Biosolids (Class B)	2007/08	2010	Professional
2	Construct – 50-mgd Facility	2010	2014	CMAR or D-B-B
3	Construct – Biosolids Facilities	2010	2014	CMAR or D-B-B
4	Eng/Arch – Central Laboratory	2007/08	2010	Professional
5	Construct Central Laboratory	2010	2012	CMAR or D-B-B
6	Construct Biosolids Facilities	2017	2020	CMAR or D-B-B
7	Engineering – Class A Biosolids	2018/19	2020	Professional
8	Construct Class A Biosolids	After 2020	After 2020	D/B/O or D/B or CMAR

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Electrical Service Modifications

Phase	Scope	Start	Complete	Project Delivery
1	Engineering – Roger Road WRF Standby Power	2010	2012	Professional
2	Construct – Power Services for New Facility	2013	2015	CMAR or D-B-B
3	Engineering – Ina Road Electrical Modification	2007/08	2010	Professional
4	Construct – Power Unification Facilities	2010	2012	CMAR or D-B-B
5	Construct – Biogas Power Generation Facilities	2012	2014	CMAR or D-B-B

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Plant Interconnect Pipeline

- Immediate need
- Engineering procurement underway
- Project delivery – CMAR
- Construction Complete no later than 2010

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Sewer Augmentation Projects

Project No.	Description (Manhole to Manhole)	Project Cost (in 2006 $)
Year 2010		
4	5627-08A to 9907-49	$2.76 million
6	8149-05 to 1726-29	$2.30 million
	3983-05 to 8149-05	$0.48 million
	1726-29 to 1726-26	$0.87 million
	1726-26 to 1726-19	$2.35 million
8	1751-09 to 1751-01	$2.57 million
9	8626-01 to 6804-15A	$0.04 million
Year 2015		
2	6036-21 to 3979-101	$0.74 million
	3919-101 to 8031-01	$1.32 million
5	8130-01 to 1779-02	$0.45 million
	9917-20 to 9910-21	$3.95 million
	5667-01 to 5662-01	$3.31 million
	1779-02 to 5667-01	$1.21 million
	9910-21 to 9910-19	$0.40 million
7	4630-09 to 4630-02	$0.73 million
Year 2020		
1	4636-30A to 4190-05A	$4.35 million
3	8635-11 to 8635-10	$0.31 million
10	9521-02 to 9549-05	$0.46 million
11	1708-22 to 6804-15A	$1.57 million

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Sewer Augmentation Summary

- CIP Costs in 5-year increments
  - 2010 $12.94 million
  - 2015 $12.11 million
  - 2020 $ 5.12 million

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Outlying Facilities Projects

- Southwest Region
  - Avra Valley WWTF
    - 2006/2007 Expansion 1 (from 1.2 to 2.2 mgd)
    - 2008/2009 Expansion 2 (Phase out existing BNROD and start up two new BNROD trains providing a total treatment capacity of 4.0 mgd)
- Southeast Region
  - Corona de Tucson WWTF
    - 2006/2007 Expansion 1 (from 0.3 to 1.3 mgd)
    - 2018/2019 Expansion 2 (from 1.3 to 2.3 mgd)
    - 2027/2028 Expansion 3 (from 2.3 to 3.3 mgd)
- Southland WWTF
  - 2009/2010 Expansion 1 (from 0.0 mgd to 2.0 mgd)
  - 2010/2011 Expansion 2 (from 2.0 mgd to 3.0 mgd)
  - 2012/2013 Expansion 3 (from 3.0 mgd to 4.0 mgd)
  - 2014/2015 Expansion 4 (from 4.0 mgd to 8.0 mgd)
  - 2022/2023 Expansion 5 (from 8.0 mgd to 12.0 mgd)

Outlying Facilities Projects, cont.

- South Region
  - Green Valley WWTF
    - 2011/2012 Expansion 1 (from 4.1 mgd to 6.1 mgd)
- Northwest Region
  - Marana WWTF
    - 2006/2007 Expansion 1 (from 0.5 to 1.5 mgd)
    - 2008/2009 Expansion 2 (from 1.5 to 3 mgd)
    - 2018/2019 Expansion 3 (from 3 to 4.5 mgd)
    - 2027/2028 Expansion 4 (from 4.5 to 6 mgd)
- Mt. Lemmon WWTF
  - No Change unless Changes in Area Restrictions

Financing Plan

1997 Bonds		**$**	**3,921,000**
	Other CIP	*$*	*3,921,000*
2004 Bonds		**$**	**147,505,613**
	ROMP Projects	*$*	*39,027,113*
	Other CIP	*$*	*108,478,500*
SDF's		**$**	**190,264,092**
	Other CIP	*$*	*190,264,092*
2008 Bonds		**$**	**564,812,417**
	ROMP Projects	*$*	*445,000,000*
	Other CIP	*$*	*119,812,417*
2012 Bonds		**$**	**373,765,658**
	ROMP Projects	*$*	*219,765,658*
	Other CIP	*$*	*154,000,000*
2016 Bonds		**$**	**130,644,408**
	ROMP Projects	*$*	*15,709,773*
	Other CIP	*$*	*114,934,635*
Total ROMP Projects		$	719,502,544
Total Other CIP Projects		$	691,410,644
Total Capital Plan		**$**	**1,410,913,188**

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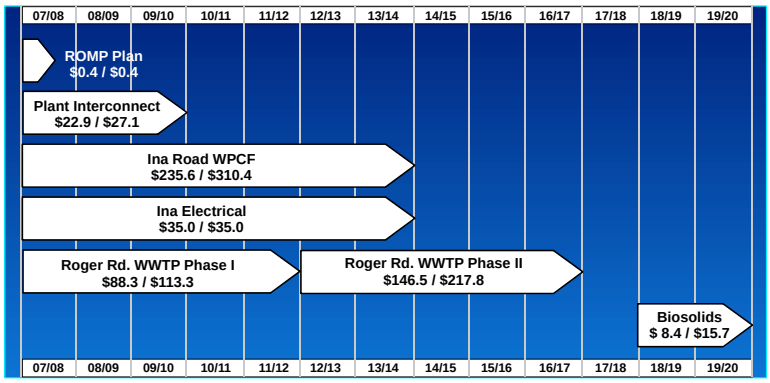
Long-Range CIP – ROMP

Dollar figures are in millions

2006 dollars / dollars based on 5% per year inflation



$501 (2006 dollars) / $684 (5% per year inflation)

Total Excluding Ina Electrical

$536.7 (2006 dollars) / $719.3 (5%/year inflation)

Total Including Ina Electrical

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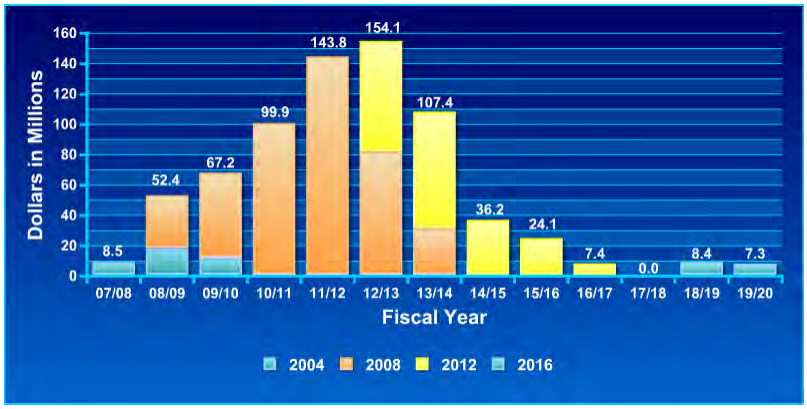
Long-Range CIP – ROMP



Projected Revenue Requirements

	2007	2008	2009	2010	2011	2012	2013	2014
Revenue Requirements ($ Mil.)								
Operating & Maintenance (1)	$ 75.4	$ 77.4	$ 80.1	$ 82.9	$ 85.8	$ 88.8	$ 92.0	$ 96.3
Capital								
Debt Service	$ 15.5	$ 24.6	$ 24.6	$ 38.1	$ 38.1	$ 63.7	$ 63.2	$ 92.7
SDF Funding	$ 18.4	$ 30.7	$ 46.5	$ 8.4	$ 14.1	$ 6.4	$ 3.2	$ 2.1
Add'l Revenue for Coverage (2)	$ -	$ -	$ -	$ 22.9	$ 23.5	$ 12.2	$ 24.9	$ 13.1
Total Revenue Requirements	**$ 109.3**	**$ 132.6**	**$ 151.2**	**$ 152.4**	**$ 161.5**	**$ 171.2**	**$ 183.2**	**$ 204.2**
% Change		*21.4%*	*14.0%*	*0.8%*	*6.0%*	*6.0%*	*7.0%*	*11.5%*

	2015	2016	2017	2018	2019	2020	2021	2022
Revenue Requirements ($ Mil.)								
Operating & Maintenance (1)	$ 101.6	$ 105.4	$ 109.4	$ 113.5	$ 117.8	$ 122.2	$ 126.8	$ 131.6
Capital								
Debt Service	$ 93.4	$ 105.3	$ 97.1	$ 97.6	$ 97.6	$ 101.9	$ 101.9	$ 104.0
SDF Funding	$ 1.1	$ 1.1	$ 5.8	$ 25.8	$ 24.4	$ 1.1	$ 1.1	$ -
Add'l Revenue for Coverage (2)	$ 14.3	$ 15.3	$ 14.9	$ -	$ 0.0	$ 14.6	$ 14.8	$ 14.5
Total Revenue Requirements	$ 210.4	$ 227.2	$ 227.2	$ 236.9	$ 239.8	$ 239.8	$ 244.6	$ 250.1
% Change	*3.0%*	*8.0%*	*0.0%*	*4.3%*	*1.2%*	*0.0%*	*2.0%*	*2.2%*

(1) Includes departmental capital outlays that are backed out for debt service coverage purposes.
(2) Revenue requirement forecast assumes that the County will maintain total debt service coverage of at least 120%.

Impact On Bill

	2007	2008	2009	2010	2011	2012	2013	2014
Typical Customer Bill (1)	$ 18.22	$ 21.41	$ 25.15	$ 26.16	$ 27.21	$ 28.30	$ 29.71	$ 32.53
% Change		*17.5%*	*17.5%*	*4.0%*	*4.0%*	*4.0%*	*5.0%*	*9.5%*
Connection Fee (2)	$ 4,724	$ 5,952	$ 7,643	$ 8,140	$ 8,653	$ 9,172	$ 9,814	$ 10,844
% Change		*26.0%*	*28.4%*	*6.5%*	*6.3%*	*6.0%*	*7.0%*	*10.5%*

	2015	2016	2017	2018	2019	2020	2021	2022
Typical Customer Bill (1)	$ 32.86	$ 34.83	$ 34.83	$ 35.61	$ 35.61	$ 35.61	$ 35.61	$ 35.70
% Change	*1.0%*	*6.0%*	*0.0%*	*2.3%*	*0.0%*	*0.0%*	*0.0%*	*0.2%*
Connection Fee (2)	$ 11,061	$ 11,835	$ 11,835	$ 12,220	$ 12,250	$ 12,250	$ 12,373	$ 12,528
% Change	2.0%	*7.0%*	*0.0%*	*3.3%*	*0.2%*	*0.0%*	*1.0%*	*1.3%*

(1) Represents the monthly sewer bill for a 10ccf customer.
(2) Non-participating connection fees.

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Appendices

Jerry Bish

Listing of Appendices

- A. Workshop Summaries
- B. Condition Assessment Data
- C. ADEQ Letters
- D. Conveyance Evaluation Data
- E. Interview Summary
- F. Enhanced Chlorination
- G. Request for Expression of Interest
- H. Reclaimed Water System Alternatives

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Other Topics

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Enhanced Chlorination Investigation/Study

Jerry Bish

UV Disinfection vs. Enhanced Chlorination – Systems

- UV Requirements
  - Lift pump station
  - Filtration
  - High Intensity UV
- Enhanced Chlorination
  - Contact tank (longer retention)
  - Higher sodium hypochlorite dosages
  - Higher sodium bisulfite dosages

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UV Disinfection vs. Enhanced Chlorination – Cost Impacts

- UV Costs $91.0 million
  - Construction/Contingency/ Engineering
- Enhanced Chlorination $17.6 million
  - Construction/Contingency/ Engineering

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Enhanced Chlorination Study/Investigation

- Identify/list critical success factors
- Research
  - Literature review
  - Conduct a facility survey
  - BADCT standards evaluation
  - On-site investigations/performance

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Florida High-Level Disinfection Requirements

- Minimum design for the chlorine contact tank *(TSS < 5 mg/L)*

Influent to Chlorine Contact Tank (FC/100 ml)	Minimum CT, mg/L* minutes
1,000	At least 25
>1,000 – 10,000	At least 40
>10,000	At least 120

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Chlorination Issues

- California Std - 5 log removal of enteric virus = "essentially pathogen free"
- Contact time and dosage (CA CT= 450)
- Type of chlorine (free or combined)
- Impact on WET, THMs, CN, NDMA …

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Request for Expression of Interest

Jerry Bish

RFEI - Status/Schedule

- RFEI posted April 23, 2007
- Pre-submittal meeting May 23, 2007
- Submittals June 22, 2007
- After receipt of submittals
  - Submittal Reviews
  - Assess ROMP report impacts

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RFEI - Objectives

- Engage the Marketplace
  - Solicit and receive private sector comment to inform public policy decisions
  - Gather perspectives from interested parties' on project delivery, private financing and related matters

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RFEI – Types of Projects

- Proposed Projects
  - New Roger Road WRF
  - Ina Road WPCF Expansion/Upgrade
  - Biogas/Power Facilities
  - Biosolids Disposal Services
  - Outlying Treatment Facilities

162

RFEI – Procurement Approaches

- Alternative Project Delivery Methods
  - Design - Bid - Build
  - Construction-Manager-at-Risk
  - Design-Build and Related Project Delivery Methods
  - Design-Build-Operate

163

RFEI Content

- Private Project Financing

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Summary

Jerry Bish

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APPENDIX B

Condition Assessment Data

Ina Road WPCF – Summary of Background/Condition Assessment
Roger Road WWTP – Summary of Background/Condition Assessment

Civil-Structural Field Assessment Ina Road
Civil-Structural Field Assessment Roger Road
Instrumentation Field Assessment
Electrical Field Assessment Ina Road
Electrical Field Assessment Roger Road

Appendix B

Condition Assessment Data

Ina Road WPCF – Summary of Background/Condition Assessment

Ina Road WPCF
Summary of Background / Condition Assessments

Condition Assessment

- Questionnaires
  - Equipment condition assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group:_____

_____

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: _____

_____

2

Condition Assessment

- Questionnaires
  - Structural condition assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure:_____

_____

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: _____

_____

3

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
STRUCTURAL:	
Poor	Older, excessive age related concrete or building structure weathering and deterioration, not properly sized for the function, may have safety related issues and excessive age related maintenance issues
Acceptable	Older, some normal age related concrete or building structure weathering, not exactly sized for the function but provides service and some additional age related maintenance issues
Good	Older, some normal age related concrete or building structure weathering, properly sized for the function and some additional age related maintenance issues
Excellent	Relatively new, sound concrete tankage or building structure, properly sized for the function and no significant maintenance issues

4

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
MECHANICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
ELECTRICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable, leaking, unacceptable odor
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions correctly, mfgr's recommended PM only, extremely reliable

Condition Assessment

- Ranking criteria

DISCIPLINE/RATING	CRITERIA
CIVIL[1]:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable
(1) Piping, valves, and other appurtenant devices	

Condition Assessment

- Structures
  - Headworks – good
  - PST & PS – good
  - Bio-Towers PS – acceptable
  - Bio-Towers – good
  - Aeration Tanks – good

Condition Assessment

- Structures
  - Blower Building – good
  - Secondary Clarifiers – good
  - RAS PS – good
  - Chlorine Contact Basins – acceptable to poor

9

Condition Assessment

- Structures
  - Gravity Thickeners – acceptable to poor
  - Floatation Thickener Building – good
  - Anaerobic Digesters – good to acceptable

10

Condition Assessment

- Equipment
  - Sewage Screens & Equipment – good to acceptable
  - Pista Grit Mechanisms, Grit Pumps & Washers – good to acceptable
  - Odor Control Biofilter – good

11

Condition Assessment

- Equipment
  - PST Collector Mechanism – unknown
  - PS Pumps – good
  - Bio Tower Engine Driven Pumps – good to Acceptable
  - Bio Tower Motor Driven Pump – good

12

Condition Assessment

- Equipment
  - Bio Towers Flow Distributor – good
  - Bio Towers Media – acceptable to poor
  - Aeration Diffusers – acceptable to poor

13

Condition Assessment

- Equipment
  - Aeration Blowers – acceptable
  - FST Collector Mechanism – unknown
  - WAS Pumps – good

14

Condition Assessment

- Equipment
  - Chlorination – Dechlorination Equipment – good
  - Non-Potable Water Pumps – good
  - Effluent Pumps – acceptable to poor

15

Condition Assessment

- Equipment
  - Thickened Sludge Pumps – good
  - Center Drive Mechanisms – acceptable
  - Odor Control Systems – acceptable to poor

16

Condition Assessment

- Equipment
  - Sludge Gas Equipment, Waste Gas Burners, Gas Compressors – good
  - Heat Exchangers, Sludge Pumps, Roof Mounted Mixers – good

17

Condition Assessment

- Electrical
  - 2400 volt Plant SWGR – acceptable
  - Power Center 1 – good
  - Power Center 2 – good to Acceptable
  - Power Center 3 – good
  - Power Center 4 – good

18

Condition Assessment

- Electrical
  - Power Center A – good
  - Power Center B – good
  - Power Center C – acceptable

19

Condition Assessment

- Electrical
  - Motor Control Centers (most) – good to excellent
  - Motor Control Center MCC CA – poor

20

Condition Assessment

- Electrical
  - Engine Generators – acceptable to good
  - Generator Main Breakers – good
  - New GDC – excellent

21

Condition Assessment

- Electrical
  - Generator Paralleling Controls – acceptable

22

Condition Assessment

- Instrumentation and Controls
  - Metering Flumes – good
  - Metering Weirs – good to acceptable

23

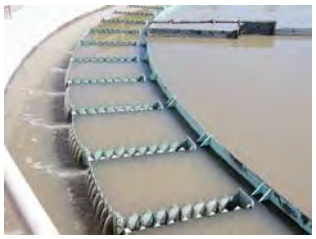
Condition Assessment

- Instrumentation and Controls
  - Magnetic Flow Meters (Sludge) – good
  - Orifice Plates (Process Air) – acceptable to poor

24

Condition Assessment

- Instrumentation and Controls
  - No flow metering to individual PST's
  - No flow metering to individual Bio Towers



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Condition Assessment

- Instrumentation and Controls
  - Remote monitoring of equipment operating status and valve status mostly not available
  - Remote operation of equipment mostly not available
  - Automatic operation of equipment mostly not available

26

Condition Assessment

- Instrumentation and Controls
  - Fiber optic system installed
  - PLC's and other SCADA devices to permit remote monitoring/operation not fully utilized

27

Roger Road WWTP

Fiber Optic Network

28

Condition Assessment

- Summary of condition assessment
  - Most major structures appear in generally good condition
  - Most major equipment appear in generally good condition
  - Most major electrical components appear in generally good condition
  - Significant lack of I&C

29

Condition Assessment

- Summary of condition assessment
  - Potential reuse of Roger Road Facilities depends largely upon whether facilities are appropriate for conversion to BNR
  - Planned improvements for several areas of the plant are necessary to maintain treatment effectiveness regardless of the final decision on the long-term continued use of Roger Road WWTP

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Appendix B

Condition Assessment Data

Roger Road WWTP – Summary of Background/Condition Assessment

Roger Road WWTP
Summary of Background / Condition Assessments

Background / Condition Assessments

- Questionnaires
  - Equipment Condition Assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group:_____

_____

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: _____

_____

2

Background / Condition Assessments

- Questionnaires
  - Structural Condition Assessment

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer:_____

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure:_____

_____

Type of Service [1]: _____

[1]Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: _____

_____

3

Background / Condition Assessments

- Ranking Criteria

Discipline/Rating	*Criteria*
STRUCTURAL:	
Poor	Older, excessive age related concrete or building structure weathering and deterioration, not properly sized for the function, may have safety related issues and excessive age related maintenance issues
Acceptable	Older, some normal age related concrete or building structure weathering, not exactly sized for the function but provides service and some additional age related maintenance issues
Good	Older, some normal age related concrete or building structure weathering, properly sized for the function and some additional age related maintenance issues
Excellent	Relatively new, sound concrete tankage or building structure, properly sized for the function and no significant maintenance issues

4

Background / Condition Assessments

- Ranking Criteria

Discipline/Rating	*Criteria*
MECHANICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable

5

Background / Condition Assessments

- Ranking Criteria

Discipline/Rating	*Criteria*
ELECTRICAL:	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable, leaking, unacceptable odor
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions correctly, mfgr's recommended PM only, extremely reliable

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Background / Condition Assessments

- Ranking Criteria

Discipline/Rating	*Criteria*
CIVIL(1):	
Poor	Generally Older, no longer functions, replacement parts may not be available, unreliable or not operable
Acceptable	New or Older, functions but needs frequent attention, some maintenance problems, may have reliability issues
Good	New or Older, functions well, some additional PM required, reliable
Excellent	New, everything functions perfectly, mfgr's recommended PM only, extremely reliable
(1) Piping, valves, and other appurtenant devices	

Background / Condition Assessments

- Structures
  - Emergency Overflow Basins – Good
  - Headworks – Good to Excellent

Background / Condition Assessments

- Structures
  - High Purity Oxygen Plant
    - PST & PS – Good
    - HPO Reactors – Acceptable
    - Secondary Clarifiers – Good
    - RAS PS – Acceptable

9

Background / Condition Assessments

- Structures
  - High Purity Oxygen Plant
    - Oxygen Production Building – Good
    - Vacuum Filtration Building – Good
    - Gravity Thickener – Good
    - DAF Thickeners – Good

10

Background / Condition Assessments

- Structures
  - High Purity Oxygen Plant
    - Anaerobic Digesters – Good
    - Service Water Building – Good

11

Background / Condition Assessments

- Structures
  - High Purity Oxygen Plant
    - Chlorine Contact Tanks - Good
    - Centrifuge Building – Good

12

Background / Condition Assessments

- Structures
  - BNRAS Plant
    - All Structures – Excellent

13

Background / Condition Assessments

- Equipment
  - Coarse Screens – Good
  - Screw Pumps – Good

14

Background / Condition Assessments

- Equipment
  - Fine Screens – Good
  - Screenings Washer and Screenings Compactor – Acceptable to Poor

15

Background / Condition Assessments

- Equipment
  - Grit Collector Mechanisms – Good
  - Grit Pumps – Good
  - Grit Washers – Good
  - Screenings and Grit Hoppers – Good

16

Background / Condition Assessments

- Equipment
  - Grit Tanks Air Blowers – Good
  - Headworks Odor Control – Good

17

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Primary Clarifier Collector Mechanisms – Good
    - Primary Sludge Pumps (Dewatering Pumps, Scum Pumps & Grinders) – Good

18

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Mechanical Aerators – Acceptable
    - HPO Generation Equipment – Good to Acceptable

19

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Secondary Clarifier Collector Mechanisms – Good
    - WAS/RAS Pumps – Acceptable to Poor

20

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - DAF and Gravity Thickener Equipment – Good to Acceptable

21

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Anaerobic Digestion Tank Equipment (pumps, heat exchangers, mixers, etc.) – Good to Acceptable
    - Sludge Gas Equipment – Good to Acceptable

22

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Service Water Pumps – Good
    - Chlorine Water Booster Pumps – Good
    - Engine Gen Cooling Water Pumps – Good

23

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Centrifuges – Good
    - Centrifuge Feed Pumps – Good
    - Cake Pumps – Good
    - Thickened Sludge Pumps – Good

24

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Centrifuge Centrate Pumps – Good
    - Polymer Feed System – Good
    - Thickened Sludge Bladder – Acceptable

25

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Centrifuge Building Odor Control – Acceptable to Poor

26

Background / Condition Assessments

- Equipment
  - High Purity Oxygen Plant
    - Sodium Hypochlorite Tanks – Good
    - Sodium Bisulfate Tanks – Good
    - Hypochlorite & Bisulfate Feeders – Good
    - Chlorine Analyzers – Good

27

Background / Condition Assessments

- Equipment
  - BNRAS Plant
    - All Equipment – Excellent

28

Background / Condition Assessments

- Electrical
  - New Headworks/Service Transformer ST-1 – Excellent
  - Unit Substations US30-1 & US30-2 – Excellent
  - Headworks MCC-30A & MCC-30B – Excellent

29

Background / Condition Assessments

- Electrical
  - Energy Recovery Building
    - 4.16KV SWRG A and B – Good
    - MCC14W1, MCC14W2 and MCC14W3 – Good

30

Background / Condition Assessments

- Electrical
  - Energy Recovery Building
    - Engine Generators – Good to Excellent

31

Background / Condition Assessments

- Electrical
  - Centrifuge Building
    - Unit Substation US-CEN1 – Good
    - MCC–CEN – Good

32

Background / Condition Assessments

- Electrical
  - Service Water Building
    - MCC17W1 and MCC17W2 – Poor
  - Chlorination Building
    - MCC12W1 – Acceptable

33

Background / Condition Assessments

- Electrical
  - Digestion Tanks
    - Substation No. 2 – Acceptable
    - MCC11W1 and MCC11W2 – Acceptable
    - MCC11W3 and MCC11W4 – Good

34

Background / Condition Assessments

- Electrical
  - Sulfur Dioxide Building
    - MCC A and MCC B – Excellent

35

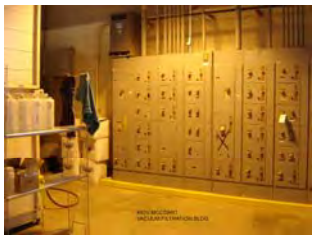
Background / Condition Assessments

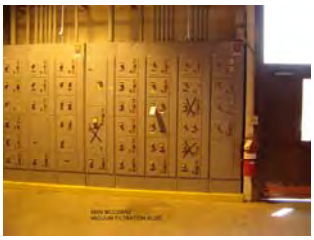
- Electrical
  - Oxygen Production Building
    - Substation No. 3 – Acceptable
    - MCC05W1 and MCC05W2 – Acceptable

36

Background / Condition Assessments

- Electrical
  - Vacuum Filtration Building
    - MCC09W1 and MCC09W2 – Acceptable





37

Background / Condition Assessments

- Electrical
  - Sludge Thickening Control Building
    - Substation No. 1 – Poor
    - MCC08W1, MCC08W2, MCC08W3 and MCC08W4 – Acceptable

38

Background / Condition Assessments

- Electrical
  - BNRAS Plant
    - All Equipment – Excellent

39

Condition Assessment

- Instrumentation and Control
  - Plant Influent Flow Metering is Accurate
  - New BNRAS Flow Influent Magmeter appears oversized; Velocity too low for self scouring
  - In general, plant is well instrumented

40

Condition Assessment

- Instrumentation and Control
  - Plant Effluent Parshall Flume – good application of nested flume for future flow increases
  - Old plant effluent flume is severely inaccurate
  - BNRAS effluent meter is head/flow calculation based on effluent weir at contact tank

41

Condition Assessment

- Instrumentation and Control
  - Noticeable lack of power actuated valves
  - Remote operation of equipment via SCADA requires manual re-positioning of hand valves, then start of equipment at workstation
  - Automatic control of equipment in many cases not being used

42

Condition Assessment

- Instrumentation and Controls
  - Good use of appropriate meter technology

- Effective automation of package control systems

43

Condition Assessment

- Plant SCADA System
  - Very Good, based on current technology
    - Commissioned in 2002
    - Redundant Servers in two locations with two core network switches
    - Fiber optic backbone
    - Lends itself to easy expansion

44

Condition Assessment

- Plant SCADA System
  - Local area controls appropriate
  - Operators use and appreciate value of system

45

Background / Condition Assessments

- Summary of Condition Assessment
  - Most Major Structures appear in generally good condition
  - Most Major Equipment appear in generally good condition
  - Most Major Electrical Components appear in generally good condition
  - Significant lack of I & C

46

Background / Condition Assessments

- Summary of Condition Assessment
  - Much of the Ina Road Facility that would be used either as a BNR process component or support process is viable. Those facilities or equipment units rated as “Acceptable” or “Poor” that are required in the BNR conversion, should be upgraded to “Good” or “Excellent”.
  - Planned Improvements for several areas of the plant are necessary to maintain treatment effectiveness prior to modifications for plant-wide BNR.

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Appendix B

Condition Assessment Data

Civil-Structural Field Assessment Ina Road

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 1 OF _____

~~ROOM~~ INA ROAD MEETING 6/13/06 9:00 AM

AM RZ JB } G&H
TRG BS

DAVE GARRETT - OPERATION SUPERVISOR
JIM PLANT SUPERINTENDENT
PAUL MAINT. SUPERVISOR
JERRY
AL } MAINT.
LARRY
BRAD

HEADWORKS — 55 YEARS OLD

- SLUICE GATES — DONT SEAL — FLOW COMING THROUGH (LINERS COME LOOSE)
- FINE SCREENS — NEED WASHERS? UPGRADE SCREENING. DISCHARGE
- SCREW PUMPS — LOWER BEARINGS BAD LUBE SYSTEM, NOW GREASELESS SEALED BEARING — NOW OK

HEAD WATERMAIN

HAVE TO TAKE WHOLE PLANT OUT OF SERVICE

PRIMARY REDUNDANT LINE

- ROLLS THAT UP WASHERS
- BAGS VERY WET WHEN SENT FOR DISPOSAL

- CAN'T KEEP UP W/ AMOUNT OF SCREENINGS
- GREASE PROBLEM (FILLS UP PRESS)
- WASHING NOW, NOT COMPACTING
- PRESS + WASHER WATERLINE (BAD)

DAVE GARRETT

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 2 OF _____

HEADWORKS - DESIGNED FOR 50 MGD 65 ACRES

EMERGENCY OVERFLOW BASIN

- USED AS DUMPING GROUND FOR ~~[illegible]~~ RICHARD ROAD (SEWER VACTOR TRUCKS) → ALSO DUMP RAGS FROM HEADWORKS IF TO MUCH LIQUID
- * → VERY ODOROUS
- THREE HOLD 18-19 MILLION GALLONS
- MOST LIQUID EVAPORATES, CAN USE PORTABLE PUMP TO PUMP TO HEADWORKS.
- ONE OVERFLOWS INTO TWO THEN OVERFLOWS INTO THREE. #2 + 3 CAN DRAIN BACK TO #1
- #2 + #3 HAVE MEMBRANE LINERS NO CONCRETE
- NO UNDER DRAIN
- ONLY USED AS OVERFLOW IF HEADWORKS GOES DOWN

PIGRECEIVING STATION NORMALLY NOT USED

FLOW INLET STRUCTURE

COUPLE OF MANHOLES, NUMEROUS INLET LINES

HEADWORKS

- ~~SE~~ GATES MANUAL OPERATED (HAVE SCADA HERE) — COARSE SCREEN
- RAW INFLUENT SAMPLING DONE AFTER GRIT
- CAN'T ACCESS GATES (TOOK STRIP LINERS OFF GATES
- 2.5 MGD EACH COARSE SCREEN
- U.S. FILTER CLEANER SCREEN
- TRASHED BELT CONVEYOR
- HAVE ROOM FOR THIRD SCREEN
- CAN BYPASS CONVEYOR INTO SCREENINGS CART
- NO BATHROOM
- NO PHONES / PC

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 3 OF _____

~~HEADWORKS CONTINUED~~

⇒ SCREW PUMPS - 3

- EVERYTHING COVERED AND ODOR CONTROLLED
- RUN LOCALLY
- 32 MGD EACH
  - USUALLY ONE PUMP, SOMETIMES TWO RUN, THIRD STAND BYE
  - HAVE ROOM FOR 4TH IN FUTURE
  - #1 + 3 HAVE GREASELESS SYSTEM, #2 HAS OLD, OIL BUBBLE BEARING BUT WILL BE TAKEN OUT

⇒ FINE SCREENS

- HAVE 3, ROOM FOR 4
- RUN 2 SCREENS NORMALLY
- HIGH LEVEL SHUTS DOWN SCREW PUMPS
- ONE MANUALLY RUNNING (CONVEYOR NOT MOVING) SLOWLY DROPS SCREENINGS ONTO CONVEYOR
  SECOND SCREEN IN AUTO THAT TIES IN BELT AND WASHER
- IF WASHER FAILS THEN THEY BYPASS INTO CART (FILLS IN 2 SHIFTS)
  RICHEY ROAD VACTORS EMPTY BINS
- LONG BELT DISCHARGES TO SHORT REVERSIBLE BELT TO TWO WASHERS (CYCLES BACK AND FORTH)

⇒ - ODORS NOTICEABLE
- WASHER DISCHARGES INTO SEPERATE PRESS.
- PRESS DISCHARGES INTO HOPPER THAT TRUCK DRIVES UNDER
- WASHER HAS PROBLEM W/ ROCKS BREAKING BRUSHES, SO NOTHING COMES OUT, SO ALWAYS IN FULL MODE
- SCREEN THAT IS OUT OF SERVICE DISCHARGES INTO CART FOR A DAY BECAUSE OF ROCK ACCUMULATION.
- NO BATHROOM

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 4 OF _____

GRIT WASHERS

- GRIT DRAINS UNDERSIZED AND ROOM FLOODS
- 3 GRIT CLASSIFIERS, ROOM FOR 4TH
- TWO TYPICALLY RUNNING
- ~~TWO LINES~~

THREE GRIT TANKS AND CLASSIFIERS, BUT ONLY TWO LINES SO USUALLY RUN JUST TWO.

- DISCHARGE INTO GRIT HOPPER THAT TRUCKS DRIVE UNDER
- NO SKYLIGHTS.

ODOR CONTROL

- WET SCRUBBERS NOT USED IN A COUPLE YEARS (3 YEARS)
- CHEMICALS PLUGGED DRAINS
- FLOW SWITCHES IN DUCTWORK TO MEAN FOR FLOWS IN ODOR CONTROL
- GET SCUMY BUILD UP, NO WAY TO CLEAN EASILY
- TURNING OFF HEATERS SAVES LOTS OF ENERGY
- CARBON DOING GOOD ENOUGH JOB BY ITSELF
- CARBON DESIGNED FOR 5 YEARS BEYOND THAT NOW AND NOT EVEN CLOSE TO BEING SPENT
- 2 WET SCRUBBERS
- 6 CARBON TANKS
- USUALLY RUN BOTH FANS
- WATER SOFTENER OUT OF SERVICE ALSO
- BLOWDOWN SENT BACK TO HEADWORKS

- VENTILATION AIR MANOLERS ONLY SET FOR HOT WATER, NO COOLING WATER
- DRAIN LINES INSULATED ?

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 5 OF _____

FINE SCREEN DISCHARGE INTO COMMON HEADER
3 GATES PER GRIT TANK

GRIT TANKS

- ALL 3 IN SERVICE
- AERATED TANKS BACK INTO ONE CHANNEL W/ SAMPLERS + PARSHALL FLUME

RECYCLE COLLECTION FOR RECYCLE PUMPS FOR CIRCULATION IN CHANNELS AND WASHERS (DO NOT USE THIS FOR WASHERS NOW)
→ SO GRIT DOESNT ACCUMULATE

- ONCE A WEEK VACTOR OUT GREASE ACCUMULATION

DRAINS FOR GRIT AND SCREENINGS HOPPERS ~~BAD~~ SLOPED WRONG WAY

BLOWERS

- MANUAL VALVES
- 4 BLOWERS
- USUALLY RUN TWO

GRIT PUMPS

- HAVE PROBLEMS W/ ROLL CENTRIC VALVES, REPLACING W/ PLUG VALVES
- 5 GRIT PUMPS
- 3 PUMPS FOR GRIT TANK 1 OR 2
  2 PUMPS FOR GRIT TANK 3
- RUN CONTINUOUSLY

- COMPRESSOR UNDER STAIRS NEED TO BE MOVED

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 6 OF _____

SUMP PUMPS

- BIG GREASE TRAP THAT GETS SENT BACK TO HEAD OF PLANT ~~IN~~ END UP BEING A BIG LOOP.
- VACTORS OUT ONCE/WEEK
- DON'T COMPRESS THE COMPACTORS SO DON'T GET AS MUCH GREASE

HPO STREAM

⇒ PRIMARY CLARIFIERS (4) 1/2 MGD EACH

- RECYCLE COMES HERE
- 2 ~~TANKS~~ SECTIONS PER CLARIFIER
- PLASTIC FLIGHT AND CHAIN
- TANKS + DRIVES FROM 70'S
- CENTRATE TRANSFER LINE FROM CENTRIFUGES (STRUVITE ~~[illegible]~~ PROBLEMS) IN HEADWORKS LINE
- TWO SCUM PITS FOR PC SCUM → 10 YRS. AGO PUT IN HELICAL SKIMMERS → NOW VERY SOLID AND CAN'T PUMP W/O ADDING WATER

H_2O PLANT REACTOR

- 4 SYSTEMS EACH 3 UNITS
- HAD A SERVICE CONTRACT, NOT ANY MORE, HAVENT BEEN OVERHAULED FOR A WHILE
- FOAM SUPRESSION SYSTEM NEVER USED
- LOTS OF MAINTENANCE BUT IT WORKS

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 7 OF _____

FINAL CLARIFIERS
ORIGINAL DRIVES, KEEP SOME MAINTENANCE
DEEP

RAS/WAS BUILDING

- RAS PUMPS LATE 80's RAS VALVES MOTOR OPERATED
  WAS PUMPS REPLACED SINCE THEN
- BUILDING FLOODED THIS YEAR, ALL MOTORS PULLED + CLEANED
- VFD'S FOR WAS + RAS IN VACUUM FILTRATION BUILDING

VACUUM FILTRATION BLDG
- LAB
- VFD'S
- ELECTRICAL GEAR

FENFERSANE FLUID MIXERS INC.
OAKVILLE ONTARIO CANADA
PLUNGER TYPE PUMP
DIGESTER FOUR REPLACED 4 FEDT MIXERS + 1 CENTER MIXER
WITH 1 FENFERSANE MIXER

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 8 OF _____

GRAVITY THICKENERS (4) / (DAF TANKS)

- #2 + #4 TURNED INTO DAF TANKS IN 80's
- #1 TURNED INTO DAF TANK IN 90's REHABBED LAST 3 YEARS
- #3 STILL GRAVITY THICK TANK
- NEW SPLITTER BOX
- PUTTING IN NEW PUMPS FOR TANKS #2 + #4
- ORIGINAL RECYCLE TANKS
- PUT IN BYPASS LINE TO SPLIT BOX
- DAF NO. 4 TANK TO BE REPLACED

- ODORS IN BLDG.
- DAF PUMPS REPLACED IN LATE 1980'S
- PUMPS ON TIMERS AND LEVEL CONTROLS

DIGESTERS

- ~~LOOKS LIKE LEAKS ON FUME TANKS~~
- ~~2 PRIMARY - 2 SECONDARY~~ ALL PRIMARY
- 4 ROT + 1 CENTER MIXERS ON ?
- EQT ONLY USED WHEN FED
- 1+3 FIXED COVERS
- 2+4 FLOATING COVERS
- SLUDGE PUMPS - 3 DUPLEX WATSON MARLOW (80's)
  2 SIMPLEX (ORIGINAL)
- HOT WATER SYSTEM IN 1980'S

- MIDDLE 2 HEX + PUMPS ORIGINAL

SERVICE WATER BLDG.

- SAND FILTER PNEUMATIC TANK (ABANDONED)
- SERVICE WATER PUMPS RECENTLY REPLACED
- COOLING WATER PUMPS FOR HEX

CALCULATION THIS SUMMER DECALORINATION

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 9 OF _____

COARSE SCREENS (2)
U.S. FILTER CLIMBER SCREENS

BELT CONVEYOR
SERPENTIX

SCREW PUMPS (2)

INVENSYS MOTOR — COUPLING SPANS BABCOCK by FLENDER REDUCER

FINE SCREENS (3)
PARKSON AQUA GUARD ~~[illegible]~~

SCREENINGS WASHER
WATERLINK HYCOR (2)

SCREENINGS PRESS
WATERLINK HYCOR (2)

GRIT WASHER
WEMCO HYDROGRITTER (3)

GRIT DRIVES (3)
~~REX HYD~~ REX HYD
POLYTECH SYSTEMS

SAMPLERS
SIGMA 900

FLUSH ~~[illegible]~~ WATER PUMPS (2)
~~[illegible]~~

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 10 OF _____

SUMP PUMP (2)
COVERED

GRIT BLOWERS
UNIVERSAL BLOWERS INC. PAC

COMPRESSOR
INGERSOLL RAND

GRIT PUMPS
WEMCO DUPLEX UNITS

FAN FOR ODOR CONTROL
NEW YORK BLOWER DUALL DIVISION

ODOR CONTROL CHEMICAL PUMP
FYBROC

CHEMICAL SCRUBBER
METPRO CORP. DUALL DIVISION

CENTRIFUGE BUILDING

- 3 CENTRIFUGES
- 4 REEVES ~~CAKE~~ FEED PUMPS } MID 60's
- THICKEN TO 8%
- JUST PUT IN ONE SCRUBBING PUMP IN THIRD FLOOR DEWATER 2 1/2 YRS. OLD
- 3 CAKE PUMPS 1 SCRUBBING 2 REEVES

- 5 HOLDING TANKS 120,000 GAL EACH
  - TANK 2 CENTRATE
  - TANK 3 THICKENED SLUDGE HOLDING TANK
  - TANK 1A, 1B, 1C INAT ROUGH DIGESTED SLUDGE
  - 2 MOYNO PUMPS PUMP THICKENED SLUDGE TO BLOODER
  - 4 HYDROMATIC PUMPS

5 pumps

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 11 OF _____

P-6A + 6B CENTRATE PUMPS THAT PUMP TO PC's

13 ALFA LAVAL CENTRIFUGES
- 1 2 1/2 YRS OLD
- 2 CHARLES
- MID 80's
- ONE OUT OF SERVICE FOR PREDICTIVE MAINT.

• NORMALLY RUN 1

POLYMER FEED PUMPS

• 3 REEVES MID 80's
• 1 VIKING 2 1/2 YRS. OLD

1 SMALL CARBON ODOR UNITS
2 LARGE CARBON ODOR UNITS } UNDERSIZED DESIGNED FOR 8 HOURS, RUN 24 HOURS

BLADDER
LINER TOP REPLACED RECENTLY, DON'T KNOW ABOUT BOTTOM

RECTANGULAR CHEM. SCRUBBER FROM FILTER BLDG MAY BE HOOKED UP, MAYBE NOT

• PIG RECEIVING UNIT

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____	SHEET 12 OF _____

PRIMARY CLARIFIER COLLECTOR DRIVE (4)
WALKER PROCESS

PRIMARY SLUDGE PUMPS (6)
WEMCO

GRINDERS (4)
MUFFIN MONSTER

DEWATERING PUMP (1)
ALLIS-CHALMERS

SCUM PUMPS (2)
GORMAN

REACTOR DEWATERING (1)
AURORA PUMP

AT MIXERS (12)
- ~~MIXING EQUIPMENT COMPANY~~
- UNION CARBIDE
- LIGHTNING

CHILLED H_2O PUMPS (2)

O_2 GENERATION COMPRESSOR (3)
JOY MANUFACTURING CO.

AIR COOLERS
BASCO INC.

REFRIGERATED AIR DRYER (1)
WILKERSON

O_2 GENERATORS (3)
BARTON & UNION CARBIDE

AIR COMPRESSOR

INSTRUMENT AIR COMPRESSOR (2)
JOY

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 13 OF _____

FINAL CLARIFIERS (4)
DORR OLIVER

NEW BNR PLANT

- (4) GATES
- (4) SUBMERSIBLE PUMPS (FAIRBANKS MORSE VERTICAL TURBINES)
- CHEMICAL SCRUBBER ODOR UNIT (1)
- JIB CRANE
- PRIMARY SLUDGE PUMPS - WEMCO (3)
- PRIMARY TANKS (2/3) w/ 2 HOLVRIS EACH
  - US FILTER COLLECTOR ~~OAT~~ MECHANISMS CHAIN-FLIGHT
- SCUM PUMPS (2)
  NOT IN NOW, WERE OVERHEATING SO BEING REPLACED
- 2 CHEMICAL SCRUBBERS

BLOWER BLDG 8.7

(4) 600 HP BLOWERS (LAMSON)

(2) HEAT EXCHANGERS (X CHANGER INC.)

(4) FILTERS

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 14 OF _____

ANOXIC BASIN MIXER (2)
CHEMINEER

GATES

(ANOXIC BASIN)
CHANNEL
~~ANOXIC BASIN~~ MIXER (116)
CHEMINEER

ANOXIC BASINS (4)

AERATION BASIN (5)

- GATES
- FINE PORE DIFFUSERS
- 5 DROPS PER TANK
- INSULATED PIPE

AERATION MIXER (10)
CHEMINEER

INTERNAL MIXED LIQUOR PUMPS (4)
VERTICAL TURBINE FAIRBANKS MORSE

JIB CRANE

RAS/WAS ROOM

- 4 RAS PUMPS (ROOM 2 FUTURE) FAIRBANKS
  MOTORS PULLED BECAUSE HOT BEARINGS
- 4 WAS PUMPS FAIRBANKS
  (5TH FUTURE)
- SCUM PUMPS (2) GORMANN RUPP

SECONDARY CLARIFIERS (2)

WALKER PROCESS 2 RAKE ARMS

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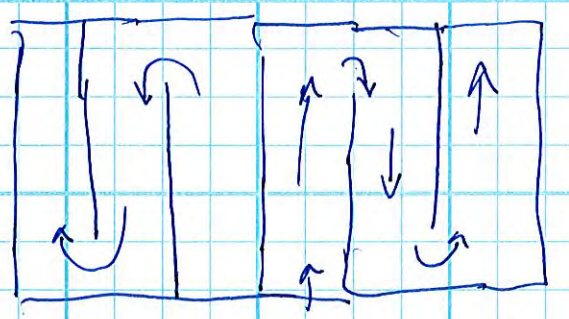
PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 15 OF _____

HYPO FEEDERS (2)
US FILTER

CCT (2)
- ONE CHEMINEER MIXER EACH
- GATES
- CHEMICAL LINE TO EACH MIXER

INJECTOR SENDS



SERVICE WATER PUMPS (3)
- FAIRBANKS MORSE
- 2 FILTERS
- ROOM FOR FUTURE 4TH

FC TANK DRAIN PUMPS (2)
- SUBMERSIBLE PUMPS
- BUBBLER SYSTEM

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PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 16 OF _____

HPO TRAIN

DAF RECIRCULATION PUMPS BETWEEN TANKS 1+? (2)
- SPOT FOR THIRD
- PEERLESS
- 2 AIR COMPRESSORS (KAESER)
- 1 WESTECH PRESSURIZATION TANK

BETWEEN TANKS 2+4
- 3 RECIRC. PUMPS (PEERLESS)
- 2 PRESSURIZATION TANKS (ONE TO BE REPLACED)

- THICKENED SLUDGE PUMPS (6)
  - CARTER PUMPS

DAF TANKS (3)
EIMCO

GRAVITY THICKENING TANK (1)
WESTECH

DIGESTER BLDG

METHANE GAS COMPRESSORS
THE NATIONAL WELDING AND MANUFACTURING CO.

HEAT XCHANGERS
2 NEW EIMCO

2 OLD ?

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 17 OF _____

SLUDGE PUMPS (4)

· MUFFIN MONSTERS (4)
· WATSON MARLOW

WATER PUMPS FOR HEX (HOT WATER PUMPS) (4)

PEERLESS PUMP

HEX PUMP (4)

WARMCO

SERVICE WATER PUMP (2)

PEERLESS

SERVICE WATER BLDG.

COOLING ~~SERVICE~~ WATER PUMPS

WORTHINGTON (3)

· CHLORINE WATER BOOSTER PUMPS (2)

SERVICE WATER PUMPS (4)

FAIRBANKS

SAMPLER PUMP (1)

WATER

* ONE FLASH MIXER FOR HYPO INTO CCT

HEX (1)

SUPERCHANGER

COOLING WATER FOR ENGINES

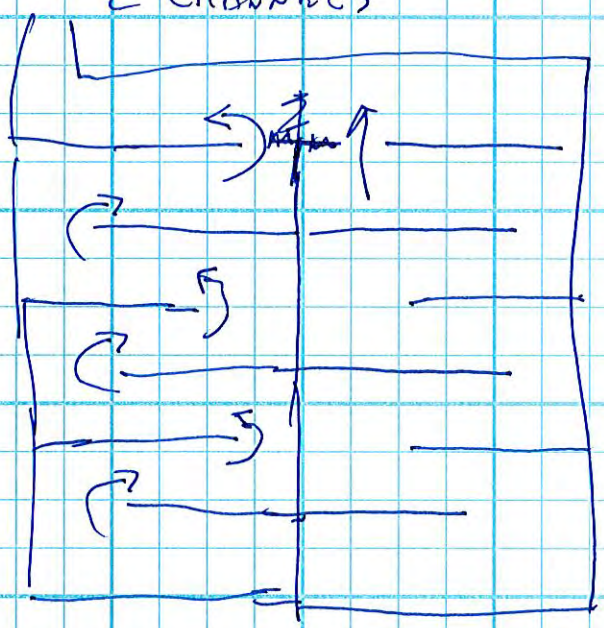
GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 18 OF _____

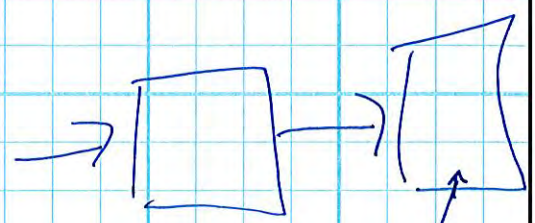
CCT's

2 CHANNELS



2 SAMPLER PUMPS

· BAY PARSHALL



DISINFECTION

STRATUS

~~SAMPLER~~ ORP PROBE

~~SULFUR DIOXIDE CONTROL ROOM~~

(2) BISULFITE FEEDERS - U.S. FILTER

2 BISULFITE TANKS

(2) ~~SODIUM HYPO~~ BISULFITE DAY TANKS

(2) SODIUM HYPO TANKS

(2) US FILTER FEEDERS

(1) GLI INTERNATIONAL CHLORINE ANALYZER

GREELEY AND HANSEN

PROJECT Ina Road ROMP	PROJECT # Civil Structural
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE 6/13/06 CDK BY _____ DATE _____ SHEET 19 OF _____

OUTFALL

- 6' ϕ FLUME INSIDE 10' ϕ FLUME
- U.S. FILTER BUBBLER
- STRANTROL 890 TRANSMITTER
- ORP ANALYZER
- TWO SIGMA SAMPLERS

22.4 MGD 98 MVOLTS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Structure: 6 EMERGENCY OVERFLOW BASINS

Type of Service (1): STORM OVERFLOW, DUMPING FROM COLLECTION SYSTEM

(1) Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments:
- 3 TANKS ⇒ #1 OVERFLOWS TO #2 WHICH OVERFLOWS TO #3. THEN DRAIN BACK TO #1
- HOLD 18-19 MILLION GALLONS TOTAL
- #1 PUMPED TO HEADWORKS
- MOST LIQUID EVAPORATES
- MAJOR ODORS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/04 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Structure: HEADWORKS BUILDING INCLUDING COARSE SCREENS, FINE SCREENS, SCREEN + GRIT WASHING

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 5 1/2 years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: ~~OTHER~~ · NO SKYLIGHTS SO CANT GET EQUIPMENT OUT

· DRAINS UNDERSIZED ON GRIT WASHERS SO ~~FR~~ ROOM CAN FLOOD

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: ~~B~~ COARSE SCREENS (2) U.S. FILTER ~~[illegible]~~ RAKE ARM

Manufacturer / Model: _____

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · 25 MGD EACH, ROOM FOR 3RD

· SERPENTEX BELT CONVEYOR

· CAN BYPASS CONVEYOR INTO MANUAL CART

· RAW INFLUENT SAMPLING DONE AFTER GRIT TANKS

· MANUAL OPERATED GATES, HAVE SEALING PROBLEMS

Additional Comments: · DOOR CONTROL IN CORNER OF ROOM

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: SCREW PUMPS (3)

Manufacturer / Model: INVENSYS MOTOR SPONS BABCOCK COUPLING

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · ROOM FOR 4TH

· #1 + #3 HAVE GREASELESS SYSTEM, #2 HAS OLD OIL LUBE SYSTEM, BUT WILL BE REPLACED

· TOTALLY ENCLOSED W/ ODOR CONTROL

· MANUAL GATES

Additional Comments: · RUN LOCALLY 32 MGD EACH

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: FINE SCREENS (3)

Manufacturer / Model: PARKSON AQUA GUARD

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · ROOM FOR 4TH

· NORMALLY RUN 2 SCREENS, 1 IN LOCAL ALWAYS GOING WITH SECOND ON TIMER THAT CONTROLS BELT, WASHER, AND PRESS

· HAVE MANUAL CART BYPASS

Additional Comments: ODOR CONTROL IN CORNER, ODOROUS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- LONG SERPENTINE BELT COLLECTS FROM 3 SCREENS AND DISCHARGES TO SHORTER REVERSIBLE BELT TO (2) WASHERS
- HIGH LEVEL ALARM SHUTS DOWN SCREW PUMPS
- SCREEN THAT IS OUT OF SERVICE DISCHARGES INTO PUSH CART FOR A DAY BECAUSE OF ROCKS WHEN PUT BACK IN SERVICE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: (2) SCREEN WASHER AND SCREEN COMPACTOR (2)

Manufacturer / Model: WATERLINK HYCOR (BOTH)

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • ODOROUS

• ROCKS WEARING DOWN WASHER RAPIDLY, ROCKS BREAK BRUSHES, SO IT IS ALWAYS IN FULL MODE AND NEVER EMPTIES

• EACH WASHER DISCHARGES INTO A SPECIFIC PRESS

• PRESS DOES NOT PRESS ANYMORE BECAUSE OF GREASES AND CRACKING

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/00 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Structure: GRIT TANKS (3)

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: · AERATED TANKS DISCHARGE INTO COMMON HEADER W/ PARSHALL FLUME AT END.

· MANUAL GATES

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: GRIT WASHERS (3)

Manufacturer / Model: WEMCO HYDRO GRITTER

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · UNITS OK, BUT DRAIN UNDERSIZED, SO FLOODING POSSIBLE.
· ODOROUS, DUCTWORK IN CORNER
· DRAINS SLOPED WRONG WAY
· 3 UNITS, BUT ONLY 2 FEED LINES

Additional Comments: · TWO TYPICALLY RUNNING

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: HEADWORKS ODOR CONTROL

2 FANS, 2 WET SCRUBBERS, 6 CARBON TANKS

Manufacturer / Model: _____

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · WET SCRUBBERS PLUGGED DRAINS, COULDN'T CLEAN SO HAVENT BEEN USED IN 3 YEARS

· CARBON DESIGNED FOR 5 YEARS, BUT ALREADY BEYOND THAT AND STILL OK

· SAVE LOTS OF ENERGY BY NOT USING WET SCRUBBERS

Additional Comments: · DRAIN LINES INSULATED

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- FANS NEW YORK BLOWER
- ODOR CONTROL CHEMICAL PUMPS - FYBROC
- CHEMICAL SCRUBBER → METRO CORP. DURL DIVISION

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: BLOWERS FOR GRIT TANKS (4)

Manufacturer / Model: UNIVERSAL BLOWERS PAC INC.

Age of equipment: 5.5 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · USUALLY RUN TWO

· MANUAL GUIDE VANES

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: GRIT PUMPS (5)

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · 3 GRIT PUMPS PUMP GRIT TANKS #1 AND #2, 2 GRIT PUMPS PUMP GRIT TANK #3
· CONTINUOUSLY RUNNING
· COMPRESSOR (INGERSOLL RAND) UNDER STAIRS IN ADJACENT STAIRWELL TO BE RELOCATED

Additional Comments: · SIGMA 900 SAMPLERS AT PARSHALL FLUME

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- SUMP PUMPS IN ROOM ADJACENT.
- BIG GREASE TRAP THAT IS VACUURED OUT ONCE PER WEEK

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Structure: HPO STREAM PRIMARY CLARIFIERS (4)
1/2 MILLION GALLONS EACH

Type of Service (1): _____
(1) Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 25 ~~YRS~~ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments:
- TOTALLY COVERED W/ CONCRETE
- ODOR CONTROL → WET SCRUBBER
- RECYCLE COMES HERE
- 2 SECTIONS PER CLARIFIER
- CENTRATE TRANSFER LINE COMES HERE BECAUSE OF STRUVITE PROBLEM
- TWO SCUM PITS, 10 YEARS AGO PUT IN HELICAL SKIMMERS, NOW CANT PUMP SCUM W/O ADDING WATER

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: 4 PC COLLECTOR DRIVES (WALKER PROCESS), 6 PRIMARY SLUDGE PUMPS (WEMCO)

Manufacturer / Model: _____

Age of equipment: 1970's years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time 8 hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · 4 MUFFIN MONSTER GRINDERS
· 4 ALLIS CHALMER DEWATERING PUMPS
· 2 GORMAN SCUM PUMPS
· EQUIPMENT HAS BEEN REBUILT SINCE PUT IN
SO IN GOOD RUNNING CONDITION

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: DAVE G.

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: HPO OXYGEN REACTOR

Manufacturer / Model: _____

Age of equipment: 1970'S years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · 4 SYSTEMS 3 UNITS EACH ⇒ 12 LIGHTNING MIXERS
· TOTALLY COVERED
· (1) AURORA PUMP DEWATERING PUMP
· HAD A SERVICE CONTRACT THAT RAN OUT, SO HAVEN'T BEEN SERVICED FOR LONG TIME

Additional Comments: · FOAM SUPPRESSION SYSTEM NEVER USED
· MAINTENANCE INTENSIVE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: OXYGEN REACTOR HPO PLANT

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: · COVERED W/ CONCRETE
· ONE BIG BREAK (NOT THROUGH SLAB) ON TOP
· CAN'T GET IN, SO DON'T KNOW WHAT INSIDE IS LIKE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: HPO PLANT FINAL CLARIFIERS

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: • VERY DEEP SIDE WALLS
• DOAR OLIVER DRIVES, ORIGINAL, NEED MAINTENANCE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: RAS/WAS BUILDING HPO TRAIN

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments:
- RECENTLY FLOODED
- ~~ALL MANUAL VALVES~~ RAS VALVES MOTORIZED
- PACKED WITH PIPES AND PUMPS
- VFD'S FOR WAS + RAS IN VACUUM FILTER BLDG.
- RAS PUMPS PUT IN LATE 80'S
- WAS PUMPS PUT IN SINCE THEN
- ALL PUMPS + MOTORS BEING PULLED AND CLEANED SINCE FLOOD

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: VACUUM FILTRATION BLDG. HPO TRAIN

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: ONLY USED FOR 1) CAB, 2) ELECTRICAL GEAR 3) VFD'S FOR WOS + RAS 4) STORAGE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: (1) GRAVITY THICKENERS / DAF TANKS (3) HPO TRAIN

Type of Service (1): _____

(1) Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: ORIGINALLY ALL TANKS GRAVITY THICKENERS

- IN 1980's #2 + #4 TURNED INTO DAF TANKS
- IN 1990's #1 TURNED INTO DAF TANK
- ODORS IN BUILDING

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: DAF / GT EQUIPMENT

HPO TRAIN

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: 1) DAF PREPROCESS RECIRCULATION PUMPS BTWN TANKS #1 + #3 => SPLIT FOR THIRD => 2 KAESER AIR COMPRESSORS => 1 WESTECH PRESSURIZATION TANK => 2) DAF RECIRCULATION PUMPS BETWEEN #2 + #4 => 3 PREPROCESS PUMPS => 2 PRESSURIZATION TANKS (OVER TO BE REPLACED) => NO COMPRESSORS

PUMPS TO BE REPLACED

Additional Comments: (b) CENTRIFUGAL PUMPS THICKENED SLUDGE PUMPS IN BASEMENT PUMPS REPLACED IN LATE 80'S

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- DAF TANK DRIVES FEIMCO
- GRAVITY TANK DRIVE WESTECH
- SPLITTER BOX FEEDS #1 AND #3 OR #2 AND #4

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: DIGESTER 8 (4) HPO TRAIN

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments:
- ALL PRIMARY TANKS
- 3 TANKS HAVE FOUR EDT MIXERS + 1 CENTER MIXER
- 1 TANK HAS ONE ENERSAVE FLUID MIXERS INC PLUNGER TYPE PUMP
- #1 + #3 FIXED COVERS
- # 2 + #4 FLOATING COVERS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: DIGESTER EQUIPMENT HPO TRAIN

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil (1)	4	3	2	1

(1) Piping, valves, and other appurtenant devices

Additional Comments: • METHANE GAS COMPRESSORS – THE NATIONAL WELDING + MANUFACTURING CO. (GOOD)
• 4 HEAT EXCHANGERS => 2 NEW ELMCO, 2 OLDER ~~NOOD~~ DIDN'T SEE NAME PLATE (GOOD CONDITION)
• HOT WATER SYSTEM PUT IN 1980's

Additional Comments: HOT WATER PUMPS FOR HEX'S (4) PRESSURES PUMPS (GOOD)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- (4) WEMCO HEX PUMPS (GOOD)
- (2) SERVICE WATER PUMPS (GOOD)
- VAREC SLUDGE GAS EQUIP. (GOOD)

- (4) WATSON MARLOW SLUDGE PUMPS (GOOD) w/
  (4) MUFFIN MONSTERS (GOOD)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: SERVICE WATER BLDG. HPO TRAIN

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 1970's years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: BUILDING IN GOOD SHAPE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: SERVICE WATER BLDG. EQUIPMENT

HPO TRAIN

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • (3) WORTHINGTON COOLING WATER PUMPS

• (2) CHLORINE WATER BOOSTER PUMPS

• (4) FAIRBANKS SERVICE WATER PUMPS (RECENTLY REPLACED)

• (1) SUPER CHARGER HEX, COOLING WATER FOR ENGINES (NOT USED, SO HOT)

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: CENTRIFUGE BUILDING HPO TRAIN

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments:
- 5 HOLDING TANKS 120,000 GAL EACH
- TANK #2 CENTRATE
- TANK #3 THICKENED SLUDGE HOLDING TANK
- TAN # 1A, 1B, 1C IN A + ROOM DIGESTED SLUDGE
- ODORS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: · HPO TRAIN CENTRIFUGES

Manufacturer / Model: ALFA LAVAL

Age of equipment: 2 1/2 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · THICKEN TO 8%

· 4 REEVES FEED PUMPS PUTIN MID 80'S (GOOD CONDITION)

· 3 CAKE PUMPS 2) & ONE SCHMING (2 1/2 YRS OLD) IF THEY BURN GO TO THICKENING, 2 REEVES PUMPS (GOOD CONDITION)

· 2 MOYNO PUMPS PUMP THICKENED SLUDGE TO BLADDER

Additional Comments: · 4 HYDROMATIC PUMPS PUMP OTHER TANKS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- PUMPS 6A + 6B CONCENTRATE PUMPS PUMP TO PRIMARIES
- 3 REEVES POLYMER FEED PUMPS (MID 1980'S) (GOOD CONDITION) ⇒ 1 VIKING PUMP (2½ YRS OLD) (GOOD CONDITION)
- ONE SMALL CARBON ODOR UNIT } UNDERSIZED!
- 2 LARGE CARBON UNITS } DESIGNED FOR 8 HRS PER DAY, BUT NOW ITS 24 HRS/DAY
- CHEMICAL SCRUBBER FROM FILTER BLDG. MAY BE MOVED HERE TO HELP W/ ODOR CONTROL
- PIG RECEIVING UNIT HERE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: BLADDER SYSTEM

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	(3)	2	1

Additional Comments: TOP OF BLADDER RECENTLY REPLACED, BUT NO ONE KNOWS CONDITION OR BOTTOM

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒ X

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: OXYGEN PRODUCTION BLDG.

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/12/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: OXYGEN PRODUCTION EQUIPMENT HPO TRAIN

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • (2) CHILLED H_2O PUMPS
• (3) UNION CARBIDE O_2 GENERATION UNITS (OUTSIDE)
• (3) JOY MANUFACTURING CO. O_2 GENERATION COMPRESSORS
• (1) BASCO INC. AIR COOLER

Additional Comments: • (1) WILKERSON REFRIGERATED AIR DRYER

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☒

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Structure: HPO TRAIN CCT

Type of Service [1]: _____

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

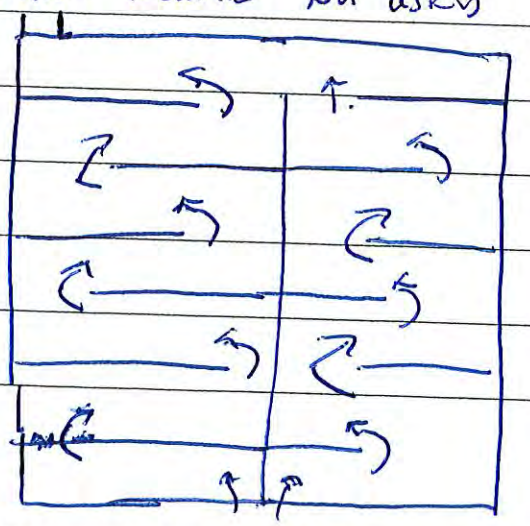
Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: 2 CHANNELS " URRS UNDERSIZED

PARSHALL FLUME NOT USED



PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☑

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 6/13/06 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: HPO CGT EQUIPMENT

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments:
- (2) US FILTER BISULFITE FEEDERS
- (2) BISULFITE TANKS
- (2) HYPO TANKS
- (2) US FILTER HYPO FEEDERS
- (1) GLI INTERNATIONAL CHLORINE ANALYZER

Additional Comments:
- STRANCO ORP PROBE

Appendix B

Condition Assessment Data

Civil-Structural Field Assessment Roger Road

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/23/06 SHEET 1 OF _____

- 3 PARKSON AQUAGUARD CLIMBER SCREENS
- 2 SMITH + LOVELESS (PISTA) GRIT TANKS MODEL 50
- GATES - RODNEY HUNT
- TWO SIGMA 900 SAMPLERS (SAMPLER A + B)
- TWO ROTOPRESS R.P. 200 MODEL SCREENINGS PRESSES TO BE REMOVED
- TWO GRIT WASHERS
- THREE PARSHALL FLUMES (ONE NOT IN SERVICE HAS GATE)
- PRIMARY CLARIFIERS # 5-10
- PUMP STATION #3 3 MOYNO PUMPS (PROGRESSING CAVITY)

PUMPS 1 AND 2 ~~SP-1 AND 2~~ PUMP SLUDGE TO BIOTOWER ~~SP-1~~ PUMP 1 ~~SP-3~~ PUMP 3 ~~SP-2~~ PUMP 2

PUMP 3 ~~SP-3~~ PUMPS SCUM

SCUM AND SLUDGE HAVE A CROSS CONNECTION

METER SLUDGE NOT SCUM DWP-1 DEWATERING PUMP

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/23/06 SHEET 2 OF _____

PUMP STATION #14

PSP-1 THROUGH PSP-7
ALL SEPTIX PUMPS

PSP-1 THROUGH PSP-5 PUMP PRIMARY SLUDGE FROM PC 1,2,3,4,9,10 TO DIGESTERS OR ~~[illegible]~~ GRAVITY TANKS (BOTH WAYS MISTAKEN)

PSP-6 + 7 TAKE PRIMARY SCUM FROM 1,2,3,4,9,10 TO DIGESTERS

PUMP STATION #5

JUST LIKE PUMP STATION 3

PSP-1 PSP-3 PSP-2

PSP-1,-2 and -3 MOVING PC

PUMP STATION #4 RIO RECIRCULATION BUILDING

BRP-1,-2,-3,-4 BRP-4 ENGINE DRIVEN

FAIRBANKS-MORSE 60" 2 STAGE

TWO ENGINES RUN ONE STANDBY
ELECTRIC IS RUN ABOUT 55 MGD AS A SUPPLEMENTAL PUMP OR IF ENGINES ARE DOWN.

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/00 SHEET 3 OF _____

PUMP STATION #7

WAS PUMPS 1, 2, 3 ITT-AC PUMPS

#3 w/ AFD RUNS OR #1 AND #2 w/o AFD RUN

24 HRS/DAY RUNS WAS TO GRAVITY THICKENERS

* GOING TO SEND WAS TO INA, SO THEY CAN CLEAN A DIGESTER

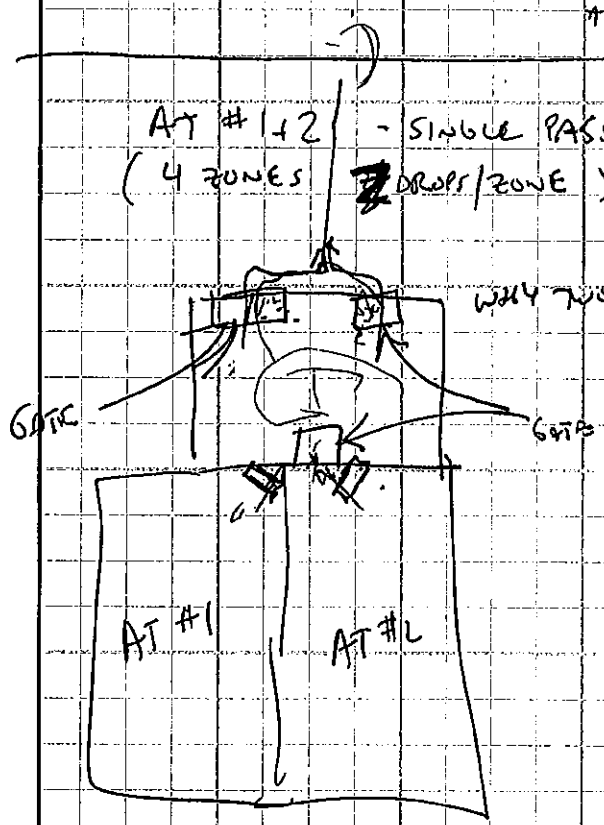
BF 7 BUBBLER CONTROLS ? ALWAYS CLOSED

WAS DESIGNED TO LET RAS AND BIOFILTER UNDERDRAIN TO WET WELL. NOT DOING THIS.

AT #1 + 2 - SINGLE PASS TANKS
(4 ZONES 7 DROPS/ZONE) × 2 VALVES

5'-0"
VALVE UPSTREAM OF METER SHOULD BE 5¢ DOWNSTREAM

WHY TWO GATES



→ 2

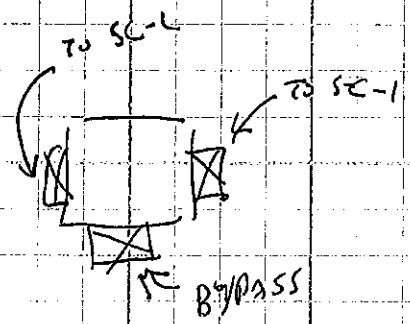
GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 4 OF _____

SECONDARY CLARIFIERS 1+2

FED FROM AT #1+2
- 2 WALK BRIDGES
- EIMCO



PUMP STATION #2

MAKE UP WATER PUMPS MWP-1, 2, 3
ALLIS-CHALMERS CENTRIFUGAL PUMP MODEL 100

4TH PUMP THAT GOES SOMEWHERE ELSE

PUMP STATION #8 2,100 gpm

THREE RETURN SLUDGE PUMPS PACIFIC PUMPING CO.
CAT # 52-S1815-089300

RSP-1, -2, -3

FSP-1, -2 NETZSCH SCUM PUMP

GREELEY AND HANSEN

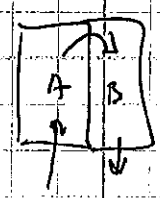
PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

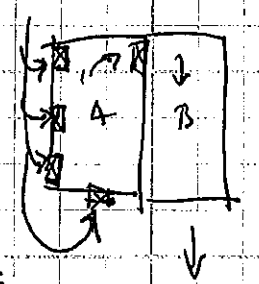
COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 5 OF _____

AERATION TANKS 3-6

COULD DO STEP FEED

TWO PASSES





VALVE 1' DOWNSTREAM OF ORIFICE PLATE

BLOWER BLDG.

NATURAL GAS BEING USED. COULD BE DIGESTER GAS, BUT NOT CLEAN. WILL BE STANDBY IN THE FUTURE

Pump Station #6

THREE RETURN SLUDGE PUMPS RSP-1, -2, -3

ALLIS-CHALMERS MODEL 150

FSP-1, -2 FINAL SCUM PUMPS NETZSCH

METER RETURN SLUDGE INTO WET WELL THEN SUCK OUT OF WET WELL

HOW CONTROLLED, WHERE TO

?

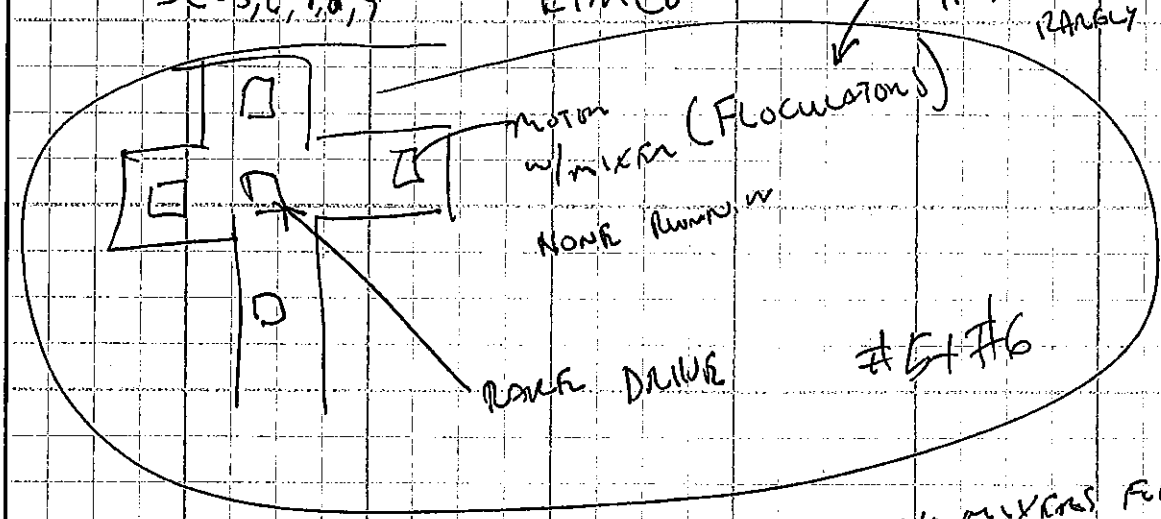
GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 6 OF _____

SECONDARY CLARIFIERS

SC-5,6,7,8,9 EIMCO



NO MIXERS FOR 7,8,9

RAKE ARM CATCHES ON WEIRS, WHICH SHOULD BE ON OUTSIDE RATHER THAN INSIDE SC-5,9,10

PUMP STATION #R BUILT IN 1992

TWO MOTNO SCUM PIPES
SEND SCUM TWO LOCATIONS 1) OUT HEADWORKS 2) TO RETURN SLUDGE

TWO RETURN SLUDGE PUMPS ONE TAKEN APART.
FAIRBANKS MORSE SPOT FOR OVER IN FUTURE

HAVE HAD TWO REPACKING. OTHERWISE GOOD PUMPS
W/ THIS CASING.

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06	SHEET 7 OF _____

Pump Station #10

THREE RETURN SLUDGE RSP-1, -2, -3 FAIRBANKS MORSE

1 STANDBY

TWO FINAL SCUM FSP-1, -2
NETZSCH

WHY RETURN SLUDGE TO SCUM LINES (TO BLOW OUT LINE)

Pump Station #9

2 RUN, 1 STANDBY

FSP-1, FSP-2 SCUM PUMPS NETZSCH

RSP-1, -2, -3 FAIRBANKS MORSE

WHY RETURN LINE INTO SCUM LINE (TO BLOW OUT LINE)

Pump Station #1

THREE MAKE-UP WATER PUMPS NONE RUNNING

MWP-1, -2, -3 AURORA

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/27/06 SHEET 8 OF _____

CHLORINE CONTACT BUILDING

NOT USED → (CHLORINE GAS EVAPORATORS WERE NOW NOT USED)

BULK ~~HEO~~ CHLORINE FACILITY

CHLORINE ANALYZERS (TWO) USED

ANALYZER #1 WALLACE + TIERNAN (MICRO/2000 ANALYZER)

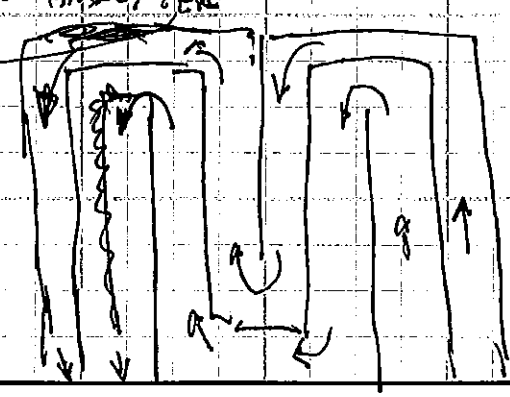
" #2 U.S. FILTER (WALLACE + TIERNAN) (MICRO/2000 ANALYZER)

SODIUM HYPO

2 TANKS IN DIRT BERM (TEMPORARY) WILL BE REPLACED W/ LARGER TANKS IN CONCRETE CONTAINMENT AREA.

- NORTH AND SOUTH U.S. FILTER. FEED SYSTEM LVN-2000 NO AIR CONDITIONING IN HOUSE
- TWO MILLTRONICS HYDRORANGERS (FOR HOLDING TANKS (NOT HOOKED UP)
- TWO U.S. FILTER WATER CHAMPS (NORTH + SOUTH)
- SAMPLE PUMPS (TWO) SEND TO ANALYZER

CHLORINE CONTACT TANK



GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/86 SHEET 9 OF _____

SODIUM BISULFITE

BULK STORAGE TANK W/ CONCRETE CONTAINMENT PUMPS TO DAY STORAGE TANK W/ CONCRETE CONTAINMENT.

TWO NORTECH SCUM PUMPS, ~~ONE IN~~ DRAW OFF SCUM WELL, SCUM SKIMMERS IN CCT

~~ONE~~ TWO U.S. FILTER LUN-2000 FERRI SYSTEMS

NORTH + SOUTH SODIUM BISULFITE INJECTORS

5 NON POTABLE WATER PUMP/

(1) GOULDS ~~HT~~ MODEL VIT FT 425 GPM 158 TDH

(4) GOULDS MODEL DWJ

~~5 ABOVE USED TO BOOST WATER FOAM~~

ONE YARD IRRIGATION PUMP PEABODY

TWO PORCHARL FUMES

EFFLUENT PUMPS

SPOT FOR FUTURE 4TH

FAIRBANKS MORSE MODEL CASLOAD FLOW 2400

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 10 OF _____

- PRIMARY 5,6,7,8 PUMPS RUN 9 MINUTES OFF 1 MINUTE 24 HRS/DAY
- PRIMARY 9,10 PUMPS RUN 7 MINUTES OFF 3 MINUTES
- ALL PRIMARIES PUMP TO GRAVITY THICKENERS
- EFFLUENT FROM SC-1 AND SC-2 IS MAKEUP WATER SOURCE FOR P.S. #2
- EFFLUENT FROM SC-3 AND SC-4 IS MAKEUP WATER SOURCE FOR P.S. #1
- ALL ~~MAKE~~ THICKENER EFFLUENT GO TO Y.S. #1
- MAKEUP WATER TO GRAVITY THICKENERS
- FLUSH WATER PUMP TO FLUSH LINE TO INA IS 4TH PUMP IN P.S. #2
- SAND WAS TO INA ROAD. THEN CAN TAKE ONE GRAVITY THICKENER AND DIGESTER OUT OF SERVICE
  - PUMP #3 IN P.S. #7 TO MAINTENANCE BUILDING TO HOSE TO PUMP STATION
- 11 1/2" TO 13" INCHES H_2O COLUMN AT DIGESTERS

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 11 OF _____

~~METERING~~ THICKENER METERING BUILDING

MAKEUP WATER TO GT-1, ~~[illegible]~~ -2, AND -3 (EACH METERED

1) WAS TO GT-1 + 2
2) WAS TO GT-1 AND -2
3) WAS TO GT-3

METERING

METERING PRIMARY SLUDGE IN 3 LINES

GRAVITY THICKENING TANKS (3)

- TWO OPERATED AT ONE TIME
- STRUCTURAL WORK DONE TO CONCRETE
- ~~EACH [illegible]~~ AN ODOR UNIT TANK 3 HAS A UNIT
- SCUM COMES THROUGH A GRINDER TO EACH TANK (MUFFIN MONSTER)

TANKS 1 AND 2 HAVE

THICKENED SLUDGE PUMPS TSP-1, 2, 3 MOYNO PC PUMPS

CENTER DRIVE MECHANISM INSIDE (COVERED) HAZARDOUS SPACE

- AIR HANDLING UNIT ON ROOF, BUT NOT ON

- ODOR UNIT ROSSWOOD INDUSTRIES CHEMICAL SCRUBBER

- MILTON ROY MODEL # C77 - SODIUM HYP FEED
- NO CAUSTIC BEING USED

- GT NO. 3 CHEMICAL RECIRC PUMP IMO WARREN PUMPS

- ODOR #3

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY A. Martin DATE ____ CDK BY ____ DATE 5/24/06	SHEET 12 OF ____

GRAVITY TANK No. 3

TSP-4, -5, -6 MOYNO PUMPS

~~RG~~ SCUM HAS ONE GRINDER w/ ROOM FOR 1 FUTURE

SEPTAGE PUMP STATION

- TANKS TILTED WRONG WAY
- ODORS NOTICEABLE
- CYCLONE FEED PUMPS CFP-1, -2

  ESSCO TORQUE FLUID PUMP (LOS ANGELES)
  MODEL 4X16H DPL

- DEGRITTED SEPTAGE PUMP
  DSP-1, -2 SAME PUMP AS CFP'S
- TRUCKS DUMP TO WET WELL, CFP'S PULL OF WET WELL TO CYCLONE. SOLIDS TO DUMPSTER. LIQUID TO EQ. BASIN
  DSP'S PULL OF EQ. BASIN
- ONCE A MONTH HOVE TO VACTOR OUT EQ. BASIN

  ~~SCUM PUMP~~
- DSP'S METERED
- DUMPSTER COVERS OPEN, SIZE SMALL

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 13 OF _____

ODOR UNIT CHEMICAL SCRUBBER
- FYBROC CHEMICAL PUMP
- CHEMFLEX UNIT

TWO CYCLONE INTO AUGER DODGE?

MDI - EB (EQ. BASIN MIXER

ANCO MIXERS

MODEL 325V - 15 X 8P

DAF THICKENERS

CAN'T GET PARTS SO THEY DON'T RUN DAF'S. COULD RUN THEM, BUT THEY WOULD REQUIRE OPERATOR TO WATCH AND CONTINUOUSLY MAKE AIR ADJUSTMENTS

TWO KOMLINE DAF'S

TWO MOYNO PUMPS

SDT #1 AND #2 BUILDING

DXH-1 AND DXH-2 RALPH B. CARTER COMPANY MODEL # HO-92042

DCP-1 CRAWL PUMP UNIT A60 VARTEC SLUDGE GA.
DCP-2

SPB-1, -2, -3 PELIGRO PUMPS

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 14 OF _____

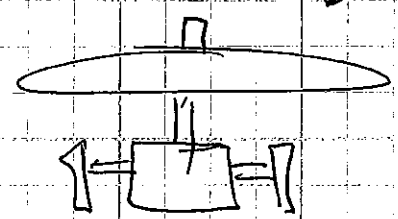
* EACH DIGESTER HAS ITS OWN BURNER

* CONTROL HOUSE #2 (SOT #3 + #4)

DXH-3 CARTER

SRP-4, -5 PELIGRO

SRP-6, -7 PELIGRO



GAS COMPRESSORS #1, #2, #3
HY-BOW ENGINEERING CO.
MIDLAND, TX

CHILLER
TRANE

DIGESTER #5 (CONTROL HOUSE #3)

ONE PUMP SRP-7? PELIGRO?

HOUSE

SP-1, SP-3 ESSCO PUMP

SP-3 PUMPING WAS TO I-10 RAD

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 15 OF _____

SDT #3 Roof

RIGHT (SOUTH) VALVE CONTINUOUSLY HISSING

9" W.C. PRESSURE

2" W.C. VACCUUM

SDT #6 CONTROL HOUSE #4

~~SP2~~ STP 2-S VAUGHAN

WEMCO TORQUE FLOW PUMP

STP-1

CDPB-S CDPA-S PACO

HOT WATER RETURN

↓

PACO PUMPS

↓

HOT WATER SUPPLY

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 16 OF _____

~~① CHANGE ORDERS~~
~~• 24" PIPE~~
~~TRANSFORMERS~~
~~② SPEC~~
~~③ SCHEDULE~~
~~④ FUTURE PLANS~~

RON RISKA

JOHN SHERLOCK OPERATIONS MANAGER
PETE MAGADDINO TRADES MAINT. FOREMAN
JACK VANRIPER MAINT. MANAGER
HELEN RUDY SUPT.

• STEVE GARRICK - OPERATIONS (WED.)

TIM HALLON - I+C

PAY 16-18 CENTS/KW

HEADWORKS

• 3 COVERED PARKSON 6mm BAR SCREENS (TWO OPERATE AT ONE TIME)
• SG UPSTREAM OF EACH SCREEN
• ALL SCREENS DISCHARGE INTO COVERED ~~SCREW~~ BELT CONVEYOR
• SG DOWNSTREAM OF EACH SCREEN
• TWO SCREENINGS WASHER COMPACTORS

BELT DISCHARGES INTO COMPACTORS DISCHARGE BACK ONTO SAME BELT

• TWO GRIT WASHERS DISCHARGE ONTO BELT
• BELT DISCHARGES INTO DUMPSTER
• DUMPSTER FILLS IN ABOUT A DAY THEN HAULED OFF

WATCH MUFFIN 40,000 TO REPLACE SERIES FOR THE SCREENING WASHER

GRIT
• TWO COVERED VORTEX STYLE GRIT TANKS

INCREASING BOD 40 mg/L DURING PILOT TEST

GRIT WASHERS BEING REPLACED W/ SMITH + LOVELESS 17' UNIT

ALL DONE BY DECEMBER 2006

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 17 OF _____

COVERED CHANNEL AFTER GRIT

PC #9+10 FED DIRECTLY FROM CHANNEL

PC #5-8 FED FROM YARD STRUCTURE #1

SIDESTREAM FLOW TO Y.S. #1 ALSO

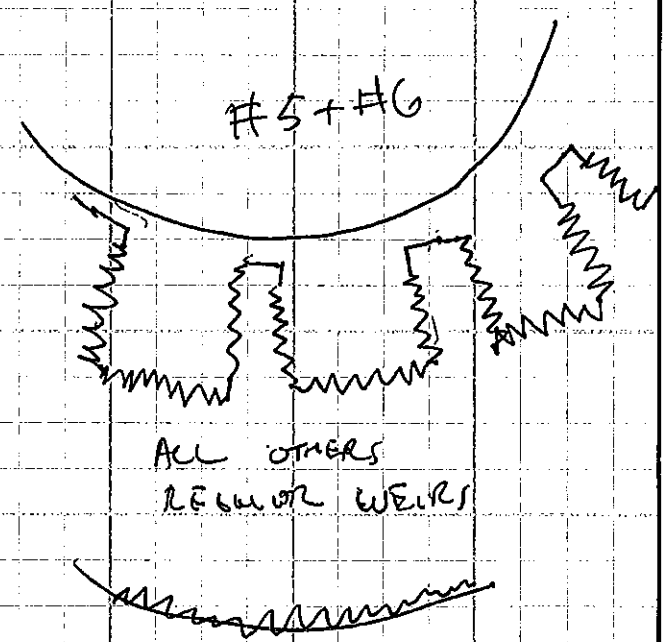
NO METERS ON ANYTHING

· ALL GATES MANUAL & BALANCE VISUALLY

PRIMARY CLARIFIERS

· TWO RAKE ARMS
· CENTER COLUMN

#5 + #6 LOWER THAN #7 + #8 SO GET MORE SOLIDS



GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CHK BY _____ DATE 5/24/06 SHEET 18 OF _____

BIO TOWERS

3 ENGINE DRIVEN PUMPS
1 350 HP MOTOR DRIVEN PUMP

PUMPS PUMP INTO TWO BIO TOWERS

- MANUALLY ADJUST RPM ON ENGINE DRIVEN PUMPS
- CURRENTLY MOTOR PUMP NO VFD, BUT IN DESIGN TO PUT VFD IN.
- SPACE FOR 5TH PUMP, NEED 5TH MOTOR DRIVEN PUMP, WANT WITH VFD

---

3 GAS FED ~~BIO~~ ENGINES

TWO BIG AIR TANKS TO START THE ENGINES
OVER SMALL AIR TANKS

NO SCRUBBER SYSTEM, SO SILENCERS GET PLUGGED WHEN THEY RUN ON METHANE, SO THEY RUN ON NATURAL GAS.

- CHANGED DRIVE AND ARMS 5 OR 6 YEARS AGO
- MEDIA IN BIOTOWERS SINCE 1979
- BIOTOWERS HAVE BREAKTHROUGH SO SENDING FLOW TO AERATION TANKS BEFORE FINAL CLARIFIERS FOR TWO YEARS FOR EXTENDED AERATION AND IT WORKS
- MP DOING STUDY ON BIOTOWERS AND MEDIA

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 19 OF _____

PS#7

- 3 WASTING PUMPS
- USUALLY RUN ONE BIG ONE OR TWO SMALL ONES
- FROM BIOTOWER TO GRAVITY THICKENER
- MAX WASTE 1200 GPM BECAUSE OF 6" LINE
- BIG ONE HAS VFD
- JUST ROUTINE MAINTENANCE NEEDED

AERATION TANKS 1-2 2,000,000 GAL CAPACITY 200-600 mg/L MIXED LIQUOR

AT'S 3-6 2.88 M GAL CAPACITY ML ~~[illegible]~~ 100-500 mg/L

~~ONE~~ NORTH TOWER TO 3-6
SOUTH TOWER TO 1-2

AT 1-2 SEND TO SECONDARY CLARIFIER 1 AND 2 AND SOME TO ~~[illegible]~~ 3 AND 4

AT 3-6 SEND TO " " 3+4, 5+6, 7+8+9

- AIR SYSTEM VERY COARSE
  DISTRIBUTION CONS DESIGNED FOR MIXING

AT 3-6 EACH TANK HAS A+B CHANNEL INTO 1 OUT OF 3

AT 1-2 ONE CHANNEL EACH

- NOT CERTAIN 1 TANK CAN COME OUT OF SERVICE FOR PREVENTIVE MAINT.

GREELEY AND HANSEN

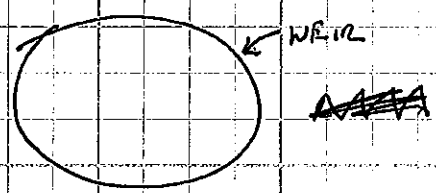
PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 20 OF _____

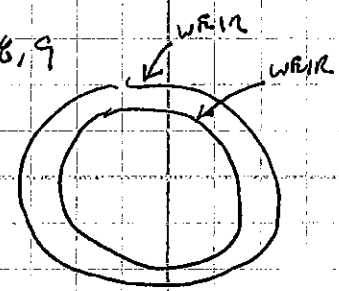
SECONDARY CLARIFIERS

- TWO RAKE ARMS
- CENTER COLUMN

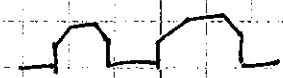
SC-1, 2, 3, + 4



SC-5, 6, 7, 8, 9



ALL TANKS



SECONDARY CAN TAKE ONE TANK OUT OF SERVICE FOR PREVENTATIVE MAINTENANCE.

SPLIT BOX FOR SC-5+6 HAS METER ON IT (TWO ~~GATES~~ DRIVES, ONE GATE PER SC)

Blowers

TWO BLOWERS HAVE TO BE RUN AT ONCE TO MAINTAIN 2 PLANTS

MANIFOLD TO TANKS 1+2 HAS LEAKS, BUT CAN ~~TAKE~~ TAKE OUT OF SERVICE. 8,000 cfm SENT TO 1+2, 3000 cfm SENT TO 3-6

ROOTS BLOWERS PUT IN IN 60's, NEW TURBICLE BLOWERS IN 90's

HAVE SPOT FOR A FUTURE UNIT

NEW ELECTRIC MOTOR DRIVEN UNITS GOING IN, ENGINE DRIVEN WILL BE STAND BYE, ENGINE DRIVEN NEED MAINTENANCE

GREELEY AND HANSEN

PROJECT Roger Road ROMP
SUBJECT Condition Assessment
PROJECT # Civil Structure
CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 21 OF _____

TWO TANKS TO BE PUT IN PERMANENTLY

TEMPORARY TWO SODIUM HYPOCHLORITE TANKS W/ DIRT BERM AROUND THEM

ONE SODIUM BISULFITE TANK W/ CONCRETE CONTAINMENT SYSTEM ~~EXTRA~~ THAT TRANSFERS TO DAY TANK

GRAVITY FEED TO TWO LIQUID V-NOTCH THEN TWO WATER CHANGES PUT INTO TANKS

SAME FOR BISULFITE SYSTEM

STARTERS + PRESSURE SWITCH JUST REPLACED

1) 5 PUMPS TAKE EFFLUENT FOR PROCESS WATER & FOR IRRIGATION
2) EFFLUENT GOES TO CITY PUMPS OUTSIDE FENCELINE
3) EFFLUENT GOES TO RIVER

EFFLUENT PUMPS &
- #3 OK
- #1 AND 2 PUMPS LOCKED UP AND DISCHARGE CORRODED WILL BE FIXED THIS YEAR

#3 RUN ONCE/WEEK TO STOP FROM LOCKING UP.

STORM WATER BASIN FULL OF CRACKS, WILL BE FIXED, NEW BASIN PUT IN W/ P.S. IN BETWEEN

PUTTING IN CAMERAS FOR SECURITY

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A.Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 22 OF _____

DIGESTERS

PRODUCE 20,000 CF of GAS
ONLY USE 7,000 CF, SO
13,000 BURNT

SILOXANE PROBLEM
SO NEED FILTER

EXTERNAL DRAFT TUBE MIXERS STRUGGLING BECAUSE DIGESTERS
HAVENT BEEN CLEANED

DIGESTER NO. 6 4 MIXERS

DIGESTERS NO. 1,2,3 3 TOP MIXERS
" NO. 4 0 MIXERS
" NO. 5 1 CENTER MIXER W/ HEAT EXCHANGER JACKET

ADDITIONAL HEATING NEEDED

- VACUUM CHOPPER PUMPS
- HAVE A STANDBY PUMP PER EACH STATION

STORAGE FOR GAS AND SLUDGE PRE-INA

SDT. NO. 3 CONCRETE LID W/ GAS BOX THAT LEAKS GAS

TWO SLUDGE PUMPS TO INA, ROOM FOR FUTURE ONE

ONE RUNS, ONE SPARE

CHILLER OK

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 23 OF _____

3 GRAVITY THICKENERS
MIXING PUMPS GOOD CONDITION

PRIMARY + WAS

WAS SPLIT EVENLY BETWEEN 2 TANKS ONE OUT OF SERVICE

GBT GOING IN THIS YEAR

SEPTAGE STATION
- 2 CYCLONE FEED PUMPS
- 2 DEGRITTED SEPTAGE PUMPS

TWO CYCLONE DEGRITTERS

VACTOR TANKS ONCE/MONTH

VERY MAINTENANCE INTENSIVE

NOT USED OFTEN

GREELEY AND HANSEN

PROJECT Roger Road ROMP	PROJECT # Civil Structure
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY A. Martin DATE _____ CDK BY _____ DATE 5/24/06 SHEET 24 OF _____

- 938,000 GALLONS WAS SENT TO INA
  810 gpm PUMPED

- ONLY ONE VALVE IN BLOWER BUILDING WORKS

1) AVRA VALLEY
   40,000 GAL/DAY 10,000 mg/l
2) RANDOLPH
   90,000 45,000 mg/l

OUTLYING FACILITIES

3) GREEN VALLEY

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: DIGESTER #6

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: EXTERNAL DRAFT TUBE MIXERS
1 BREAK BECAUSE DIGESTERS HAVENT BEEN CLEANED
IN 50 YEARS
• STP-1 WEMCO TORQUE FLOW PUMP
• VAREC GAS EQUIPMENT

Additional Comments: CPPB-S CDPA-S PARO PUMPS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- SPP 2-5 VAUGHN PUMP
- HAS ITS OWN FLARE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: CONTROL HOUSE #3 (DIGESTER #5)

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • SRP-7 PE LI 620

• UNREC GAS EQUIPMENT

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERRION

Phone Number of PCWMD Assessor: (520) 407-3721

Name of Equipment Item or Group: Common House #2 (Digesters #3 + #4)

Manufacturer / Model: ~~N~~

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	(3)	2	1
Electrical	4	3	2	1
Civil [1]	4	(3)	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • DXH-3 CARTER HEAT EXCHANGER
• SRP ~~[illegible]~~ -4,-5,-6,7 PELIGRO PUMPS
• CHILLER (TRANE)
• GAS COMPRESSOR #1,2,3 HY-BOW ENGINEERING Co. MIDLAND TEXAS

Additional Comments: EACH DIGESTER HAS A BURNER

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- EACH DIGESTER HAS TOP MOUNTED MIXERS
- DIGESTER # 3 LEAKS GAS CONSTANTLY THROUGH CRACK IN ROOF AND BLOW OFF VALVES
- VAREC GAS EQUIPMENT

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/27/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-7721

Name of Equipment Item or Group: SDT #1 AND #2 BUILDING

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • HEAT EXCHANGERS (DXH-1 AND DXH-2) RALPH B. CARTER COMPANY MODEL #HO-92042
• DCP-1, -2 CRANE PUMPS UNIT A60
• VAREK SLUDGE
• SPB-1, -2, -3 PELLETED PUMPS

Additional Comments: • EACH DIGESTER HAS ITS OWN BURNER

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- EACH DIGESTER HAS ROOF MOUNTED MIXERS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☑ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: DAF THICKENERS (2)

Manufacturer / Model: KOMLINE SANDERSON

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time NOT hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · ~~[illegible]~~ HAS BROKEN PARTS AND CANT GET REPLACEMENTS

· DONT USE PRESENTLY

· TWO MOYNO PUMPS

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520 - 407 - 3721

Name of Equipment Item or Group: SEPTAGE PUMP STATION

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · TANKS FOR SAMPLING PITCHED WRONG WAY, NO SAMPLING IS DONE

· ODORS VERY NOTICEABLE

· CYCLONE FEED PUMPS (CFP-1, -2) ESSCO TORQUE FLUID PUMP MODEL 4x16HDPL

Additional Comments: · DEGRITTED SEPTAGE PUMP (DSP-1, -2) SAME AS CFP-5

EQUIPMENT CONDITION ASSESSMENT

- WET WELL AND EQUILIZATION BASIN PLUG. EVERY MONTH A CREW GOES INTO WELL AND BASIN TO CLEAN OUT.
- TWO CYCLONES DEGRITS AND DISCHARGES TO DUMPSTER
- DSP.S METERED
- CHEMICAL SCRUBBER OUTSIDE DUMP STATION
- PYBROC CHEMICAL PUMPS

- EQ BASIN MIXER (MDT-EQ) ANCO MIXERS MODEL 325V-15XP

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: GRAVITY THICKENING TANKS (3)

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · STRUCTURAL REPAIRS DONE ON 1+2 · TANKS 1 AND 2 HAVE A CHEMICAL ODOR SCRUBBER. TANK 3 HAS A CHEMICAL SCRUBBER · GT-3 ODOR UNIT HAS NO CAUSTIC BEING PUMPED TO IT. · AIR UNITS ON ROOFS

Additional Comments: · CENTER DRIVE MECHANISM (HAZARDOUS LOCATION)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- TSP-1, -2, +3 (MOYNO PUMPS) FOR GT-1 + 2
- TWO MUFFIN MONSTER SCUM GRINDERS FOR GT-1+2
- ODOR UNIT IS ROSSWOOD INDUSTRIES CHEM. SCRUBBER
- GT No. 3 ODOR UNIT HAS MILTON ROY MODEL #C731 SODIUM HYPO FEED PUMP AND IMO WARREN PUMPS CHEMICAL RECIRCULATION PUMPS
- GT #3 HAS THREE MOYNO THICKENED SLUDGE PUMPS AND ONE MUFFIN MONSTER SCUM GRINDER

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 5/23/06

Name of Equipment Item or Group: THICKENER METERING BUILDING

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • MAKEUP WATER TO GT-1, -2, -3 EACH METERED

• METERING PRIMARY SLUDGE IN 3 LINES (TWO TO GT-1, AND -2 ONE TO GT-3)

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520 · 407 · 3721

Name of Equipment Item or Group: EFFLUENT PUMPS

Manufacturer / Model: FAIRBANKS MORSE MODEL CASCADE FLOW 24003

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · HAVE ROOM FOR FUTURE 4TH

· TWO PARSHALL FLUMES UPSTREAM

· TWO DON'T CURRENTLY OPERATE

· ONLY PUMP WHEN RIVER GRUFL IS UP

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520.407.3721

Name of Equipment Item or Group: NON POTABLE WATER PUMPS

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: SERVICE WATER PUMPS - (1) GOULDS MODEL VIT FT AND (4) GOULDS MODEL DWJ.
· PUMPS DRAW OF CCT EFFLUENT CHANNEL UPSTREAM OF DISINFECTION
GHE PEABODY YARD IRRIGATION PUMP

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520- 407-3721

Name of Equipment Item or Group: DISINFECTION

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • ONE BULK STORAGE SODIUM BISULFITE TANK FEEDS A DAY TANK. BOTH HAVE A CONCRETE CONTAINMENT WALL

• TWO U.S. FILTER WATER CHAMPS FOR INJECTION

• TWO ANALYZERS IN DECHLORINATION BUILDING

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: CHLORINE CONTACT TANK / CHLORINE FACILITIES

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

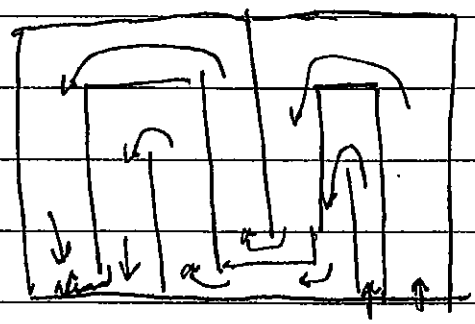
	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • WALLS INSIDE CCT ARE BLOCK
• TWO CHLORINE ANALYZERS (#1 + #2 WALLACE + TIERNAN MICRO/2000 ANALYZERS)
• TWO EXST. SODIUM HYPO TANKS SURROUNDED BY DIRT BERM TO BE REPLACED W/ LARGER PERMANENT TANKS W/ CONCRETE CONTAINMENT WALLS

Additional Comments: • TWO MILTRONIC HYDRORANGERS FOR HOLDING TANKS (NOT HOOKED UP)

- TWO U.S. FILTER WATER CHAMPS FOR HYPO IN SAME CCT INLET CHANNEL
- TWO SAMPLE PUMPS SEND TO ANALYZERS



MIRROR SOUTH

- TWO NETZSCH ~~Fom~~ SCUM PUMPS DRAW OFF SCUM WELL

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #1

3 MAKEUP WATER PUMPS TO GRAVITY THICKENERS

Manufacturer / Model: AURORA

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: MOTOR RUNNING

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: 5/23/04 Name of PCWMD Assessor: J. Sherlock

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: Pump Station #10

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · 3 Fairbanks Morse Return Sludge Pumps
· Two Scum Pumps (Netzsch)
· Return Sludge has a connection to scum line.

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520 - 407-3721

Name of Equipment Item or Group: PUMP STATION #12

Manufacturer / Model:

Age of equipment: 1992 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • TWO MOYNO SCUM PUMPS

• ~~TO~~ TWO FAIRBANKS MORSE RETURN SLUDGE PUMPS (ONE OUT OF SERVICE CURRENTLY)

• ROOM FOR 3RD FUTURE RETURN SLUDGE PUMP

Additional Comments:

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: SECONDARY CLARIFIERS No. 3,4, 5,6,7, 8, AND 9

Manufacturer / Model: EIMCO

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

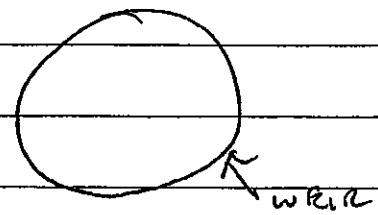
Additional Comments: · TWO RAKE ARMS

· RAKE ARM CATCHES ON WELDS ~~[illegible]~~ WHICH SHOULD BE ON OUTSIDE BUT ARE ON INSIDE ON SC-8, AND 9

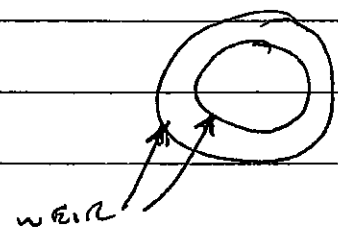
· FLOC MIXERS ON SC-5,+6 (NOT USED) 3,4,

Additional Comments: _____

WEIRS - 3+4



WEIRS 5 - 9



PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: SECONDARY CLARIFIERS #1 AND #2

Manufacturer / Model: EIMCO DRIVE

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

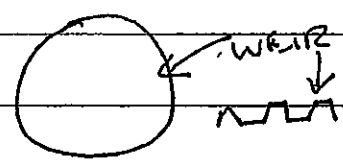
Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · TWO RAKE ARMS

· 4 FLOC MIXERS FOR POLYMER ADDITION (NOT USED)



Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #6

Manufacturer / Model: RETURN SLUDGE PUMPS (3) ALLIS-CHALMERS
SCUM PUMPS (2) NETZSCH

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: · METER SLUDGE INTO WET WELL THEN SUCK OUT OF WET WELL. WET WELL IS TWO WET WELLS CONNECTED BY A GATE. TWO PUMPS ~~[illegible]~~ CONNECTED TO SOUTH WET WELL, ONE PUMP CONNECTED TO NORTH WET WELL

Additional Comments: ~~[illegible]~~ · HARD TO DETERMINE EXACT LAYOUT

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: _____ Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: Pump Station #8

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time Continuous hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • Three Return Sludge Pumps (Pacific Pumping Co.) RSP-1,-2,-3

• Scum Pumps Netzsch FSP-1,-2,-3

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #2

MWP-1, 2, 3 MAKE UP WATER PUMPS

Manufacturer / Model: ALLIS-CHALMERS MODEL 100

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil (1)	4	3	2	1

(1) Piping, valves, and other appurtenant devices

Additional Comments: PUMP TO GRAVITY THICKENERS

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: BLOWER BUILDING

3 ENGINE DRIVEN BLOWERS

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • DIGESTER GAS NOT USED, NATURAL GAS USED

• TO BE REPLACED W/IN THE YEAR W/ NEW ~~[illegible]~~ ~~[illegible]~~ BLOWERS. EXISTING BLOWERS WILL REMAIN AS BACKUPS

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-807-3721

Name of Equipment Item or Group: AERATION TANKS #3-6

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • VERY COARSE DIFFUSERS

• RUN IN PLUG FLOW, BUT HAS GATES FOR STEP FEED

• TWO PASSES PER TANK

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520 - 407 - 3721

Name of Equipment Item or Group: AERATION TANKS #1 AND #2

Manufacturer / Model:

Age of equipment: OLD 1951 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil (1)	4	3	2	1

(1) Piping, valves, and other appurtenant devices

Additional Comments: · SINGLE PASS

· AIR PIPE HEADER TO #1 AND #2 HAS A LEAK

- PLUG FLOW ONLY

· REDUNDANT GATES BETWEEN AT #1 AND #2 AND FC #1 AND #2

Additional Comments: · VERY COARSE DIFFUSERS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

- CONCRETE LOOKS OK

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/04 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #7

WAS PUMPS (3)

Manufacturer / Model: ITT AC

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil (1)	4	3	2	1

(1) Piping, valves, and other appurtenant devices

Additional Comments: • #3 HAS AFD SO IS USUALLY RUN OTHERWISE USE BOTH #1 AND #2 (CONSTANT SPEED)
• TRYING TO SEND WAS TO INA SO A DIGESTER CAN BE TAKEN DOWN AND CLEANED

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: ~~Pump Station #~~ A. MARTIN

Date of Assessment: 5/27/06 Name of PCWMD Assessor: J. SHERLOK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #4 (BIO RECIRCULATION BUILDING)

Manufacturer / Model: FOUR 60" 2-STAGE FAIRBANKS MORSE PUMPS -1, -2, -3 ~~ANSTON~~ ENGINE DRIVEN ; -4 ~~ENGINE~~ MOTOR DRIVEN

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • ONE ENGINE IS RUN UP TO 900 RPM. THEN SECOND ENGINE IS TURNED ON AND FLOW IS MANUALLY BALANCED BETWEEN THE TWO. MOTOR DRIVEN PUMP IS RUN ABOVE 55 MGD.
• CAN BE RUN ON DIGESTER GAS, BUT NO SCRUBBER

Additional Comments: SYSTEM SO SICK ANYES CLUG

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

ENGINES, SO NORMALLY NATURAL GAS IS USED.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #5

Manufacturer / Model: MOYNO PC PUMPS

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: ☐ PSP-1 ☐ PSP-3 ☐ PSP-2

SAME AS P.S. #3

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/25/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PUMP STATION #14

Manufacturer / Model: SEEPEX PUMPS (7)

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: PSP-1 TO 5 PUMP PRIMARY SLUDGE FROM PC-1,-2,-3,-4,-9, AND -10 TO DIGESTERS OR GRAVITY THICKENERS (BOTH WAYS METERED PSP-6 AND -7 PUMP SCUM FROM PC-1,-2,-3,-4,9,-10 TO DIGESTERS

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☑ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-7721

Name of Equipment Item or Group: PUMP STATION #3

Manufacturer / Model: 3 MOYNO PC PUMPS

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: PUMPS 1 AND 2 PUMP SLUDGE TO BIOTOWER
PUMP 3 PUMPS SCUM
• SLUDGE AND SCUM HAVE A CROSS CONNECTION
WATER SLUDGE NOT SCUM
DWP-1 - DEWATERING PUMP

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: PRIMARY CLARIFIERS #5-10

Manufacturer / Model: FEMCO

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: • CANT TAKE TANKS DOWN ~~[illegible]~~, SO MAINTENANCE CANT BE DONE.

• TWO RAKE ARMS OFF CENTER COLUMN

• #5-8 FED FROM YARD STRUCTURE #1, #9+10 FED FROM INFLUENT CHANNEL

Additional Comments: • NO METERS SO GATES ARE

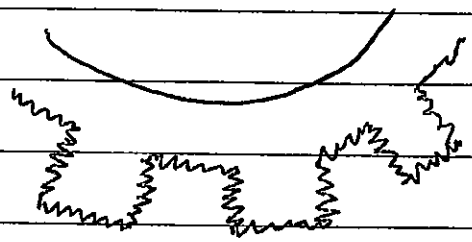
PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

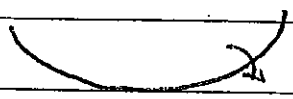
EQUIPMENT CONDITION ASSESSMENT

MANUALLY OPERATED AND TANKS ARE VISUALLY BALANCED

- #5+6 WEIRS



- #7-10 NORMAL



- #5+6 LOWER THAN #7+#8 SO GET MORE SOLIDS

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: 5/27/06 Name of PCWMD Assessor: J. Sherlock

Phone Number of PCWMD Assessor: 520-407-3721

Name of Structure: Primary Clarifiers #5-10

Type of Service (1): (1) Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	(2)	1

Additional Comments: Concrete in good condition

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: 5/27/06 Name of PCWMD Assessor: J. Sheralow

Phone Number of PCWMD Assessor: 520-407-7721

Name of Equipment Item or Group: Two Rotopress R.P. 200 model screenings presses and two grit washers

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time Continuous hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1
Civil [1]	4	3	2	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: All to be removed by quarter 1 of 2007. JWC washpressers going in for screenings.

• Grit washers to be S+L

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martins

Date of Assessment: 5/27/06 Name of PCWMD Assessor: J. Barlock

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: Sigma 900 Samplers (Two: A + B)

Manufacturer / Model: Sigma 900

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time Continuous hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: _____

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. Sherlock

Phone Number of PCWMD Assessor: 520-407-3721

Name of Structure: GRIT TANKS, HEADWORKS, PARSHALL FLUME, INFLUENT CHANNEL

Type of Service (1): Wastewater Tankage

(1) Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: _____ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: ALL CONCRETE LOOKS GOOD.

- EVERYTHING COVERED
- ONLY TWO OF THREE PARSHALL FLUMES IN SERVICE. THIRD IS FUTURE

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. Martin

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. Sharrocock

Phone Number of PCWMD Assessor: 520 - 407 - 3721

Name of Equipment Item or Group: Pista Grit Tanks (Two)

Manufacturer / Model: Smith + Loveless Model 50

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time Continuous hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: Look to be in good shape, plant reports no problems.

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520 - 407 - 3721

Name of Equipment Item or Group: ~~RODNEY~~ GATES

Manufacturer / Model: RODNEY HUNT

Age of equipment: VARIOUS years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time MINIMAL hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: ALL PLANT GATES ARE MANUAL, ALL SEEM TO BE IN GOOD SHAPE, BUT AREN'T EXCERCISED FREQUENTLY, BECAUSE PLANT CANT TAKE TANKS OUT OF SERVICE

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/00 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Equipment Item or Group: BELT CONVEYOR FOR SCREENINGS, SCREENINGS COMPACTOR ~~BOOSTER~~, GRIT WASHER

Manufacturer / Model:

Age of equipment: 20/0 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: BELT IS COVERED WHERE SCREENS DISCHARGE ONTO BELT, PLOWS LOWERED OR RAISED TO SEND SCREENINGS TO SCREENINGS COMPACTOR, DISCHARGES TO TRUCK

Additional Comments:

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/00 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: PARKSON, CLIMBER SCREENS

Manufacturer / Model: PARKSON AQUA-GUARD

Age of equipment: APPROX ~~10~~ 9 years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	(2)	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: PLANT PERSONNEL VERY HAPPY W/ ~~THE~~ SCREENS.
NO PROBLEMS W/ SCREENS OR MAINTENANCE
~~CONTINUE~~ ALL SCREENS AND DISCHARGES COVERED

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/23/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: _____

Name of Equipment Item or Group: HEADWORKS ODOR CONTROL EQUIP

BIOFILTERS 3 TOTAL

Manufacturer / Model: _____

Age of equipment: _____ years

Power Rating (hp, kw, btu/hr, etc) _____ (include units)

Average Weekly Run Time CONTINUOUS hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	(2)	1
Electrical	4	3	2	1
Civil [1]	4	3	(2)	1

[1] Piping, valves, and other appurtenant devices

Additional Comments: SOME CORROSION SPOTS ON UNITS, 6/10" H_2O LOSS ACROSS SYSTEM, ONE BLOWER FOR EACH BIOFILTER

Additional Comments: _____

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

STRUCTURE CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: A. MARTIN

Date of Assessment: 5/22/06 Name of PCWMD Assessor: J. SHERLOCK

Phone Number of PCWMD Assessor: 520-407-3721

Name of Structure: EQUALIZATION BASINS (1951 RC'S)

Type of Service [1]: WASTEWATER OVERFLOW TANKAGE

[1] Wastewater Tankage, Sludge Tankage, Equipment Room, Personnel Room (office, break, lab, etc,) or other (define).

Age of Structure: 65+ years

Condition - Rate the Structural category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

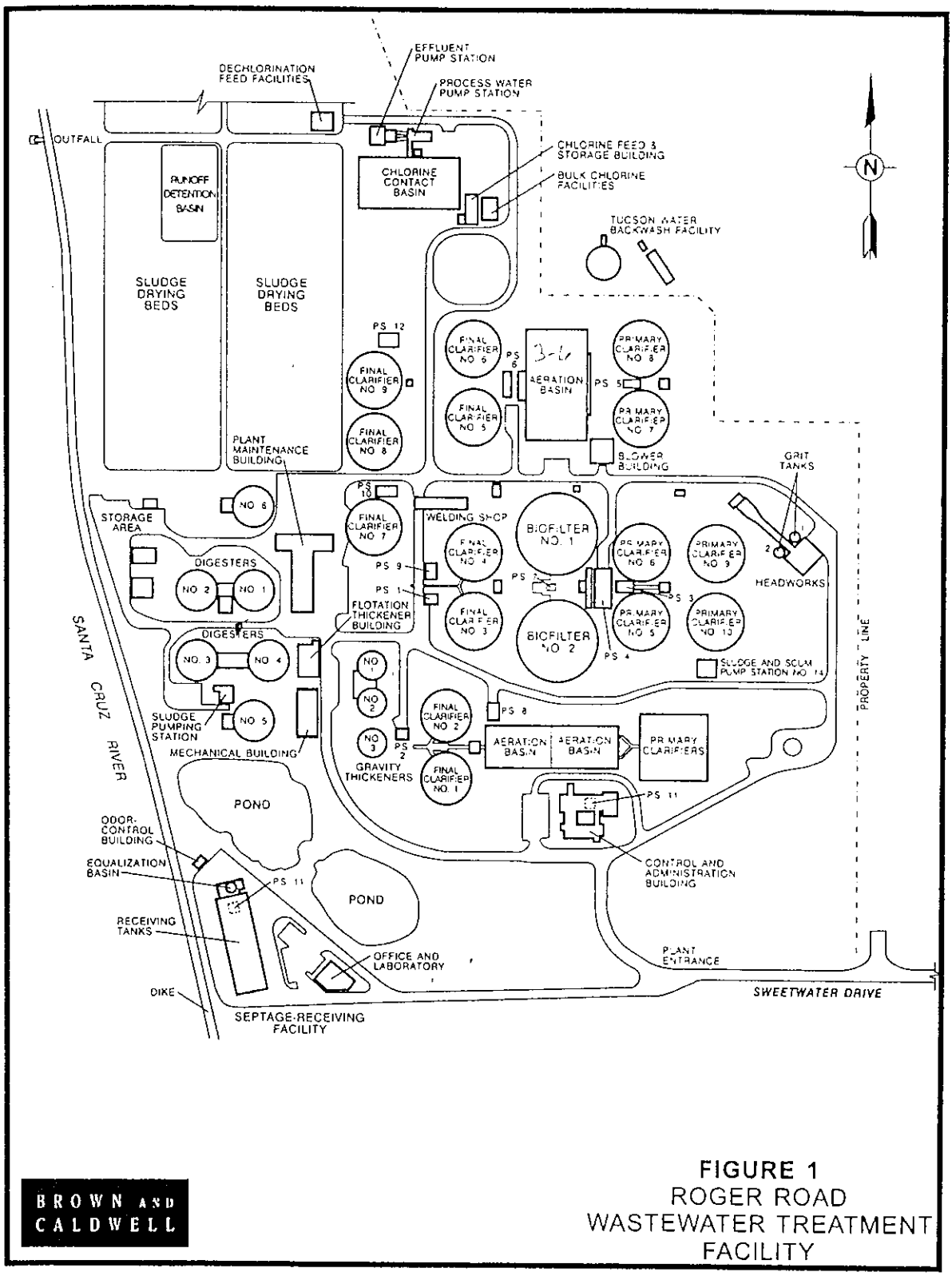
	Poor	Acceptable	Good	Excellent
Structural	4	3	2	1

Additional Comments: 880,000 GALLONS CAPACITY

Appendix B

Condition Assessment Data

Instrumentation Field Assessment

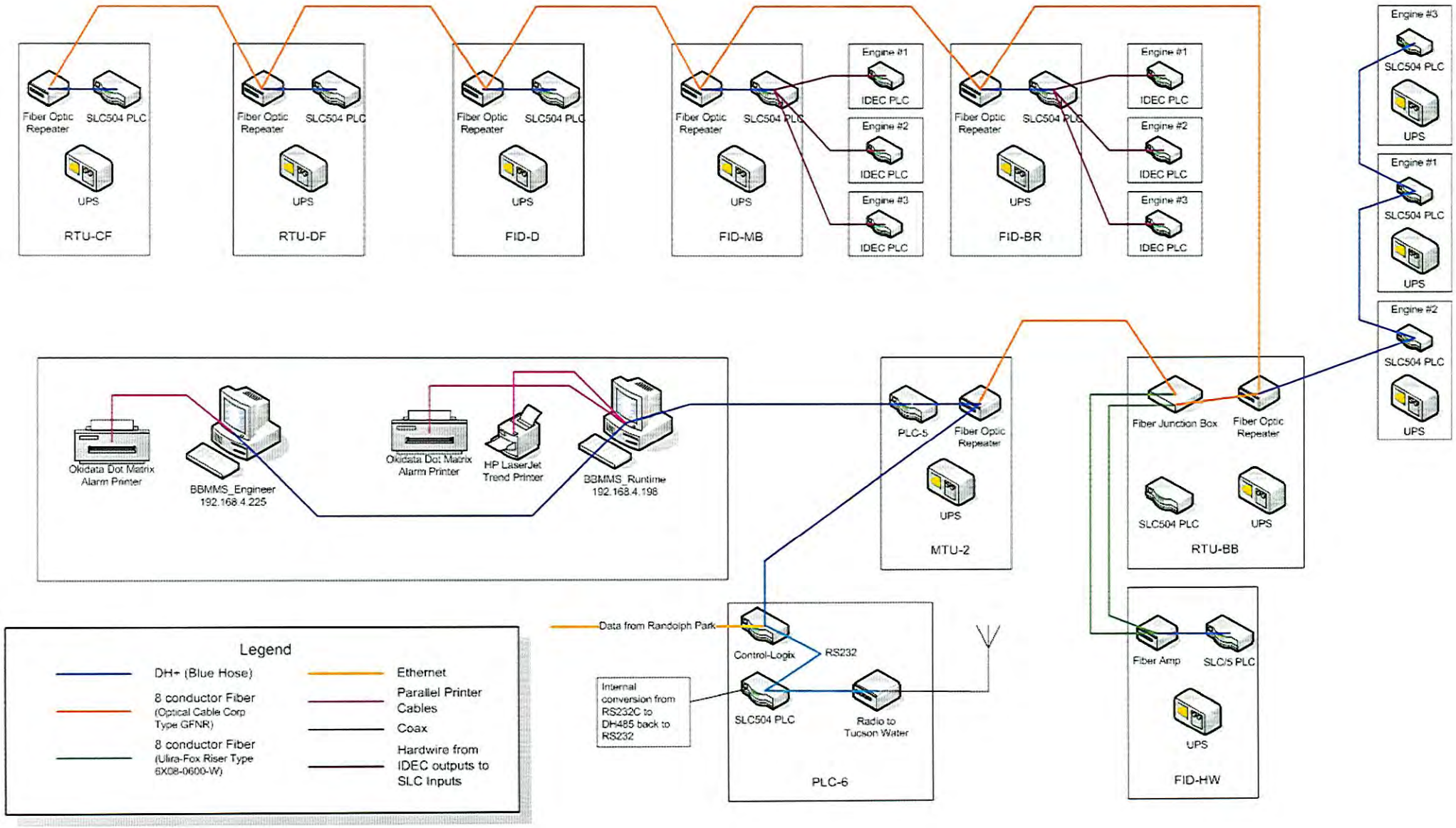


BROWN AND CALDWELL

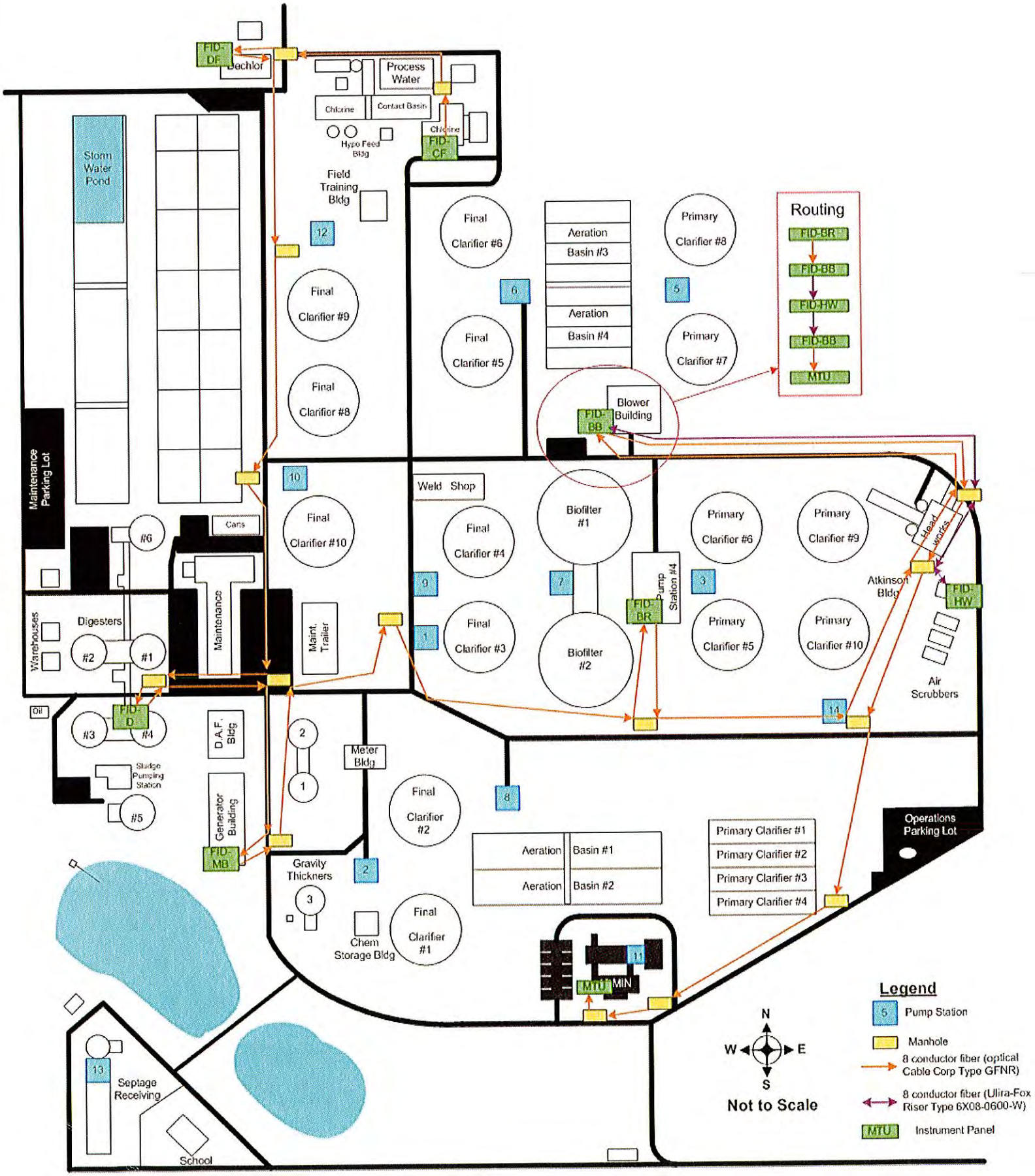
FIGURE 1
ROGER ROAD
WASTEWATER TREATMENT
FACILITY

ROGERMAPCDR

Roger Road SCADA System



RRWWT Plant


FID-DF
Dechlor
Process Water
Chlorine
Contact Basin
Chlorine
Hypo Feed Bldg
FID-CF
Storm Water Pond
Field Training Bldg
12
Final Clarifier #6
Aeration Basin #3
Primary Clarifier #8
Routing
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FID-BB
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FID-BB
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Final Clarifier #5
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Blower Building
FID-BB
Maintenance Parking Lot
10
Weld Shop
Biofilter #1
Primary Clarifier #6
Primary Clarifier #9
Head works
Final Clarifier #10
Cans
#6
Final Clarifier #4
9
7
Pump Station #4
3
Atkinson Bldg
FID-HW
Warehouses
Digesters
#2
#1
Maintenance
Maint. Trailer
1
Final Clarifier #3
FID-BR
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Oil
FID-D
#3
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D.A.F. Bldg
2
Meter Bldg
14
Sludge Pumping Station
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#5
Generator Building
Final Clarifier #2
8
Operations Parking Lot
FID-MB
Gravity Thickners
2
Aeration Basin #1
Aeration Basin #2
Primary Clarifier #1
Primary Clarifier #2
Primary Clarifier #3
Primary Clarifier #4
3
Chem Storage Bldg
Final Clarifier #1
11
MTU
MIN
13
Septage Receiving
School
N
W
E
S
Not to Scale
Legend
5 Pump Station
Manhole
8 conductor fiber (optical Cable Corp Type GFNR)
8 conductor fiber (Ulira-Fox Riser Type 6X08-0600-W)
MTU Instrument Panel

GREELEY AND HANSEN ENGINEERS

PROJECT ROMP

SUBJECT Condition Assessment

PROJ NO. Instrumentation

CLIENT Pima County WMD

cell 520-404-9130

Wastewater Management

Jack Van Riper
Maintenance Manager
Roger Road WWTP
2600 W. Sweetwater Drive, Tucson, AZ 85705
(520) 407-3740 (Voice Mail) Fax: (520) 407-3749
(520) 888-4801 (Switchboard)
Email: jack.vanriper@wwm.pima.gov

Wastewater Management

John W. Sherlock
Operations Assistant Manager
Roger Road WWTP
2600 W. Sweetwater Drive
Tucson, AZ 85705
Phone: (520) 407-3721 Fax: (520) 407-3715
Email: john.sherlock @wwm.pima.gov

HELEN RUOY - Plant Supt.

ROD RISCA -

STEVE GARRICK - operator

TIM HARMON - 1st C lead @ Roger Road

Rober Krause - 1st C lead @ Outlying

FRANK GALL - Supt of Outlying

Ken Weber - operations supervisor

Jeff Graunke

GREELEY AND HANSEN

PROJECT Pima | PROJECT #
SUBJECT Roger Road | CLIENT

COMP BY TDG DATE 6-4-06 CDK BY DATE SHEET OF

PS #	SERVICE
1	Makeup H_2O
2	" "
3	Primary 5 & 6
4	BIOTOWER LIFT
5	Primary 7 & 8
6	Final 5 & 6 RAS
7	WAS
8	Final 1 & 2 RAS
9	" 3 & 4 "
10	" 7 & 8 "
11	(Admin)
12	Final 9 RAS
13	Septage
14	Primary 1-4, 9 & 10

FID #	FACILITY
FID- CF	Chlorine Facil
DF	De-chlor Facil
D	Digesters
MB	Maintenance (Generators)
BR	BIOTOWER (via Headworks)
BB	Blower Bldg → TOTAL = 3 PLCs + fiber gateway
HW	Headworks (via BB & back thru HW)
MTU	Admin Bldg

W I 10 Frontage Rd
N Business Center Dr
10
W Sweetwater Dr
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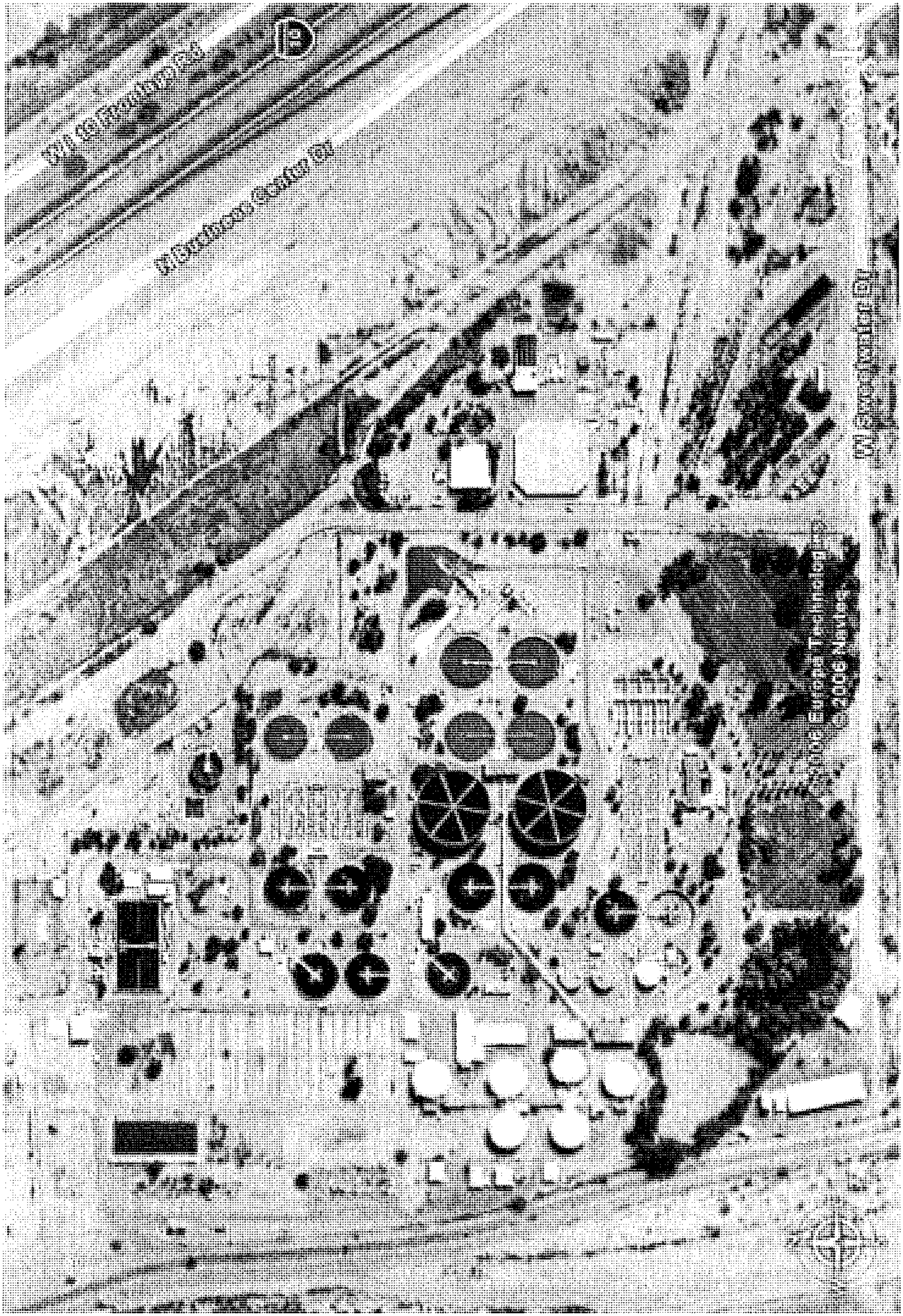
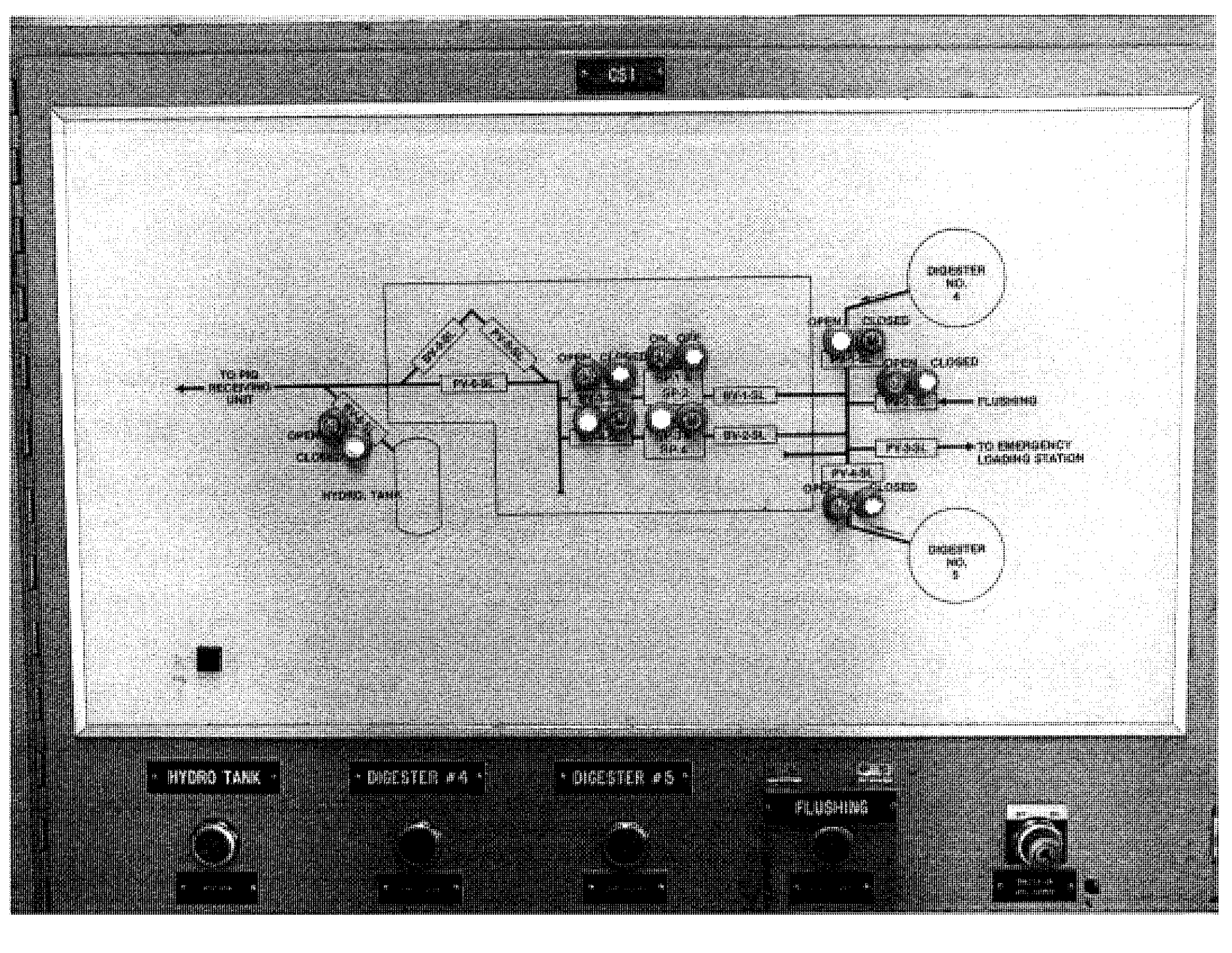
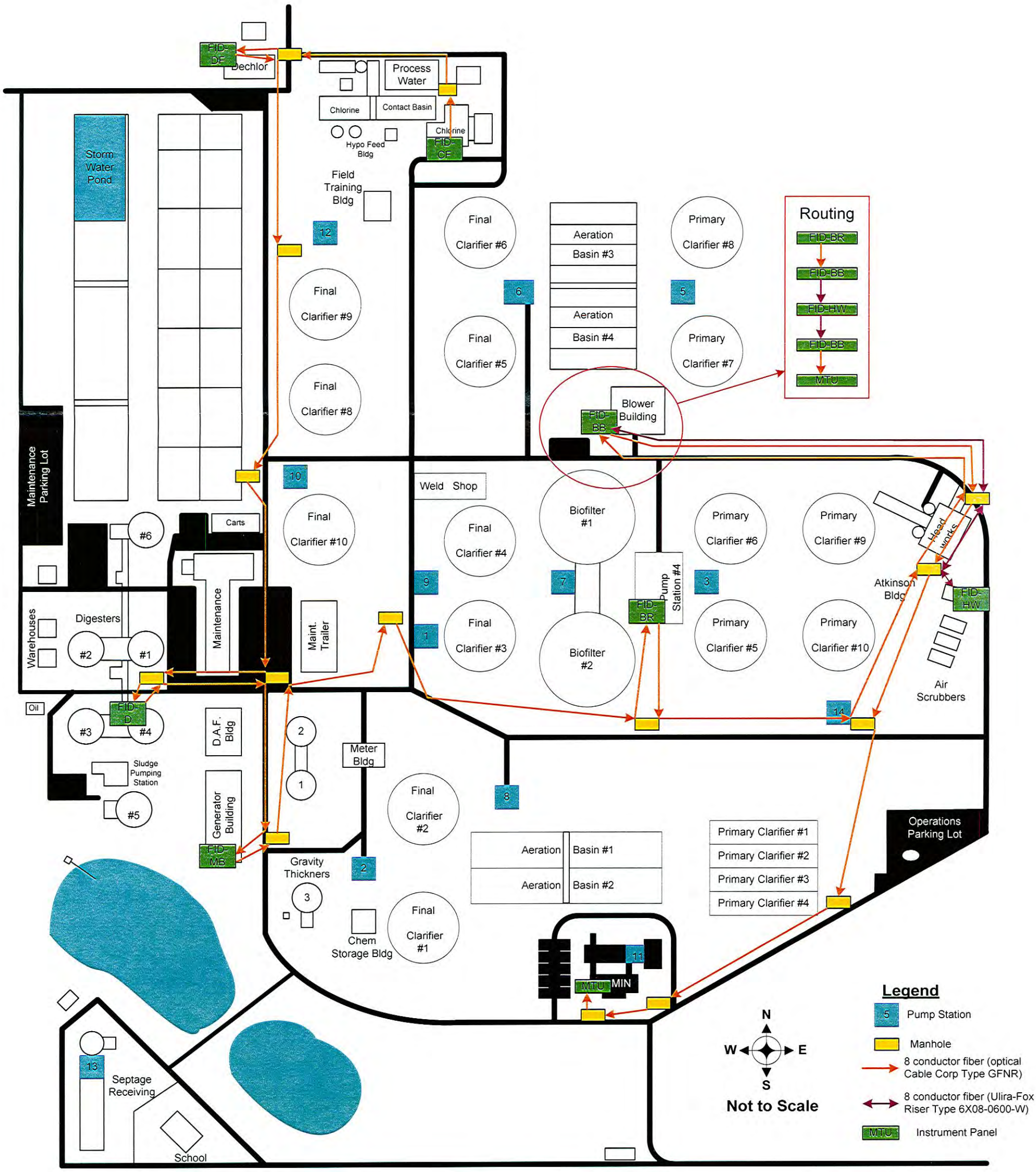
© 2006 Navteq
Google




C51
TO PO2 RECEIVING UNIT
OPEN
CLOSED
HYDRO. TANK
PV-4-3L
OPEN
CLOSED
ON
OFF
SR-2
SR-4
SN-2-3L
SN-2-5L
DIGESTER NO. 4
OPEN
CLOSED
OPEN
CLOSED
FLUSHING
PV-4-5L
TO EMERGENCY LOADING STATION
PV-4-3L
OPEN
CLOSED
DIGESTER NO. 5
HYDRO TANK
DIGESTER #4
DIGESTER #5
FLUSHING

RRWWT Plant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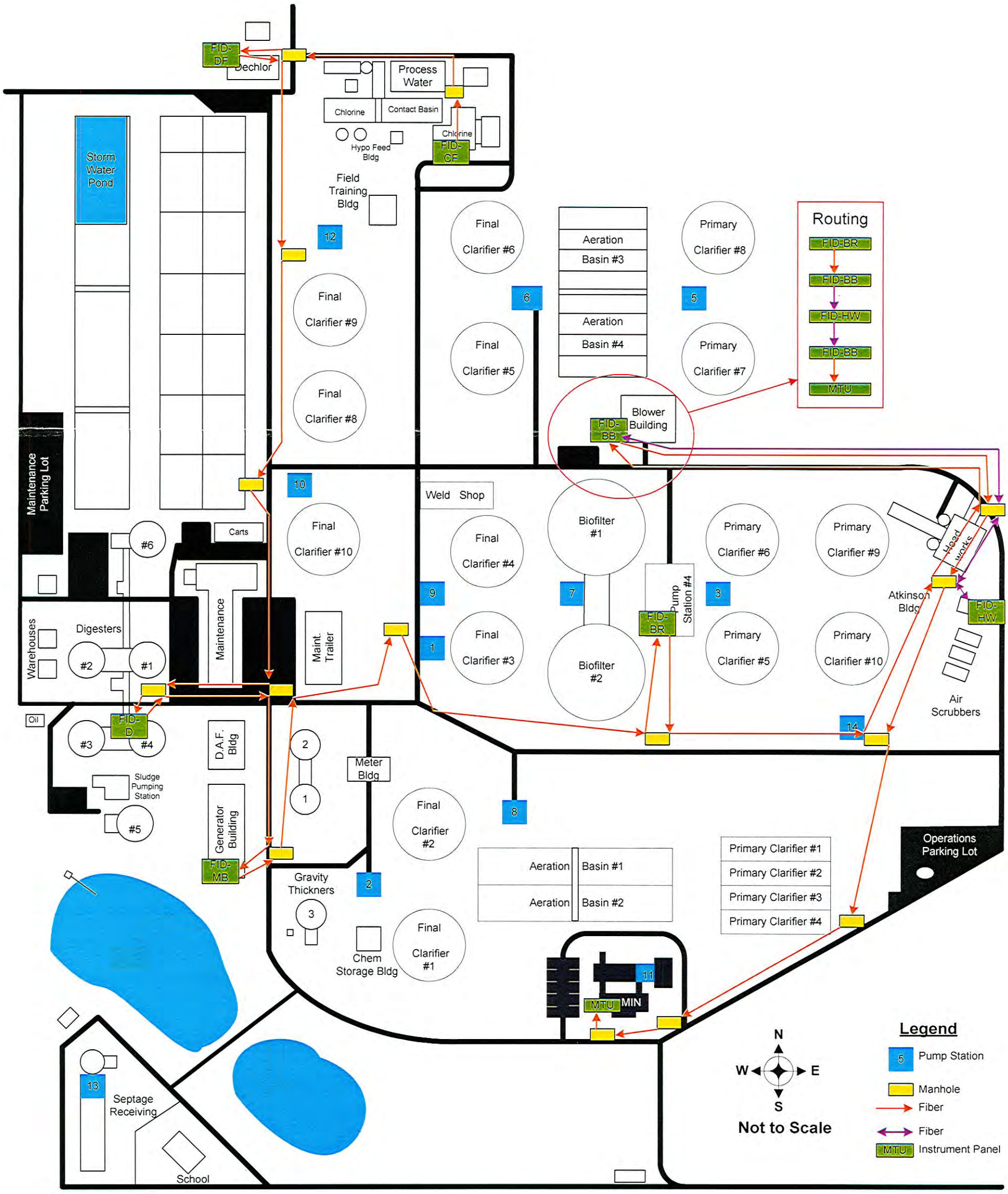
RRWWT Plant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GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-1 OF _____

HEADWORKS

Parkson Aquagard 1, 2, 3 All run in Hand (2 of 3)
Bubbler for high channel
" " high dp

ROTOPRESS A, B

New JWC washer compactors on order
2 grit screws being replaced, old ones rusted out on bottom

Grit Tank Panels
Auto mode = timer control

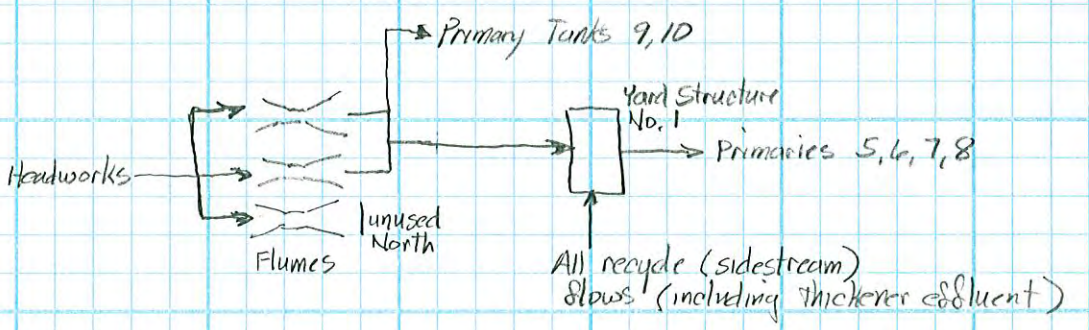
All panels to be relocated to new building

HEADWORKS ODOR CONTROL

3 Biotowers, each w/ fan
Each has 2 water feed rotameters w/ sol valve & dp x-mitter
Measures loss across biofilter
Reads 0.62" w.c.

HEADWORKS FLUMES

3 Flumes - 2 are in parallel & combined upstream & downstream
1 is unused - dedicated to interconnect w/ INA RD
reads 22.23, 23.51 mgd



ORIGINAL PRIMARY TANKS 1-4

Now used as 880,000 gal equalization basins

PRIMARY CLARIFIERS 5-10

Drives all manual, flow split is manual, by eyeball

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-2 OF _____

PUMP STN # 3 →

{All sludge to grav thickeners
All scum to digesters}

Primaries 5 & 6

3 sludge pumps w/ HOA
Auto timer control - Pump 9 min, off 1 min - repeat
Foxboro M2800 magmeter

2 scum pumps
All manual control
No meter

PUMP STN # 5

Primaries 7 & 8

3 sludge pumps w/ HOA (Pump 3 has Hand-Rem-Off-Auto)
Auto timer control - Pump 9 min; off 1 min - repeat
Foxboro M2800 magmeter

2 scum pumps
All manual control
No meter

PUMP STN # 14

Primaries 1, 2, 3, 4, 9, 10

3 sludge pumps w/ HOA
Auto timer control - Pump 7 min, off 3 min - repeat
Brooks magmeter

2 scum pumps w/ HOA
All manual control
No meter

BIOTOWERS (2)

Fed by: 3 gas engine pumps & 1 electric pump
Sample ports not functional
media settlement - MPI to TV camera ports
Blowers run whenever ambient T > 60°F, run all summer

No flow measurement of split to biotowers
Manual butterfly valve @ each feed
Tim Harmon working on flow measurement. (48" lines)

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5-3 OF _____

INTERMEDIATE (BIOTOWER) PUMP STN #4

3 GAS driven pumps @ ~ 25 mgd each
1 electric pump @ 33 mgd (soft start)
can only run one electric motor because of X-former

Gas engines
methane crud fouls engines
only using natural gas for last year
Manual speed adjustment only.
try to maintain wetwell @ 20-25'
@ 30' raise rpm
900 rpm max @ ~ 32 mgd
32 mgd → start lag pump

Electric pump is for emergency or if engine goes down
Also used as 3rd pump >55 mgd.

- Bubbler panel used to throttle BF-7 to maintain wetwell level w/ engines at constant speed. This allowed RAS & effluent to flow back into wetwell to satisfy pumping rate - NO LONGER USED
(RAS no longer returned to biotowers)

PANEL FID-BR
SLC-5/04 w/ DH+ fiber adapter
each pump has Lead-Lag 1-Lag 2
they still use switches as a reminder

Bubbler works good but most of pneumatic purge ckt has been bypassed.

FLOW SPLIT TO AERATION BATTERIES

No way to measure or know how flow split occurs

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5-4 OF _____

AERATION TANK 1 & 2

Air control valve 5' upstream from oridice plates
ΔP indicator = ITT Barton 2200 scfm (0-2250)
3000 scfm maxed out (0-3000)
2000 " " " (0-2000)

LDO Probes @ end of each Pass (new instruments)
Tank 1 = 3.09 mg/l
" 2 = 3.29 "

AERATION TANKS 3-6

Butterfly control valve ~4' downstream from oridice plates
~12-14" line
Plenty of straight run upstream
ΔP indicator = Old Foxboro Type 37 dp
reading 1000 scfm @ Tank 1
3000 " " " 2

LDO Probes @ End of pass B
Tank 3 (probe missing)
4 2.41 mg/l
5 3.05
6 2.88

BLOWER BUILDING (always run 2 blowers)

RTU-BB has AB 1771-AF1 DH+ to Fiber converter

Turblex blowers (3) w/ AB controls, engine driven
Natural gas fuel use only.
Isolation valves on main header - only one is operable

North and South feed is isolated and metered
FCI GF90-AAIA00BAAA00160DD2A1
Blower 2 = 7600 scfm
" 3 = 3250 "

Blowers controlled by modulating inlet guide vanes
with blower rpm constant @ 1250

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5-5 OF _____

BLOWERS (con't'd)

City planning 2 new blower buildings, each dedicated to Aeration Batteries 1-2, 3-6

Planning AFD controlled blowers

Existing blower building will become standby.

FLOW SPLIT TO FINAL TANKS - GENERAL

Splitter structures have up-closing gates to act as weirs
Thinking about motor actuators on the gates for control

Installing Milltronics OCM-3 @ each gate for flow measurement
(only split to Final Tanks 7 & 8 have X-ducers)

SPLIT TO FINALS 1 & 2

Two flow splits in series.
1st one combines right downstream - no reason for it
2nd splits flow

SPLIT TO FINALS 3 & 4
Gate structure (2)

SPLIT TO FINALS 7 & 8
Gate structure (2)
Has flow transducers (level @ OCM-3)
reading to No. 7 = 6.11 mgd
8 = 5.98 "

SPLIT TO FINALS 5, 6, 9
Gate structure (4 gates)
one gate closed completely (future tank)

FINAL CLARIFIERS
All manual controlled

5 & 6 have mixers (flocculators w/ polymer feed)

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET 5-6 OF _____

Pump STN #7

3 WAS Pumps
No. 1 & 2 = constant speed - operate together
No. 3 = AFD - operate alone @ 900 gpm

Brooks Mag 5000 magmeter on discharge

Generally waste @ preset rate for 24 hours to Grav Thickeners

Pump STN #1
3 makeup water pumps to thickeners (Source = final tanks 3 & 4)
All manual control @ MCC above grade
No flow meters

Pump STN #2
4 Pumps total
3 makeup water pumps to thickeners (Source = final Tanks 1 & 2)
1 flush pump to flush sludge line to INN ROAD
All manual control @ MCC above grade
No flow meters

Pump STN #8
(from Final Tanks 1 & 2)

Return sludge meter from each clarifier (2)
Foxboro M-2800 series (2810-SABA-A9)
reading 1.8 mgd

Pump STN #6
(from Final Tanks 5 & 6)

Return sludge meter from each clarifier
Foxboro M-2800 series
RAS flows to 2 chamber wetwell ← The only station like this
RAS pumps (3) take suction from each half of wetwell

2 scum pumps - no metering
RAS suction from #6 ties to scum suction.

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-7 OF _____

PUMP STN #9
(from Final Tanks 3 & 4)

3 sludge pumps (RAS)
Return sludge meter on suction from each final tank (Foxboro M-2800)

No meter on scum pumps (2)

Pump STN #10
(from Final Tanks 7 & 8)

3 RAS pumps
Return sludge meters on suction from each final tank
- Krohne Altometer IFS3800 reading 1.62 mgd (newer)
- Foxboro 2810 reading 1.6 mgd (out of FS range of 5 mgd)

Meters reduced 18×10 w/ plug valves either side

2 scum pumps - unmetered

Pump STN #12
(from Final Tank 9)

2 RAS pumps (one removed for repair/replacement)
Return sludge meter on pump suction
- Brooks Mag 7500

2 scum pumps - unmetered

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5-8 OF _____

DISINFECTION

Flow pacing measurement - each contact tank
Ultrasonic level / flow transducer @ beginning of tank
Computes flow over weir at end of tank
TOO FAR AWAY

NaOCl storage
2 temporary tanks - no level measurement.
Permanent tanks on-site w/ level flanges

NaOCl Feed (in dedicated small building)
Hypo feeders for North and South feed points
US Filter LVN-2000 Liquid Feed System
- Rotameter & Control valve
- ΔP regulator
- PCU Electronic Controller
  Reading 5.59 mg/L Residual Cl_2

Water Champs (North and South)
Installed in same common inlet channel to contact tanks

Residual Analyzers
Located in unused gas chlorinator room
- Analyzer #1 = TOTAL Cl_2 @ contact tank = 6.4 mg/L
  Sample fed from just inside feed point to East contact tank
  (can't be 1 minute down from Hypo feed point)
  Also has readout for disinfection ORP = 105 mv
- Analyzer #2 = Process water = 3.6 mg/L
  This is residual @ end of contact tank

DECHLORINATION

Flow pacing measurement = 2 Parshall Flumes added together
Bisulfite Storage
One bulk tank and one day tank in containment
Bisulfite Feed (in dedicated small building)
North and South liquid feeders - same as hypo
Water Champs
Upstream of Flumes
ORP Measurement
2 analyzers in unused SO_2 building (old de-chlor bldg)
Stantrol 890 - reads 105 mv (equivalent to 71% F.S.)
measures effluent either at 1) down stream from flumes
2) Outfall sample location

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-9 OF _____

Contact Tank Misc

Service Water
5 pumps operate automatic based on pressure switches

Irrigation Water
1 pump

Tucson Water
Tucson water draws to Sweetwater Plant
They are limited by a weir structure
They have a magmeter - not connected to plant.
They monitor water qual from data link to Plant SCADA

Thickener Metering Building

Makeup Water
Metered to Grav Thickener 1
" " " 2
" " " 3
} Brook Mag-5000

Waste Sludge
Metered to Grav. Thickener 1
" " " 2
" " " 3
} Brooks Mag-5000

Primary Sludge
Metered to Grav Thickener 1
" " " 2
" " " 3
} Brooks Mag-5000

DAF Facility (2 units)
Has not been operated in over a year
Originally for Biotower sloughing only.

Komline-Sanderson - from 1972
controls have failed and parts not readily available
staff unsure of operation - nobody around anymore who actually knew how to operate it. They had trouble getting pressurization tank level control to be stable.

They are reportedly going to consider using DAFs for WAS thickening.

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-10 OF _____

Gravity Thickeners (3)

Collector & Grinder panel has HOA switch, set to "Hand"

Thickened Sludge Pump controls = HOA, (set to "Auto" for #3 only)

EIT combustible gas detectors inside poison rapidly - every few months

Thickener 1 & 2

Odor control dis-assembled to pour new foundation

No thickened sludge flowmeters

Thickener No. 3

Odor control running w/ Hypo only

pH & ORP control → NaOH is not being fed

not even hooked up.

- Personnel seemed confused about how this works

NaOCl and NaOH feed pumps set to "Off"

pH reading 3.18 (low alarm)

ORP " 623 mV

Brooks and Rosemount redundant magmeters - thickened sludge

All thickener effluent goes back to Yard Structure No. 1

Septage Receiving Station

Multi-tank receiver has been bypassed, now flows to wetwell directly

Dump → wetwell → 2 cyclone feed pumps → cyclone → Grit → Dumpster

→ Eq. basin → 2 degrit effluent pumps → Headworks

One magmeter (4") on degritted septage

2 air compressors for bubblers

Odor scrubber w/ pH & ORP control

They want to eliminate this station → High odors & maintenance

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5-11 OF _____

Digesters

Digesters 1, 2, 3, 6 = primary digesters, fixed level, fixed covers
No level measurement

All digesters have gas flow transmitters on 1) System gas
2) Burner gas (waste)

FCI GF90 mass flow meters

Digester 3
vents regularly thru relief @ roof, set @ 9" w.c.
However, all waste gas regulators ~ 12-13" w.c.

Doesn't make sense, waste was being flared continuously.

Digesters 4 & 5 = secondary digesters w/ gas holder covers.
Cover level position X-mitter @ each
Liquid " transmitter @ each

Cover level = Varec 2500B indicator transmitter
Liquid " = F&P + Foxboro flange mount dp

Gas Compressors located @ Digester 3 & 4 Control Bldg.
3 compressors
Discharge ~ 40 - 45 psi

Heat exchanger & condensate separator on discharge line

FID-D panel located outside door

Sludge Pumping Station
located by Digester No. 5

2 sludge transfer pumps w/ discharge magnetes
(old Tischer and Porter)

Discharge then enters pig launch
System transfers secondary digester sludge to INA RD.

Insert pig → pump sludge to INA → insert pig → flush line

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-12 OF _____

Outlying Facilities

(per discussions w/ Ron Ricca, Helen Rudy, John Sherlock, Jack Van Riper)

They don't see much need for us to visit more than 2 or 3 of the outlying plants

Robert Krause - I&C lead for outlying
Frank Gaul = Supt. of "
Ken Weber = Ops supervisor "
Jeff Graunke = operations "

Randolph Park
- 3 mgd membrane bioreactor
- Sends 90,000 gal/day solids @ 4,500 mg/L
- Scalping plant w/ remainder & solids sent to Roger Road

Avra Valley
- 1.2 mgd oxidation ditch
- Sends 40,000 gal/day solids @ 10,000 mg/L
- Will have thickening used allows sludge to be used for mine tailing remediation

Green Valley
- 4.1 mgd Lagoon & BNR oxidation ditch
- Aerobic digesters w/ BFP
- Already disposes of own sludge

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET S-13 OF _____

I & C Issues

Air flow meters to Aeration Tanks
- Tanks 1-2 meters have control valves immediately upstream
  - will require piping changes for proper metering
- Tanks 3-6 meters have control valves downstream
  - OK for flow control
  - Good amount of upstream pipe for new meter

All meters are presently orifice plates w/ local ΔP flow indicators
very old ~ 1970's

Blower discharge air flow meters
FCI GF90 thermal mass flow going North & South
Appear to have proper meter runs

Return Sludge Flow Meters
Reduced size meter w/ eccentric reducers and plug valves on each side of meter. Not ideal flow pattern but at least they're all consistent. No way of quantifying error. Probably no greater than 5%

Plug valves full open, but still distorts flow profile

Sludge meters @ Thickener Metering Bldg.

Good meter arrangements

Digester Gas Metering
FCI GF90 mass flow meters
Appear to have proper meter runs.

Level Transmitters
- wetwells = bubbler - no problems
  - Biotower pump wetwell, septage facility
- Flow split chambers to final tanks = ultrasonic level/flow computation
- Digester liquid - flange mount dp - no problems
- See Digester covers - cable servo - no problems

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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Automatic Controls

Some being used, but for most part, plant is operated manually.

No capability of remote operation via SCADA

SCADA System

HMI (2 stations)

Running Rockwell RS-VIEW software

Monitor trends of analog inputs

" equipment and process alarms

There is virtually no display of equipment running status or valve positions, although all that info is reportedly wired to the PLCs, just not accessed by the SCADA server.

PLCs

There is a network of Allen Bradley SLC PLCs on a DH+ network

Network Backbone

- Fiber optic trunk runs throughout plant, connects various process areas
  - Chlorination
  - Dechlorination
  - Digesters
  - Generator (maintenance) Facility
  - Biotowers
  - Blower Bldg
  - Headworks
  - Admin Bldg.

The entire plant = less than 600 monitored & computed parameters, many of which (~120) are from abandoned chlorine & SO_2 facil.

This is in need of major upgrade, including ability to remote restart equipment after power failure

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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John Sherlock - Ops Mgr

Pete Mergaddino - Trades Maint Foreman

Jack Vanriper - Maint Manager

Helen Rudy - Supt.

Ron Riska -

Steve Garrick - operator

Tim Harmon - I&C

I&C

Robert Brown - settling

Frank Graf - supt of "

70,000 gal/day from Rancho

70,000 " from Avra

10,000 gal/L

Always will have thickening and or mix facility remediation

Green Valley already deals w/ it

Jeff Grounke

Own sludge.

Ken Weber - ops supervisor

Orig Primaries #1-4 880,000 gal new eq. basins

I&C washing computer - new 2 on order
& gate screws being replaced.

Run 2 screws in hand.

3 parshall flumes - Math doesn't go anywhere - intercomparch
2 usually read same - in parallel / - come together downstream
report on this

Yard structure) - all side stream flows into
that feeds 5,6,7,8

Primaries 9-10 feed direct from flumes

Intermed. Pump Station
3 gas driven pumps @ 25 mgd each
2 normally run manual speed adjust engine
1 electric 33 mgd - soft start.
Tim working on flow measurement to the 2 bistowers - not have yet
methane & natural gas feed.
Can only run one elec motor because of transformers

4/8"
manual Butterfly valve to each tower

AB I&C 5/64 on DH7 filter

Methane kills engines - only using Nat gas for 1 year
Blowers are strictly Nat gas.
Only thing on methane is generators.

4.98 mg @ each tanks.

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 2 OF _____

Biotowers

Sample ports not functional

Waste sludge pumps w/ Badger Magnetic

3 pumps, normally only run 1 w/ AFD @ 900 gpm
2 fixed speed pumps run together, or 1 w/ VFD

Flow split to final clarifiers thru 4 splitter boxes w/ up closing gates for control.

Installing OCM-3 @ each split now (one box already installed)
Thinking about motor actuators on gates.

No way to know how flow splits to Peridin batteries - or measure

Blowers - 3 existing - always run 2

All on natural gas

Planning for 2 more elect. Blow Bldgs to be duty - then exist will be stdby.

PS #6

Pumps RAS & scum

Disinfection:

Flow measurement? using effluent weir by scum pipes.

Water dilution w/ rotameters & use filter control valves & PCU.

Process flows - NPW

5 pumps automatic on pressure switches.
1 irrigation
Tucson water has magmeter.

III = 72%

Bisulfite flumes (2) added together pacus Bisulfite

Gas compressors

PSI gauges? don't know what they do.

Sludge Transfer to Ina - 2 pumps & 1 magmeter

GREELEY AND HANSEN

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✓ DAF
hasn't been run in a year

✓ Septage pH, ORP control on odor.

Sending to Tucson Water – via radio
Randolf Park Ethernet.
Roger Road. pH+

Robert Kraus
I&C lead
for anything

PIC 12 →

✓ Headworks Odor Control
3 units w/ Fan
Has 2 water flow rotameters w/ sol. valves & dp venturi
Controls unknown by TRG
w/ loss across bubbler
reads 0.62" wc

✓ Headworks

✓ Control Panel ← all run in hand
Parkson Aquagard 1, 2, 3 — AP bubbler
Rotopress A, B, — channel Hi bubbler

✓ - Panels to be relocated into new building
New screen washers ordered

✓ Grit Tank panels
Auto = timer control

✓ 3 Parshall Flumes → 22.23, 23.51 mgd reading

✓ Pump Station 3 between Primaries

Foxboro M2800

Sludge magnetic
No meter on scum

Auto control is timer
I = auto from PS 5
II " " " 6
III off.

GREELEY AND HANSEN

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P.S. #14

from PS 1,2,3,4,9,10 sludge & scum

Sludge mixed to digesters & grav. thickeners
Brooks mags

Sludge = HOA, #9 & 10 set Auto
Scum HOA set off

PS #5 HOA Hand Pump Off-Auto
Pump 1 & 2 Pump 3

sludge = on-off-on-off
scum = manual only

PIC 55

Sludge mixed Foxboro
Scum not "

BIOTOWER Pumps

Manual Speed adjust on engines
SCC 5/04 in ~~each~~ FID-BR

Blowers on when >60°F on all summer

32-mgd - start lag, adjust speed @ 20-25', @ 30' roller rpm
880 rpm 900 rpm max

Lead Lag1 Lag2 based on ?

Electric is energy or if a engine goes down (3rd pump on) >55 mgd

Bubbler Panel

Bubbler ckt bypassed

Sample valves (6) do not flow

BF-7 was originally controlled by bubbler to maintain well level w/ Tower pumps @ constant speed. No longer used - RAS is no longer pumped into biotowers.

PS #7

WAS pumps (x3)

WAS Magnetic Brooks May 5000

1 & 2 together or #3 on VFD
const. speed

wasting @ preset rate for 24 hours to Grav Thickeners

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
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AERATION 1 & 2

Control valve ahead of meter. ~ 5'-6'

Airflow orifice plate & dp indicator ITT Barton 0-2250 scfm
reading 2200 0-3000 maxed out
0-2000 scfm

No way to control airflow accurately

LDO probes (new) 3.29 mg/L Tank 2
3.09 " Tank 1 } at end of pass

Influent gates control split ?

Final Clarif. 1 & 2

Strange flow splitter - then split again between tanks
Manual collectors NO REASON

PS #2

3 makeup + 1 flush pump to flush to Inv

Makeup water pumps (4) to thickeners
Source 1 & 2 clarifiers (final) manual @ MCC above

PS #8

Return sludge metering from ea final Tank on pump suction ×2
" " pumps = On-Off
magmeters = old Foxboro 2810-SABA-A9 (M-2800 series)
reading 1.8 MGD

Air Tanks 3-6

Air flow = orifice ahead of BV (~ 4') - too close
12-14" like

reading 1000 @ tank 1
3000 @ tank 2
old Foxboro Type 37 dp

LDO #6 = 2.88
5 = 3.05
4 = 2.41
3 = XXXX (probe missing)

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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BLOWER BLDG

RTU-BB has AB- 1771-AF1
DH+ to Siber

FCI SF90-AA1A00BAAA00LGØDD2A1
North = 3250 scfm
South = 7600 scfm

Blower 3
Blower 2]- isolated

Turbex Blowers w/ AB controls

Flow splitter (one shutoff)

PS # 6

RAS from 5 & 6, suction metered separately
Old Foxboro M2810-SABA-AS
No way to control flows

3 sludge pumps suck from wetwell
2 scumpumps — no metering

RAS suction from 6 tied to scum suction

Final Tanks 5 & 6
have mixers (flocculators)

PS # 12

Sludge metered from #9 on pump suction:
Brook Mag 7500
2 RAS pumps (one missing)
2 scum pumps (no meter)

PS # 10

3 sludge pumps suck from common header fed by 2 mags on suction from 7 & 8
18 × 10 reducer to Krohne Altometer IFS3800 new
reading 1.62 mgd
Also Foxboro M2810 reading 1.6 mgd
2 scum pumps

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
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PS #9

3 sludge pumps suck from 2 RAS flowmeters # 3 & 4

PS #1

3 makeup water pumps
No controls
No meters

Source = Secondaries 3 & 4
Manual @ MCC above

Splitter to Final Clarif 7 & 8 has Milltronics OCM-3
reading 5.98 mgd
6.11 mgd

all ready for it.
No sunshield @ transducer

Disinfection:
Old chlorinator Room → Residual = 3.4 mg/l total Cl_2
→ ORP = 105 & Cl_2 = 6.4 mg/l total Cl_2
has analyzer selector switch 1-2
Analyzer #1
Analyzer #2 - process water. = similar residual below bisulfite

Hypo feed room:
North & South feeders = US Filter LVN-200 liquid sys
= Rotameter valve, DP reg. & PCU controller.
5.59 mg/L = reading.
North & South water pumps

Residual sample right after water pumps & enters contact tank.

Bisulfite Feed Room
North & South feeder - same as hypo
Reading 0.21 mg/L ORP reads 105 - probably next to old samplers.

Unused Dechlor Bldg
Standard ORP same
107 mV = 11.5%

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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Primary 5 6 7 8 pump 9 minutes, off 1 minute
" 9,10 " 7 " off 3 minutes } all go to grav thickeners (#2, 3 in service)

All thickener effluent goes to grav structure #1

Thickener Metering Bldg.

Makeup Water
Metered to thickener 1
" " " 2
" " " 3
ea = Brooks Meter MAG 5000

Waste Sludge lines in (2)
Metered sludge to thickener 1
" " " 2
" " " 3
ea = Brooks MAG 5000

Primary Sludge metered to Thickener 1
" " " 2
" " " 3

Thickener Gravity

HOA for Collector Grinder Lat.

Thickeners 1,2 have no thickened sl. meters

EIT combustible gas monitors poison rapidly

TSP 1,2,3 controls = HOA, in Auto

Odor control #3 Thickener - only using Hypo.

Thickener #3 has Brooks & Rosemount meters on thickener discharge — one for future

Septage

One mag on degritted septage (4")
2 degritt pumps, 2 cyclone feed pumps, 2 air compressors

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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Digesters 1 & 2

FCI (GF90) meters on ea digester system
" burner

Digester 3 & 4

Gas compressors w/ Temp X-mitters on disch chiller heat exchanger.
EIT gas detectors
46 psi discharge.
32 psi disch.

FID-P @ Digesters

Sludge pump disch -
meter @ pig launch

Not All digesters - Flow? and dp X-mitters for level
5, 4, only - they're the secondary.

4 & 5 has Varec 2500B indicator transmitter.

Digester 5 - roof & stuff

Control House #1 - Dig. #6

Sludge Gas System 54 scfm
Flare - 103 scfm 12 1/2" wc.

DAF

Karlin Sanderson
Repeatedly can't get parts or figure out how runs.

GREELEY AND HANSEN

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Pumped 810 gpm to IWA WPS

RS VIEW TRENDS

1) Influent Flow @ Headworks 41.18
2) Effluent - North Parshall 8.08
" South " 7.6
3) Influent Flow 41.18
Secondary Effluent Flow 33
Effluent Flow 15.64
4) Chlorine Residual 5.9
5) Generator 1 Load 268.3
" 2 " 0
6) " 3 " 0
7) PS4 Dig Gas Flow 0
Generat " " " 122
8) Dechlor ORP Deox-2000 -150 unhooked
Final ORP 85 mV
9) Digester Gas Pressure PT1-DCB2 1
PT1-GB 45
PT1-PS4 45
PT2-DCB2 1
PT3-DCB2 47
Total Avg Gas Cap 84 calculated.
10) PS #3, Prim Clarif 5 & 6 Sludge Flow 207
11) PS #5, " 7 & 8 " " 226.3
12) PS #14, " 9 & 10, 1-4 " " 1-4 -74.9
" " " " 9 & 10 131.4
13) PS # 8 Final Clarif 1 " " 1.7
" " 2 " " 1.72
14) PS #9 " " 3 " " 1.64
4 " " 1.62
15) PS #6 " " 5 " " 1.64
6 " " 1.75
16) PS #10 " " 7 1.66
" " 8 " " 1.65
17) PS #12 " " 9 1.69
10 No Value
18) Yard Structure No 1 Side Stream -2
19)

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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Trends (cont'd)

19)	Metering Bldg - Prim Sl to Thickener	1	-250
	" " " " "	2	202
20)	" " " " "	3	318
	" " " " (future)	4	(-250)
21)	" " Makeup Water to Thickener	1	-375
	" " " " "	2	-375
	" " " " "	3	-375
22)	" " WAS to "	1	455
		2	-298
23)	PS #7 WAS Flow		911
24)	Thickener 1 Sludge Flow to Digesters		5.6
	" 2 " " " "		111.5
25)	Metering Bldg WAS to Gravity Thickener	3	452
26)	Gas Temperature TT1-GB		106
	" " TT1-PS4		82
27)	Thickener 3 - Sludge Flow to Digesters		114.1
	4		-75

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
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COMP BY TRG DATE MayJun/06 CDK BY _____ DATE _____ SHEET _____ OF _____

Facility Improvements to be made

Electrical Service

Stormwater Basin Improvements

Bio Towers Assessment

Headworks Improvement.
Remove Screen washers & replace w/ new washer/compactor
Replace Grit Screw Conveyor

Gravity Thickener Repair (2 of 3 are bad)
Probably DAFT thickeners

	Project	Design Estimate Equipment	Design Estimate Installation or Service	Design Estimate Spare Parts	Total	FY 05-06	FY 06-07	Contract	Design Assigned to:	Timeline	Comments	Spending 05/06 Fiscal Year	Update	
1	**Rehabilitate Sludge Line**	$400K	$50K	0	$1million	$22K-50K		Work is being done by Kenneth Riddles, Patrick Paddock and Fred Bass	Kenneth Riddles Fred Bass Patrick Paddock		Going out to Bid next week Pete Mulvey is handling easement location contract Ken needs to	$22K-$50K	Pre-Bid due back to Procurement 5/16	1
2	**(2) Washer Compactors**				$710,726 GMP	$25,000	$685,726	JOC #1 QCCI	Maria Hollingsworth John Sherlock/ Jack Van Riper	Construction complete 01/02/2007	Working on purchasing equipment by 6/1 S&L submittal on grit screw received by QCCL on 05/06/06 had numerous errors and was returned for resubmit. JWC submittal on washer compactor is due on 05/22/06 to ACCI			2
3	**(2) Grit Auger Troughs**													3
4	**Replace or Repair Effluent Pumps ~~and Add VFD's?~~**				200K?	50K?	150k?	JOC #3 QCCI	Jack Van Riper/ Maria Hollingsworth		Expecting GMP #1 on April 14 for reduced scope.			4
5	**Replace Pump #4 Controller with VFD**				$308,250	$100K	$208,250	JOC #2 QCCI	Howard Woolsoncroft Timothy Harmon Jack Van Riper	Construction complete 08/01/06	Expect 1st GMP proposal by May12.	$100K		5
6	**Chlorine Containment Basin**	For Bisulfite-use existing chlorine tank behind building.				>100K		JOC #4 QCCI	Bob Buecher Jack Van Riper		Doing containment only The price is too high. Need breakdown on subcontractors fees/times, etc.			6
7	**Stormwater (emergency) Basin**	0	$190K		$1,397,300 Engr. Est. Add alternate	-0-	$1,397.3K	QCL-Design	Maria Hollingsworth	Completion 01/31/07 Notice to proceed was issued for Item #7.	Two basins joined for one single project, with new pond as base bid and rehab pond as an add alternate. Received Bid documents from Maria		Advertising for Bids 5/5/06 Pre-Bid-5/19 Bid-5/25 Award 06/06	7
8	**Stormwater (permanent) Basin**				$1,781,400 Engr. Est. Base Bid	Design-$97K Build -0-	$1,781.4K	Assessment-Design Bid-Build QCL-Engineering-Design	John Munden Bob Buecher Maria Hollingsworth-Construction Frank-Design					8
9	**Truck Ramp Enclosure-Design**	0	0	0	<$100K	<$100K		Design/QCL	Michael Kostrzewski/ Jack Van Riper	Preliminary in 1 mo. Final Design 4 mos. Notice to Proceed was issued May 4, 2006	This is part of odor control to cover truck and conveyor at the headworks. Preliminary Design awarded to B&C as QCL. ($100,000). Select contractor by September 1, 2006. Completion construction by FY 2006-07 ($1.5-2.0 million). Complete Preliminary Design June 1, 2006 Design Scope to Procurement July 1, 2006 Need isolation valves at Pump Station 14.	$100K	Brown & Caldwell Get Final Report	9
	Conveyor Belt-Odor Control-Constr.				$250K $3 million									
10	**Odor Control Study**				$1.5m				Bob Buecher Edward Jandali		Meeting 5/11/06 had more changes redefining hours and scope to reduce cost.			10
11	**Cover Primary Clarifiers**				<$100K	<$100K		Assessment /QCL Design/Study	Michael Kostrzewski Jing Luo	4 weeks	On Hold until Odor Control Study		In Procurement-QCL	11
12	**Backup (Blower) Aeration System**	0	0	0	$91K	$91K	$1.5m Construction	Design/QCL	Michael Kostrzewski/ John Sherlock		Waiting for 90% from Chris.		Stantec	12
13	**Belt Thickener (enclosed) Expansion/Replacement**				$30K			Assessment-QCL QCL-Design	John Sherlock Jing Luo Maria Hollingsworth		Overflow box needs to be reconstructed.Solids handling a problem.		Greeley & Hansen	13
14	**Biosolids**	Tabled-5 YR CIP Funding. Part of Facility Plan. Being discussed by Biosolids Committee. Send more sludge to Ina vs send all sludge to Ina. All issues re: Centrifuge, Belt Thickener, DAF's will affect this project.				$99,969		QCL-Design	Jing Luo	Complete Contingency Plan April 3, 2006	Brown and Caldwell meeting on Contingency Plan.		Meeting 5/17/06	14

	Project	Design Estimate Equipment	Design Estimate Installation or Service	Design Estimate Spare Parts	Total	FY 05-06	FY 06-07	Contract	Design Assigned to:	Timeline	Comments	Spending 05/06 Fiscal Year	Update	
15	Biotower Condition Assessment	0	0	0	$100K	$100K		QCL	Jing Luo		Scope is being re-written to focus on the operation and condition of the Bio-Towers. Procurement has sent the scope out to consultant. Fee proposal has been received with a total cost of $98,296.		Meeting with Malcolm Pirnie-5/2/06	15
16	NdeN Evaluation/ Flow Optimization Study				**$2million**				Ron Riska	6 months	Reuse Workshop on 5/31/06		Greenley & Hansen	16
17	Electrical Upgrade						$500K $10million	Design Construction Contract CMAR QCL-electric	Maria Hollingsworth Jack Van Riper		Scope reduced to include only predesign work, to be used as input to NdeN /long range planning study. Expect BOS contract award 18 April 06 and completion by 01 Aug 06. Maria wants Kennedy/Jenks to do master plan for electric Remove gas scrubbers from electric upgrade Pre-design by August. Greeley & Hansen will reduce design. Limited amount of funds.		Paul will submit to Board of Supervisors for 5/16/06 agenda	17
18	SCADA System for Roger Road WWTP (O&M)	$600K	$1.1m	0	$750K $2.2m			Design/QCL	Michael Kostrzewski Stu Spaulding Jack Van Riper		On Hold. Use Allen Bradley throughout our system Need to communicate to base station			18
19	Instrument Upgrades	$180K	0	$60K					David Longobardi Stu Spaulding			$80K	We will install in-house	19
20	#6 Aeration Isolation Valves							JOC #6 QCL	John Sherlock/ Maria Hollingsworth					
	#7 Valve & Vault- Secondaries 1 and 2				$48,802				Maria Hollingsworth	08/15/06	John will discuss this project with Quest. John is putting together a Scope.			20
	#8 Valve & Vault- Pump Station 6				$85,819				Maria Hollingsworth	09/29/06				
	#9 Isolation Valves At Pump Station 14				$28,786				Maria Hollingsworth	08/04/06				
	#10 Furnish, Install & Relocate Flow Meters				$72,347				Maria Hollingsworth	09/29/06				
21	Odor Control Thickener #1 & #2				$250K				Jack Van Riper		Non-automated single chemical scrubber Platform is rusted and tower is leaning slightly Platform is deteriorating and leaking. 8,000 CFM for Scrubber System		Getting quotes for the equipment	21
22	Trailer Replacement Operations with Engineering Maintenance								Pete Magaddino		Operations need 10-chair conference room with 2 offices for Operations 3 offices for Engineering, receptionist area with bathrooms and women's change room with showers Maintenance need lunchroom with locker room with showers (current trailer)		Waiting on Floor Plan	22
23	Roger Road Administration Building										Waiting for the outcome of the NdeN Directors moved it until the study is done.			23

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY AJM DATE 6/15/06 CDK BY _____ DATE _____	SHEET ~~Out~~ OF-1 OF _____

OUTLYING FACILITIES (9)

→ RANDOLPH PARK – 3.5 MGD
- MEMBRANE FACILITY
- CAN'T GET 3.5 mgd CAN GET 2.8 mgd
  HEADWORKS RESTRICTIONS

→ PIMA COUNTY FAIRGROUNDS 100,000 gpd DURING FAIRE
- COMPLE HUNDRED OTHERWISE
- SET OF PONDS

→ CORONA DE TUCSON .75 mgd
- PONDS GETS 100,000 gpd NOW LOTS OF CONSTRUCTION
- PACKAGE PLANT
- EVAPORATED OR SAT BASINS
  ↳ SOIL AQUIFER TREATMENT

→ AVRA VALLEY PLANT
- BEING UPGRADED FROM 1.2 mgd TO 2.2 mgd
- OXIDATION DITCH PLANT
- DISCHARGE TO PERC BEDS
- 4 mgd OX DITCH FUTURE

→ MORANA WWTP
- NOW 150,000 gpd
- 3 SMITH & LOVELESS (NIT + DENIT) PACKAGES
- PUTTING IN 4TH AND BIO-LAC AND FILTER 4 OR 6 MGD OX DITCH
  ↳ S+L

→ GREEN VALLEY · 3 mgd
- OX DITCH (1.5 mgd)
- PONDS (1.5 mgd)

→ ARROW VAQUA + RILLITO PONDS

RANDOLPH PUMPS SOME OF ALL OTHERS WET HAULS TO A SEWER

AVRA + ARROWVAQUA → ROGER
~~CORONA → ROGER~~
ANTI. LEMON → INDA
MORANA → INDA
OTHERS → ROGER

GREELEY AND HANSEN

PROJECT ROMP | PROJECT # Instrumentation

SUBJECT ONCE DOWN NOW SOME OF RELIABLE MOTORS REPLACED IN ONE YEAR NOT AS GOOD AS PATERSON | CLIENT Pima County WMD

COMP BY _____ DATE _____ CDK BY _____ DATE _____ SHEET OF-2 OF _____

LOTS OF SPRAY WATER

RANDOLPH PARK

RESTRICTING PLANT

(4) SCREENS JONES + ATWOOD (6mm + 2mm) MATE W/ HOLES

ODORS AT LIFT STATION

AERATED GRIT TANKS

(2) SCREEN PUMPS

SCREENINGS WASHER COMPACTOR

NOT USED BECAUSE OF SMELL

GRIT WASHER CYCLONES (2)

WEMCO

~~FOUL SUMP~~ SCREENINGS SUMP PLUGS EVERY WEEK

(1) US FILTER CHEMICAL SCRUBBER

- LOTS OF LEAKS
- SODIUM HYPO TANK
- SODIUM HYDROXIDE TANK
- SAME AT LIFT STATION

AGITATION AIR BLOWER

TURBOTRON

- ONLY FEED CHLORINE TO LIQUID STREAM, ~~SO~~ BECAUSE CITY WANTS CHLORINE RESIDUAL.

(ROTARY) PROCESS WATER

PEERLESS PUMP

~~TW~~ (2) AIR COMPRESSORS

(~~12~~) ANOXIC BASINS (6)

RAW SEWAGE PUMPS (3)

FAIRBANKS

AERATION BASINS (6)

- MEMBRANES IN BASIN 1/2

GRIT PUMPS (2)

WEMCO

- SOME CONCRETE SURFACE WEAR ON OLD TANKS

(6) TROJAN UV $

SSOP

WAS PUMPS (2)

VOGELSANG

(6) PERMEATE PUMPS

GOULDS

RAS SAMPLER (1)

SIGMA

(6) BLOWERS

(5) BACKWASH FILTER PUMPS

PEERLESS

FINAL EFFLUENT SAMPLER (1)

SIGMA

(2) SCUM PUMPS

ROTARY LOBE VOGELSANG PUMPS

HIGH O&M COSTS UV, MEMBRANE

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 1 OF 3 OF _____

GREEN VALLEY

- PVC ROTTING FROM SUN EXPOSURE
- INFLUENT WET WELL 30' DEEP NEED BYPASS TO GET BELOW 3' TO DRAIN OVERFLOW BASINS
- HAVE AERATORS IN DIGESTERS. THE AERATORS AREN'T GETTING AIR INTO TANKS
- GBT - 4% SOLIDS
- BFP - 15% SOLIDS
- THEN TO DRYING BEDS

- LIKE PARKSON SCREEN
- DONT LIKE PARKSON WASHER COMPACTOR
- BIOFILTERS
- NOT EASY TO ISOLATE ONE FILTER TO TAKE OUT OF SERVICE

- ALGAE PROBLEMS W/ SUN AND NO COVERS/ROOFS

AVRA VALLEY

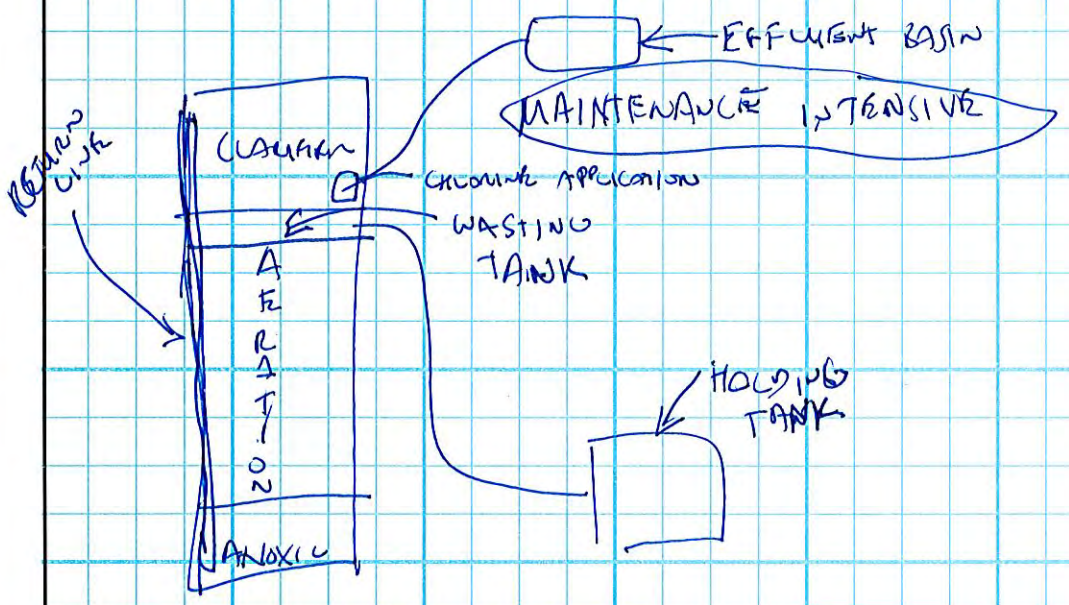
- EMERGENCY GENERATOR W/ MANUAL SWITCH, ONLY 1/2 LOAD OF THE PLANT
- PARKSON AQUAGUARD SCREEN
- EQ BASIN
- OXIDATION DITCH ORIGINALLY TEMPORARY, WORKS SHOTCRETE, CRACKING
- 2 CLARIFIERS
- OUTDOOR PUMP STATION
- 2 GRAVITY THICKENERS

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 0F-4 OF _____

MARANA VALLEY

- WASHER COMPACTOR SCREEN
- (2) GRIT CHANNELS
- 3' WIDE PARSHALL FLUME UNDERSIZED FOR FUTURE
- 4 PACKAGE PLANTS
- SUPPLEMENTS W/ METHANOL AS A FOOD SOURCE



- PUTTING IN LINED BIOLAC DITCH

IN GROUND BIOFILTER

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET _____ OF _____

GREEN VALLEY

3 mgd total
Oxidation ditch (BNROD) = 1.5 mgd
Ponds = 1.5 mgd

BNROD System is relatively new
Very operator friendly - set @ constant flow
- all else goes to ponds

Aerated Lagoons / Polishing Ponds - takes everything > BNROD flow

Influent Wetwell : 38' deep
Normal operating level is higher the EOB level
↑ (emerg overflow basin)
∴ EOB will not drain back
→ Have to put controls in bypass mode to pump down lower to allow EOB to drain back

Aerobic Digesters :
Don't get enough air
Basically act as just aerated sludge storage tanks

Sludge → GBTs → Digesters → BFP → Drying Beds
(4% solids) (15% cake)

Drying beds at Limit of Capacity

They like Parkson screen
They DO NOT like Parkson washer/compactor

PVC piping is rotting from exposure to sun.

Have biofilters for odor control at headworks
not easy to take one filter out of service

Algae problems due to sun, no covers/roofs

SCADA allows remote control

Subdivisions creeping closer from the west

Asarco mine takes sludge and mixes with mine tailings to reclaim land

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET _____ OF _____

AURA VALLEY

2.2 mgd ultimately
1.2 mgd now

Oxidation Ditch which discharges to percolation beds
Rotors are low maintenance
Ditch liner is Gunnite - has some problem areas structurally

Influent → Parkson Aquaguard screen → Eq. Basin
→ Oxidation ditch → 2 Clarifiers → Effluent Reservoir → Evap/perc beds

Sludge from clarifiers (WAS) sent to 2 gravity thickeners, then sent to INA ROAD WWTP

Effluent reservoir can also be sent (pumped) to spray field

Emerg. Generator:
Manual start only, manual transfer
Takes 1.5 hours to do this
Only runs 1/2 of plant load
Needs auto start and transfer switch

No SCADA, just an alarm dialer

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET _____ OF _____

MARANA

North side of county - very high growth area

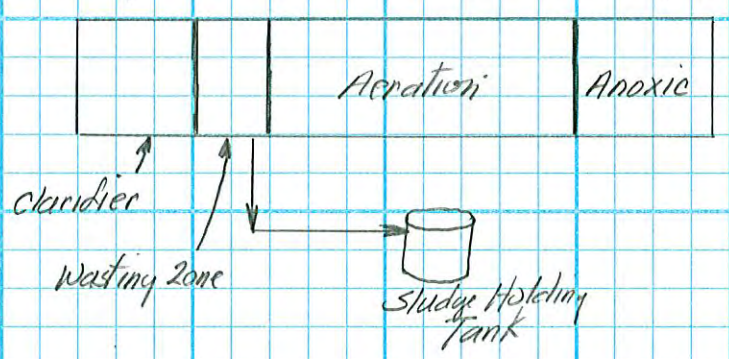
Presently 150,000 gal/day

Treatment = Four 50,000 gal/day package plants

3-inch parshall flume @ headworks (max capacity = 0.7 mgd)
Washer compactor screen
Two grit channels
Package plants ← maintenance intensive

Proposing a Parkson "Biolac" activated sludge treatment system in an excavated basin (0.5 mgd capacity)

Existing Package Plants (Nitrification / denitrification)



In ground bio filter for odor control at headworks

SCADA:
PLC-5/2 has redundant processors
" SLC I/O chassis
Very plain Wonderware SCADA terminal
Alarm dialer software

GREELEY AND HANSEN

PROJECT Pima Co
SUBJECT Meet w/ Ken Weber
PROJECT #
CLIENT
COMP BY DATE CDK BY DATE
SHEET 9 OF

Robert Krause
Chief I&C guy

OUTLYING FACILITIES

TOTAL = 9

Mount Lemon: 2-3000 gal/day design 15,000 gal/day.
Send people every day

Randolph Park 3.5 mgd rated - can't get that thru it. ~ 2.8 mgd
due to restrictions @ headworks

Fairgrounds Small ponds 200 gal/day
1000 gal/day during fair

Corona de Tucson: Lakeside plant ~ 0.75 mgd package.
100,000 gal/day
Small ponds - SAT Basins or evaporated
Soil Aquifer Treatment.

Avra Valley: 2.2 mgd (now 1.2 mgd)
Oxid. ditch
discharge to perc beds

Marana WWTP: 150,000 gal/day
3 Smith-Loveless Nit-deNit plants
putting in 0.5 mgd BIOLAC

Green Valley: 3 mgd
New plant: Ox ditch (BNROD)
Old " Ponds (

Aravaca Pond
Rillito Pond

Randolph pumps solids back into sewer (to Roger Road)
All others (except Green Valley) haul wet solids back
to either Roger or Ina.

Marana
Mt Lemon

Green Valley - Asarco mine takes sludge
and mixes w/ tailings to reclaim land

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 10 OF _____

SCADA PIC = 244

Randolf Park - can't control, dial out
lots of problems (2 shifts / day)

Green Valley - sorta same

Avra - dial out dialer (no computer)

Marana - small Scada PO & levels, alarms (only local) with dialer

Mt Lemon - dialer

Headquarters manual only during day.
All others same except Randolf. ← 2 shifts/day

Randolf.

Plant Scada ← also @ lift Station - same
Xenon " } separate computers.
← factory can call in.

Xenon will transfer some info to plant SCADA

Computer @ lift station does same as plant.

SCADA is biggest problem - integration of different systems

Have to manually restart after power fail.

Lift Stn bar screens limit ability to pump to plant
+ 130,000 gal / day potable water use @ lift Stn Sor - because of no permeate water line from plant. screen spray.

$50,000 year for UV bulbs
8-10 yr membrane life @ $3-5 million to change

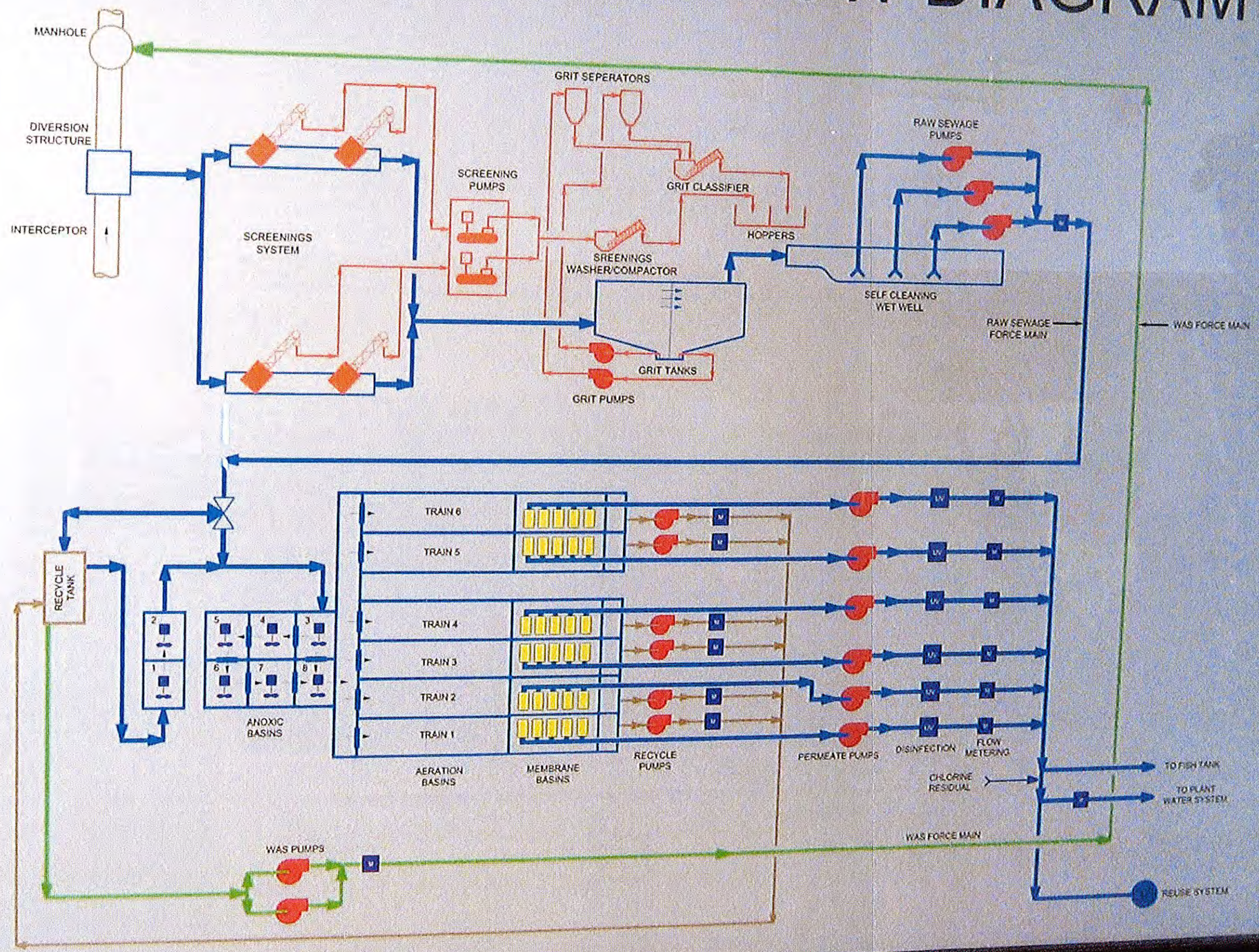
Lift Stn has odor control
screenings returned to sewer, bypass washer compact for

dist PIC 245
LAST PIC = 267

RANDOLPH PARK WRF - FLOW DIAGRAM

LIFT STATION

WATER RECLAMATION FACILITY



GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE 4-15-04 CDK BY _____ DATE _____	SHEET 11 OF _____

GREEN VALLEY (last PIC = 100-288)

New BNROD
Old Aerated Lagoons / Polish Ponds

- BNROD is very operator friendly - constant flow

Aerobic digesters don't get enough air
basically just aerated sludge storage tanks

Sludge → GBTs → Digesters → BFP (15% cake) → Drying Beds

Drying beds @ limit of capacity

Influent Wetwell: normal operating level > EOB level
∴ EOB won't drain back
- have to put controls in bypass to pump down lower to allow EOB to flow back

PVC is rotting from sun exposure (disinfection)

SCADA
- Works OK - Wonderware (redundant servers)
- Not password protected for changes
- Central is capable of remote control
- 3rd Workstation monitors turbidities - Noisy server

Last PIC = 100-288

first PIC = 100-268

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE 6-15-06 CDK BY _____ DATE _____	SHEET 12 OF _____

AVRA Valley

Emergency Generator
manual start, manual X-fer – 1½ hours to do this
Only runs ½ the plant load
They need auto-start and transfer switch

Ditch liner is Gunnite – some problem areas

Rotors in BNROD are low maintenance

2 sludge tanks → liquid transfer to trucks

No SCADA, just alarm dialer

first -289
Last PIC: 100-303

MARANA

Four 50,000 gal/day package plants

3-inch parshall flume @ headworks (max capacity = 0.7 mgd)

Proposing a BioLac system in Excavated Basin

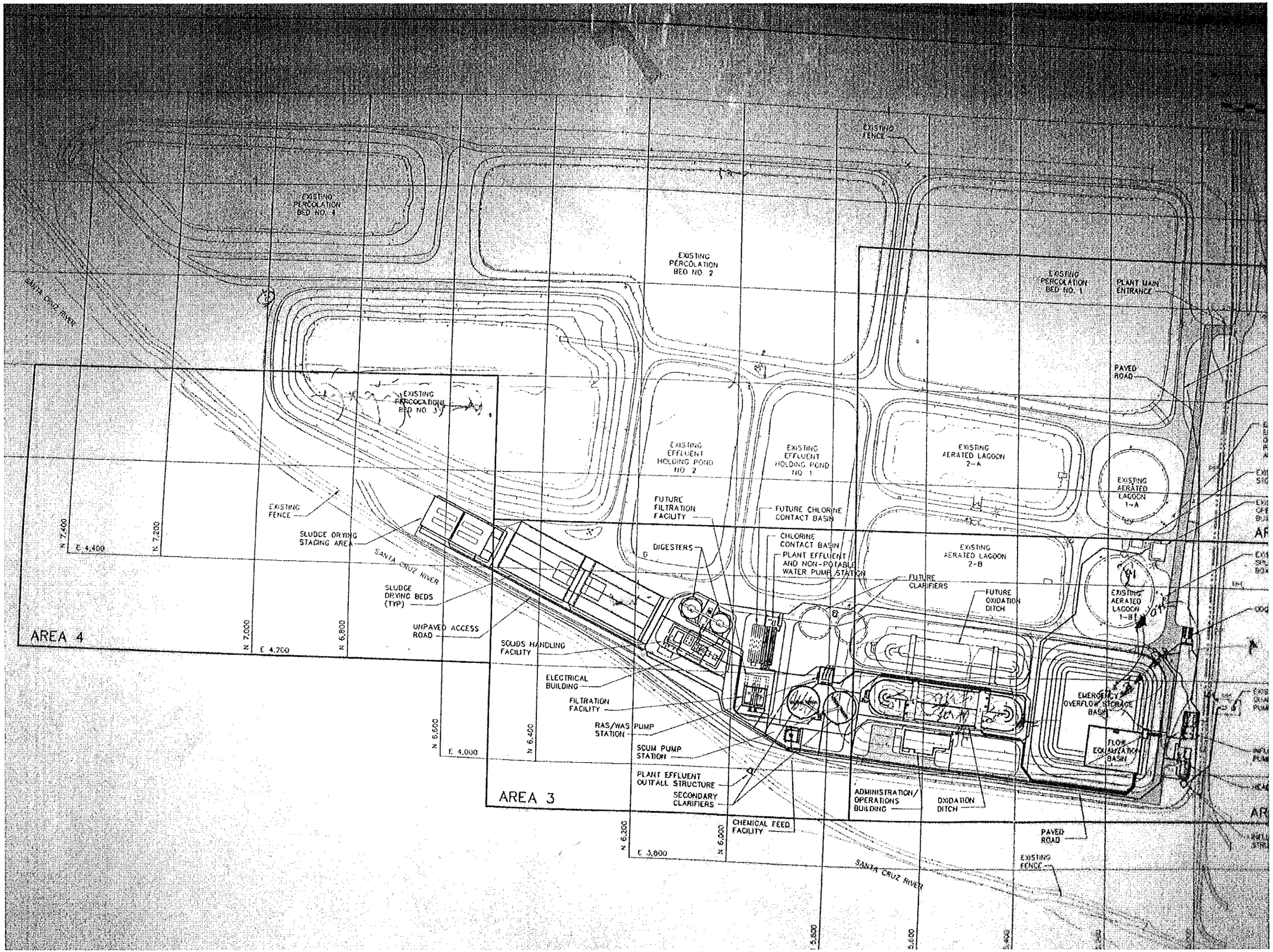
Very plain Wonderware SCADA terminal
Alarm dialer software

PLC-5/20 with SLC I/O chassis
↑ Redundant processors

BioFilter for odor control

first pic 304
last pic 316

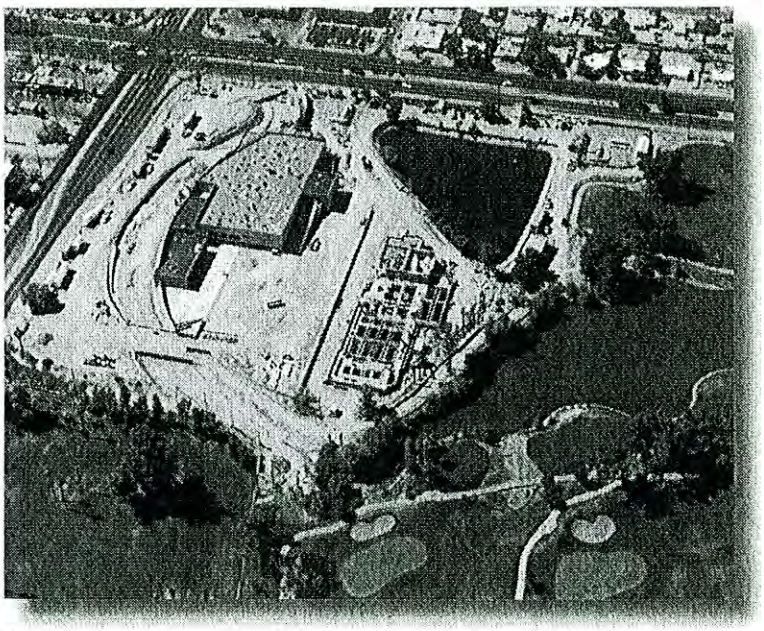
GREEN VALLEY



Randolph Park Water Reclamation Facility (WRF)

The Randolph Park WRF was originally constructed by the City of Tucson and put into operation in 1975. In 1979 an Inter Governmental Agreement (IGA) between the City of Tucson and Pima County transferred all wastewater treatment responsibilities from the City of Tucson to Pima County. Pima County then operated the plant from 1979 until it was shut down in 1995 during construction of a flood control project on the adjacent golf course. The plant was originally rated at 1.5 MGD, but had an average flow rate of about 634,000 GPD.

In February 2000, the City of Tucson and Pima County entered into a Supplemental IGA. This agreement included restarting the Randolph Park WRF. A portion of the flow of the refurbished facility was designated for irrigation of the adjacent City-owned Golf Course. The remaining plant flows are to be wheeled by Tucson Water to Pima County facilities.



To maximize the reuse benefits from the Randolph Park WRF, it was decided to double the plant capacity on the small site, and thereby change the flow from 1.5 MGD to 3.0 MGD. Even though the plant site is very small, it is in an ideal location to take advantage of the City of Tucson's reuse system. This allows the effluent to be pumped directly into the Tucson Water reuse system without a long force main.

The plant consists of three major components, a lift station, a force main, and the main plant. The lift station is located approximately 2.3 miles to the west of the main plant. This location was needed in order to obtain enough wastewater for the 3.0 MGD facility. Wastewater is scalped from an existing 42-inch Aviation Corridor Interceptor. The remaining flow in that collection sewer continues downstream to the Roger Road WWTP for treatment.

To maximize the main plant site, screenings and grit facilities are also located at the lift station. This has the added benefit of minimizing solids depositions in the force main, as the main solids are removed before pumping. The force main conveys flows to the main plant, where the existing tankage has been re-engineered to allow for the installation of membranes for a membrane bioreactor (MBR) process. The MBR was also selected to maximize use of the existing acreage, as well as provide for a minimum of Class A quality reuse water. The facility is permitted for Class A, but is capable of producing Class A+ reclaimed water.

There are no solids handling facilities located on the site. All solids are conveyed back to the 42-inch Aviation Corridor Interceptor for treatment at the Roger Road WWTP.

Ina Road Water Pollution Control Facility (WPCF)

The Ina Road WPCF will soon be a 37.5 MGD wastewater treatment facility. After passing through newly constructed common Headworks, it was designed for an ultimate 50 MGD flow, consisting of an influent pump station, bar-screens and grit chambers, the wastewater is treated in two different treatment trains, the original 25 MGD High Purity Oxygen (HPO) activated sludge process treatment

Contact! Ken Weber

SUB-CHAPTER 5.3 OUTLYING FACILITIES CURRENT CONDITIONS

PCWMD provides service to the areas adjacent to the Metropolitan Treatment Facilities by operating several small capacity plants. These small capacity plants are located throughout eastern Pima County where population densities provide their economic justification. These small capacity plants are collectively known as the Outlying Treatment Facilities. Although not included in the scope of the 2006 Metropolitan Area Facility Plan Update, a brief discussion and overview is included to acknowledge their existence and functions.

The Outlying Treatment Facilities include Arivaca Junction WWTF, Avra Valley WWTF, Corona de Tucson WWTF, Ed Pastor Kino Environmental Restoration Project (KERP), Fairgrounds WWTF, Green Valley WWTF, Marana WWTF, Mt. Lemmon WWTF and the Rillito Vista WWTF.

The Facility Plan also considers the total area immediately south of the Roger Road WWTP Tributary System designated "The Southlands" that, upon development, could flow by gravity to the Roger Road WWTP. The Southlands tributary system does not currently culminate in a treatment facility but rather at a "collection point." The Southlands collection point concept is a planning tool to permit estimating future treatment needs of this area that is predicted to experience major growth in the coming decades and is not discussed in Current Conditions.

Site plans and flow diagrams are not included in this presentation (see Figure 5.3.1).

Arivaca Junction Wastewater Treatment Facility

Arivaca Junction WWTF is located in extreme southern Pima County at the Santa Cruz County line and Interstate 19 (I-19). This WWTF is a 66,000 GPD per day, aerated lagoon whose effluent is used to irrigate nearby pastureland. This facility will be closed upon completion of a combination gravity/pressure sewer line to the Green Valley WWTF.

No current repairs are needed at this facility.

Avra Valley Wastewater Treatment Facility

The Avra Valley WWTF is located roughly 10 miles southwest of Tucson at 10,000 West Snyder Hill Road. The site, which has a total area of 140.39 acres, has been the location of a WWTF since 1967. The population in the area served by the WWTF has expanded rapidly in the period from 2000 to 2005. During this period, a large casino operated by the Pascua Yaqui Tribe contributing flow to the WWTF was constructed. The ADWF and PDWF to the WWTF in December 2004, measured by the SCADA meter at the WWTF's entrance, was 0.90 MGD and 1.49 MGD respectively.

The WWTF's treatment and disposal capacity is rated at 1.2 MGD ADWF and 2.2 MGD PDWF. The main treatment component is an oxidation ditch installed in 1994.

The sewage enters the WWTF through a lift station discharging first to a screening channel then into a flow-equalization pond with a volume of 0.37 million gallons. Treatment by extended aeration, activated sludge, and biological nitrogen removal in an anoxic zone occurs within the oxidation ditch. Additional denitrification and stabilization is achieved using aquaculture. Disposal is completed through evaporation and percolation. The waste activated sludge is pumped into sludge holding tanks. The sludge is allowed to thicken during the fill and draw process. After it is concentrated it is hauled to the Ina Road WPCF for further processing and disposed of with processed biosolids from the Regional Biosolids Facility.

The oxidation ditch is designed for a flow of 1.2 MGD with a loading rate of 14 pounds BOD per 1,000 cubic feet of volume per day. This flow is at the lowest range of capacity for the equipment

to allow maximum operability for the manipulation of a denitrifying anoxic zone. The oxidation ditch is equipped with aerators to supply oxygen as well as submersible mixers.

The aerated mixed liquor from the oxidation ditch flows into two clarifiers via a distribution box. The settled sludge is returned to the oxidation ditch or sent to the sludge storage tanks for liquid-solid separation and hauled to the Metropolitan Treatment Facilities for further processing.

The clarified effluent can be discharged into the effluent reservoir or any one of the four peculation ponds. The percolation ponds are used in rotation with a fill and dry cycle for each pond. The effluent reservoir can also be discharged into the Black Wash spray field system.

Condition Assessment

Treatment capacity was reviewed to determine if additional capacity may be achieved with the same facility. It was determined the WWTF can reach the higher capacity ratings, currently estimated to initially be 1.6 MGD and ultimately 2.2 MGD with additional enhancements and equipment.

The WWTF presently has no outstanding repair issues; however, the integrity of the existing oxidation ditch requires evaluation. The evaluation will require emptying the present oxidation ditch. Therefore, the evaluation cannot be performed until this facility is expanded with an oxidation ditch of the same or larger capacity. There are areas of the current oxidation ditch considered likely to require repairs, particularly the sections of the ditch constructed of "gunite" concrete together with their supporting soils. Additionally, as the WWTF approaches the new design capacity (2.2 MGD), an additional percolation pond may be required.

The WWTF is considered a candidate for expansion in the immediate future to meet the growth in its tributary area, which will be discussed in Chapter 5.4.

Corona de Tucson Wastewater Treatment Facility

The 200-acre Corona de Tucson WWTF is located approximately 22 miles southeast of the City of Tucson at 1100 West Sahuarita Road. The present facility, rated at 0.117 MGD Disposal Capacity, was constructed in 1983. This facility may be incorporated into a larger regional facility in the rapidly growing region in the "Southlands" portion of the Tucson Metropolitan Area.

The WWTF consists of two soil cement lined stabilization ponds of 3.3 and 3.7 acres, operating at average of four feet depth of water. Mechanical aeration was not provided in the original design. The stabilization ponds can be operated either in parallel or series. The WWTF is designed so that the treated water from the stabilization ponds can overflow into an adjacent 10.2-acre lined evaporation pond. There is also a 6.1-acre unlined pond serving as a recharge basin.

Sewage enters the WWTF through a gravity interceptor and then passes through a Parshall flume flow-metering chamber. After passing through the flume, the flow enters a series of "splitter manholes" dividing flow between the stabilization ponds.

The flow enters the stabilization ponds through 18-inch diameter pipes, which extend out into each pond. Stabilization of organic material, a natural occurrence of biological, chemical and physical processes takes place here.

Discharge flows from the storage and stabilization ponds to the evaporation pond where the surcharge capacity and surface area of the ponds provides for storage and evaporation of all inflows. No discharge of effluent to surface or groundwater occurs at this site. The evaporation pond provides enough surface area to completely dispose of 117,000 GPD. Surface evaporation rates can be expected to vary from a maximum of 9 to 10 inches per month during the summer to a minimum of about two inches per month in the winter.

At present there are no repair requirements; however, the WWTF is in a rapidly growing area and is in need of expansion. The initial capacity expansion will be through the installation of mechanical aerators and will utilize Soil Aquifer Treatment for disposal and increase the capacity to 300,000 GPD. This expansion is complete and awaiting the required ADEQ permits to begin operation. The second stage of expansion, a 500,000-GPD-package plant oxidation ditch is currently being engineered for installation and commissioning in the fourth quarter of 2005. The effluent will be recharged and stored in the aquifer for future beneficial use.

Ed Pastor Kino Environmental Restoration Project (KERP)

The newly constructed Ed Pastor KERP provides innovative water conservation for Pima County. This project, built as a joint effort with the U.S. Army Corps of Engineers, utilizes stormwater and reclaimed water, stored in the 120-acre Ajo Detention Basin, to irrigate county owned facilities at the nearby Kino Sports Complex. The project also involves transforming the once concrete basin into a riparian habitat serving as a refuge for migrating and native wildlife. In addition to providing a riparian habitat, the stored water is used to irrigate ball fields and parks. Although the KERP is operated by Pima County's Stadium District, PCWMD provides testing of the waters and assists with the operation and maintenance of the onsite pump station. As this is not really a treatment facility with no plans for expansion, it will not be included in the discussion of the future for Outlying Treatment Facilities.

The recirculation pumps require modification and also the addition of a chlorination/dechlorination system is considered likely.

Fairgrounds Wastewater Treatment Facility

This WWTF, located at the Pima County Fairgrounds, is a 3,000 GPD evaporation pond facility operated for the convenience of the public during events such as the Pima County Fair, concerts, sporting competitions and specialty shows.

The WWTF needs improvements to the influent box and the addition of a SCADA recording flowmeter.

Green Valley Wastewater Treatment Facility

The Green Valley WWTF, the major facility serving southern Pima County, is located on a 52-acre rural site, 3/4 mile north of the Green Valley residential area at 2201 N. Old Nogales Highway, approximately 250 feet east of the Santa Cruz River. The original WWTF was constructed in December 1964, expanded in 1972 and again in 1981. The latest expansion, completed in 2004, added a 2.0 MGD Biological Nutrient Removal Oxidation Ditch (BNROD) increasing the total plant capacity to 4.1 MGD ADWF.

The Green Valley WWTF processes wastewater through two separate parallel treatment trains, the Original Train and the BNROD Train. The plant includes the following major components:

Headworks (screenings/grit removal and direct flow to either the emergency overflow basin or the influent pump station)

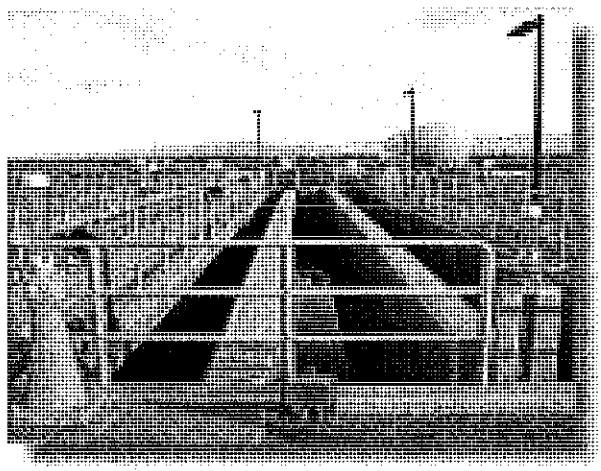
- Emergency Overflow Basin.
- Influent Pumping.
- Metering Station.

Lagoon Train (original treatment plant)

- Aerated Lagoons.
- Effluent Polishing Ponds.
- Percolation Beds.

BNROD Train

- Activated Sludge Process Oxidation Ditch with Biological Nutrient Removal (BNR).
- Secondary Sedimentation.
- Recycle Activated Sludge (RAS) / Waste Activated Sludge (WAS).
- Solids Handling.
- Filtration.
- Disinfection.



Influent flow passes through the headworks for screening and grit removal then flows to the influent Pump Station. Screenings and grit are disposed of at a municipal landfill.

The influent pump station is comprised of a wet-well and pump station. The Pump Station discharge divides flow between the original and BNROD trains. Should a power failure occur, the influent wastewater diverts to the emergency overflow pond. When power is restored, wastewater can be valved back to the pump station.

Lagoon Train

Influent directed to the original treatment train passes through primary aerated lagoons, secondary aerated lagoons, an effluent holding pond and percolation beds. The two primary, mechanically aerated lagoons may be operated in parallel. These lagoons are concrete lined, aerobic aerated units providing a high rate of oxygen transfer from air to wastewater and discharge to the secondary lagoons. The secondary, mechanically aerated facultative lagoons provide partial mixing and aeration by means of floating aerators and are capable of being operated in series or parallel.

The Aerated Lagoons discharge to two parallel effluent polishing (maturation) ponds providing natural aeration for biochemical oxidation and solids settling.

Effluent from the polishing ponds is disposed of through rotation to four percolation beds, totaling 11 acres, used alternately. The effluent is directed to one percolation bed at a time then the bed is allowed to dry while the effluent is directed to the next pond. Effluent discharged the percolation beds may be provided to local entities for reuse and/or recharge or may be discharged to the Santa Cruz River.

Once every 5 to 10 years, biosolids, which have settled in the bottom of the secondary aeration lagoons and polishing ponds, are removed and disposed of by land application or to the Tangerine Road Landfill.

BNROD Train

The parallel BNROD treatment train is an activated sludge with biological nutrient removal process carried out in an oxidation ditch wherein the influent flows around a loop and is aerated by a mechanical brush rotor system. Submersible mixers operate continuously to maintain the activated

sludge in suspension. To achieve nitrification, an aerobic zone is when the aerators are operated. Denitrification is achieved in an anoxic zone created when the aerators are off. The oxidation ditch overflows a weir to secondary clarifiers.

The secondary clarifiers settle the activated sludge. Return activated sludge is pumped to the oxidation ditch inlet structure while WAS is pumped to the gravity belt thickeners. Effluent flows to the filters where the multi-media filter of sand and anthracite reduces suspended solids/turbidity to less than 2 NTUs.

The WAS flow is pumped through polymer addition static-mixers and discharged onto two parallel gravity belt thickeners. The thickened WAS (TWAS) is pumped to parallel aerobic digesters. Digested (stabilized) solids are pumped through a static mixer to a belt filter press. The produced filter cake is discharged to a hopper and then moved to a sludge drying bed. Liquids decanted off the biosolids (supernatant) are returned to the head of the treatment process. The biosolids are transferred from the storage facility to the truck loading facility for disposal.

Filtered effluent flows by gravity to a chlorine contact tank where the required dosage of sodium hypochlorite is added to the mixing chamber. Flow passes over a weir to the reclaimed water pump station.

Reclaimed water can be used for off-site open access turf (golf course) irrigation and onsite for industrial water, fire protection, and landscape irrigation. Any effluent not used for reclaimed water is either recharged or discharged to the Santa Cruz River.

Other plant facilities include a control building with storage space for spare parts, a maintenance workshop area, and a motor control center.

The original treatment train requires the following repairs to continue to function at design capacity:

Table 5.3.1 Recommended Improvements and Conceptual Costs for Green Valley WWTF

Modify the headworks screens by replacing the manual screens with mechanical screens	$250,000
Replace secondary lagoon aerators	$180,000
Upgrades to electrical systems	$80,000
Replace the damaged street lights	$20,000
Earthwork to repair erosion damage to the pond and lagoon berms	$40,000
Re-grade, repair and repave site roads	$40,000
Total	**$610,000**

Marana Wastewater Treatment Facility

The 200-acre Marana WWTF is located 1 mile east of Trico Road and 1 1/8 miles north of Trico Marana Road. It presently serves the area of "central" Marana, the area adjacent to Trico-Marana Road and I-10, with a trunk sewer flowing west along Trico–Marana Road to the WWTF site. The original 23,000-GPD design capacity plant, comprised of two facultative/evaporation ponds (FEP) operated in series, opened in 1986. The WWTF proved adequate until year 2000, as growth was concentrated elsewhere in the town. Since 2000, development in the area served by the Marana WWTF has accelerated requiring plant capacity expansion.

A new 150,000 GPD facility composed of three 50,000 GPD packaged plants was placed in operation in the Fourth Quarter of 2001. Package plants are manufactured treatment plants previously been approved by permitting agencies. Presently the WWTF is operated at 70,000 GPD with flow being divided among the three package plants until influent flow exceeds 150,000 GPD. The east pond of the original FEP facility was converted to an emergency influent storage basin.

The resulting effluent quality meets discharge water quality standards for Class B effluent that can be discharged into the Santa Cruz River, used for agricultural irrigation, or recharged to groundwater.

The current WWTF capacity was increased, in 2005 by the addition of a fourth 50,000-GPD package plant. The present influent pump station will require enlargement together with the installation of a recording flow meter. The main equipment slab requires repair and voids under the slab need to be grouted. These repairs and additions are currently estimated to cost $385,000. The current expansion and long range plans for this facility are further discussed in Sub-chapter 5.4.

Mt. Lemmon Wastewater Treatment Facility

Background

The Mt. Lemmon WWTF, a 12,500 GPD package plant Oxidation Ditch Facility treats sewage from the small mountain community of Summerhaven in the Coronado National Forest. Unlike the remainder of PCWMD's system, the Mt. Lemmon experiences freezing wintertime temperatures. Aside from a few restaurants and gift shops, the WWTF serves a residential population. Effluent is disposed of through spray irrigation on 10 acres of U.S. Forest Service land.

The 2001 Bullock Fire heavily damaged the spray field as well as destroyed much of the residential community and commercial center of Summerhaven; however, the WWTF was undamaged. The main concern now is the aftermath of the Bullock Fire creating a hazardous environment due to dry and brittle timber.

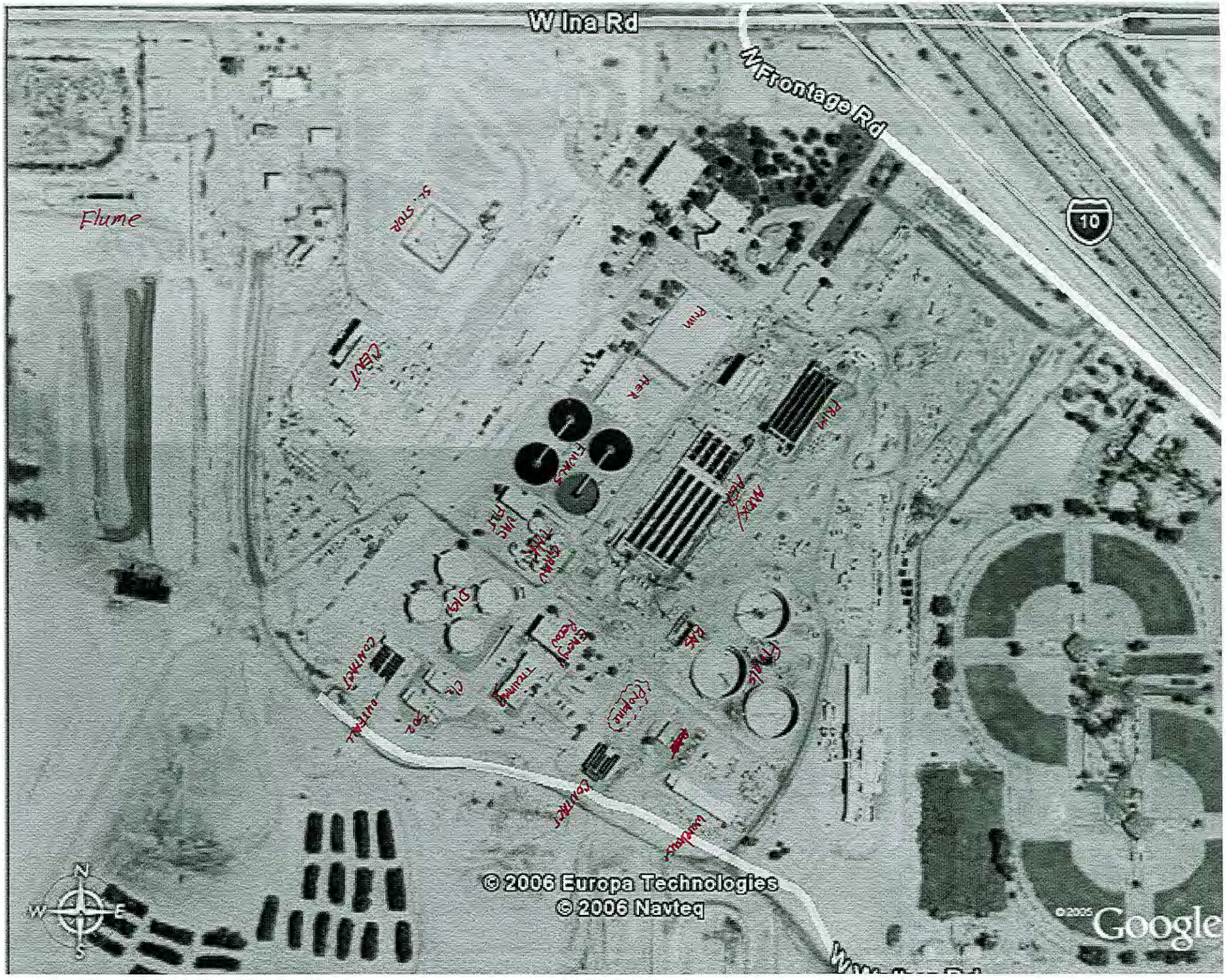
The WWTF's current needs are limited to re-coating the package plant oxidation ditch estimated at $100,000.

Rillito Vista Wastewater Treatment Facility

There are no current repair issues at this WWTF. An expansion of the WWTF in the long term to relieve the Continental Ranch Pump Station has been discussed and is under review also at this time. Flow-monitoring improvements are also needed.

The Southlands

The Southlands is a future treatment area containing only the Corona de Tucson Basin at this time.


W Ina Rd
N Frontage Rd
10
Flume
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Ina Rd WPCF Condition Assessment Survey
Meeting - June 13, 2006

Dave Garrett	PCWMD - Ina Ops	579-6024
Mandley Rust	PCWMD - Eng.	744-9041
Brett Barber	Greeley and Hansen	317.924.3380
Paul Jordan	PCWMD - Maint Mgr	744-4236
Jerry Miller	PCWWD Maint Foreman	744-4236
Albert Manriquez	Pima County / Ina Rd / maint	744-4236
LARRY CONLEY	MAINT	744-4236
JIM DOYLE	P.C.W.M. INA ROAD	744-4236
TIM GREIF	Greeley & Hansen	312-578-2322
ANDY MARTIN	GREELEY + HANSEN	312-578-2364
RON ZANKO	" " "	312-578-2452
Jerry Bish	" " "	602-778-8417

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GREELEY AND HANSEN

PROJECT PimA
SUBJECT INA Road / 6-13-06 Meeting
PROJECT #
CLIENT
COMP BY DATE CDK BY DATE SHEET 1 OF

Dave Longobardi
Larry Sawicki - I&C
Jim Doyle - Plant Supt.

Headworks
Sealed bearings on screw pumps
Gates don't seal.
Fine screens
address disposal of screenings
washer get damaged by rocks
can't bypass washers
rags stay too wet
Emerg. overflow basins (EOB)
grease is a problem w/ press
so they bypass washer-presses.
washing, not compacting now

EOB's (3) 18-19 mg.

Headworks LEL monitor about the only one working

Hardly any motor operated valves or gates or limit switches

Samplers now downstream from screen & grit.

Only run 1 coarse screen
Rake mechanism bounces
3rd screen space available.

No PA or bathroom (there is a phone)

Screw Pumps run in local manual (Computer manual available)
32 mgd per pump - normally run only one
1 & 3 have greasers bearings
2 doesn't
4) is future

Fine Screens
Level switches (LSH shuts off screw pumps)
Fine screen auto = interlock (3 - 2 run at a time)
1 runs manual = continuous all day
1 runs auto = timer in computer.
conveyors run interlocked by computer.

Not compacting

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 2 OF _____

Classifiers (3) Controllogics 5000

work OK

Odor Control

Wet scrubbers - not running

Scrubber ducting - no way to clean inside

low velocity in flow switches — FCI

Carbon scrubbers work good. (6)

Grit Basins (3)

metering sensors were problem

air flow motions.

Single Peashall Screw

OCM III

2 flush water pumps in sump

accumulate grease.

Vactor 1 per week - to EOB

Run continuously

2 auxm actuators always open.

Blowers

Remote control but no way to re-valve except manual.

Grit Pumps (8) for 3 grit basins.

Automatic Cleaning/flushing - not used.

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 3 OF _____

OLD PRIMARIES
common inf. channel, including all recycle
No problem w/ collectors - plastic flights, chain

SCUM
helical skimmers - lots of grease
run on timers - continuously every day
pump the pit once a day - to digesters
Severe corrosion in bldg (Skimming Bldg)
2 pits - east & west for 2 primaries each

Reactors (4)
ATI DO probes
2 LOX Tanks - 1 load/week LOX

RAS/WAS
new magmeters (F&P) 90's
WAS pumps upgraded
5 return
5 WAS
Flooded last Feb
% RAS
RAS can now blend into all 4 aer tanks

Vac Filters - gone

1,2 & 4 are now DAF
New splitter box
#1 new pumps & accessories
#4 & 2 belting repaint in-house
#4 out of service
~~Digital~~ ~~Thickener~~ Sludge Pumps
mags relocated to discharge in 80's

Digester 1 & 3 Digest -
2 & 4 Floater -

Chlorine 450 mV
6.3 ppm total

90-100 mV dechlor S.P.

Power Sl. Pumps 15 on 15 min off (2 at a time)

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET 4 OF _____

HEADWORKS

Screw inlet channel - Multiranger Plus @ 1.73'
Screws run in local manual to control surges
SCADA capable
Fine Screens - one manual computer
both set "Rem" @ dial SES
3rd lockout/stop
One runs auto computer to interlock w/ conveyor 1
Conveyor 1 feeds reversing conveyor to screen washer
w/ level sensor - alternates
No compaction due to grease
plus shuts down entire system if
rocks prevent compaction.
Grit Washer 2 runs simul.
Truck loading
manual by chute
Activate bin vibrator
open gate,
2 bins, one for screen, 1 for grit

Grit Tanks
220 scfm 150°F
FCI AF88 blow on each grit tank

Air blowers
Computer (remote) mode - but manual isol valves,

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD
COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____	SHEET 5 OF _____

Avara-Gru takes all solids - 8%
3rd Centrifuge - 2½ years
All others - mid 80's

7 mgd 5' old flume
19 mgd 6' new flume

PICS up to 100-0048

Centrifuges

INSTRUM & CONTROL

Dave Longobardi - Harold
Larry Sowicki Tom

SCADA 2002 commissioned 2004 done
→ Backup domain server in Admin PC02
→ Historian (lower left) @ Admin = Wonderware Industrial SQL Server
2 servers @ admin now = Incusity (3rd party)

RAID 5 controller is not maintained
2-3 drives bad
connected to City Backbone thru firewall

PC1 & PC2 comm via dedicated fiber pair
one ethernet port.

maintain PLC logic from Maint bldg.

new plant = 48" magnetics < 1 fps way oversized.

9' weir wall 2¼" head @ 12.5 mgd

Sonic & bubbler @ new 6' flume

New plant:
intl mag. oversized
WAS - spacing trigger read flow w/ no operation.
Scum weirs - can float bldg.

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET 6 OF _____

O2 purity 66-90% w vents 40-60% open

DO = 17 ppm ATI clean every 20 minutes

PLCs Control Logix in major plant area

Package controls = SLC-5/04 Diff to control logix

New primary collector drives = micrologic.

New Aeration Blower Control = Flex-Logix w Control Net.

2 major core switches

Island mode: turn into local I/O servers.

OLD PLANT PLCS up to 100-0115

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET 7 OF _____

New Plant

Interm Pump Stn (4 pumps)

IPS-1	0-23.2 "wc
" 2	17.35 "
" 3	47.09 "

Prim St. Pumps

Tigermag each - (4") ~18" upstream & down

ABB dp's w/ insert venturis for air flow

EIM mov's for air flow

Danfoss Evita USC500D DO probes

Babbles for scum

Contrologix 5555 w/ Controlnet & Ethernet/IP

ABB level monitors in contact tanks up to PIC 169

GREELEY AND HANSEN

PROJECT ROMP	PROJECT # Instrumentation
SUBJECT Condition Assessment	CLIENT Pima County WMD

COMP BY T.Greif DATE MayJun/06 CDK BY _____ DATE _____ SHEET 8 OF _____

OLD PLANT (CONT'D)

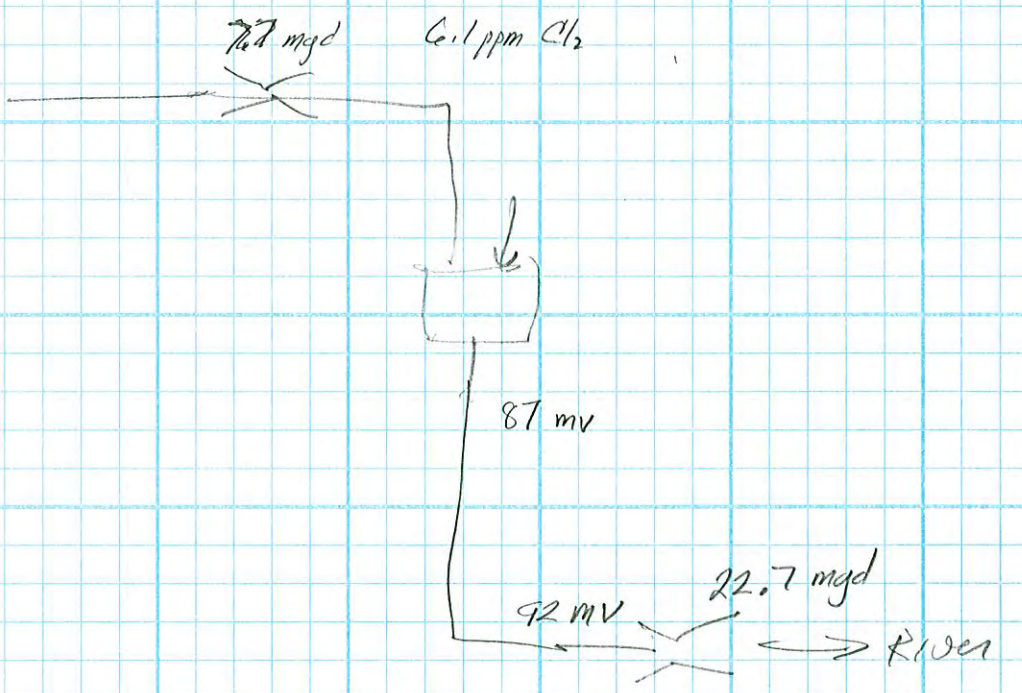
Bisulfite

US Filter RCU feeder (2)

Stantrol 890 ORP
probe = 80 mv
SP = 140

Hypo

2 feeders
Cl_2 analyzer 6 ppm



Randolph Park Water Reclamation Facility (WRF)

The Randolph Park WRF was originally constructed by the City of Tucson and put into operation in 1975. In 1979 an Inter Governmental Agreement (IGA) between the City of Tucson and Pima County transferred all wastewater treatment responsibilities from the City of Tucson to Pima County. Pima County then operated the plant from 1979 until it was shut down in 1995 during construction of a flood control project on the adjacent golf course. The plant was originally rated at 1.5 MGD, but had an average flow rate of about 634,000 GPD.

In February 2000, the City of Tucson and Pima County entered into a Supplemental IGA. This agreement included restarting the Randolph Park WRF. A portion of the flow of the refurbished facility was designated for irrigation of the adjacent City-owned Golf Course. The remaining plant flows are to be wheeled by Tucson Water to Pima County facilities.

To maximize the reuse benefits from the Randolph Park WRF, it was decided to double the plant capacity on the small site, and thereby change the flow from 1.5 MGD to 3.0 MGD. Even though the plant site is very small, it is in an ideal location to take advantage of the City of Tucson's reuse system. This allows the effluent to be pumped directly into the Tucson Water reuse system without a long force main.

The plant consists of three major components, a lift station, a force main, and the main plant. The lift station is located approximately 2.3 miles to the west of the main plant. This location was needed in order to obtain enough wastewater for the 3.0 MGD facility. Wastewater is scalped from an existing 42-inch Aviation Corridor Interceptor. The remaining flow in that collection sewer continues downstream to the Roger Road WWTP for treatment.

To maximize the main plant site, screenings and grit facilities are also located at the lift station. This has the added benefit of minimizing solids depositions in the force main, as the main solids are removed before pumping. The force main conveys flows to the main plant, where the existing tankage has been re-engineered to allow for the installation of membranes for a membrane bioreactor (MBR) process. The MBR was also selected to maximize use of the existing acreage, as well as provide for a minimum of Class A quality reuse water. The facility is permitted for Class A, but is capable of producing Class A+ reclaimed water.

There are no solids handling facilities located on the site. All solids are conveyed back to the 42-inch Aviation Corridor Interceptor for treatment at the Roger Road WWTP.

Ina Road Water Pollution Control Facility (WPCF)

The Ina Road WPCF will soon be a 37.5 MGD wastewater treatment facility. After passing through newly constructed common Headworks, it was designed for an ultimate 50 MGD flow, consisting of an influent pump station, bar-screens and grit chambers, the wastewater is treated in two different treatment trains, the original 25 MGD High Purity Oxygen (HPO) activated sludge process treatment

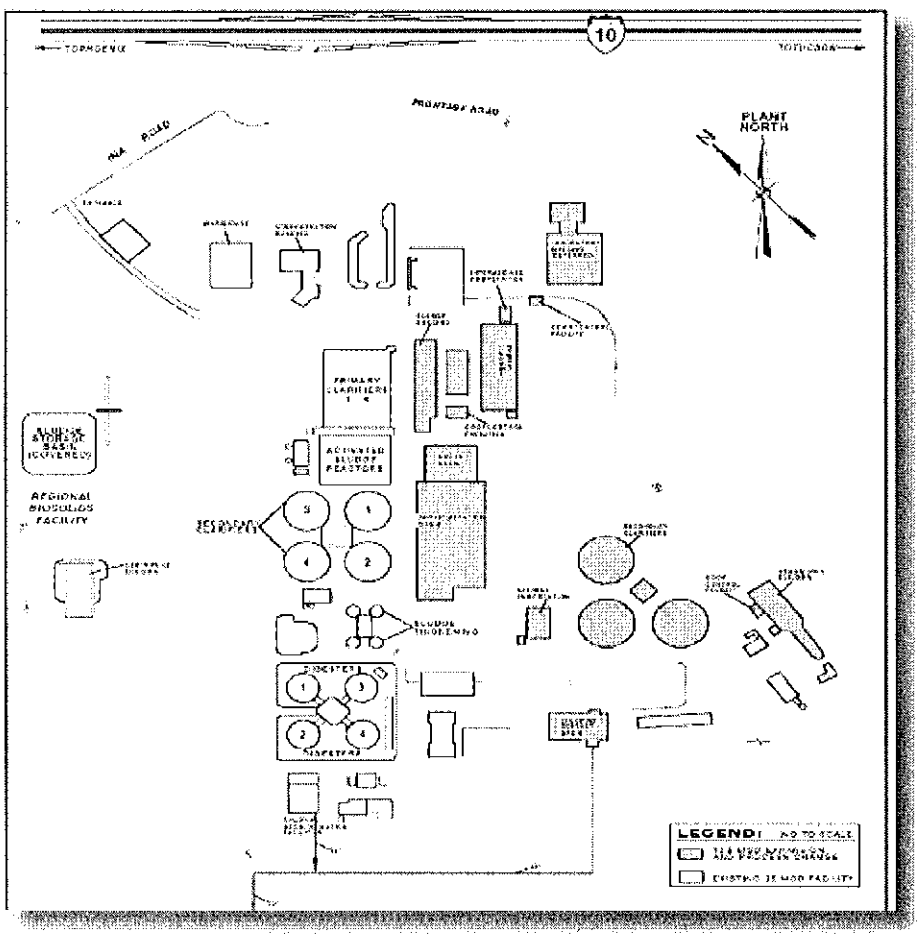
train and a recently completed 12.5 MGD Biological Nutrient Removal Activated Sludge (BNRAS) process. The Headworks, during emergencies, bypasses both trains by routing the wastewater to three emergency influent overflow storage basins.

The HPO-Activated Sludge (HPOAS) Process is a variation of the conventional activated sludge process that uses high purity (85 to 95 percent) oxygen. Typical oxygen concentrations in the reactor are 4 to 8 mg/l with common values as high as 16 mg/l. The original Ina Road WPCF was an EPA innovative technology grant project that influenced Pima County toward utilization of the HPO process.

The original (first) 25 MGD treatment train was designed in 1973 and constructed during the period 1975 to 1977. The treatment train consists of primary clarification, HPO aeration basin activated sludge process and secondary clarification and disinfection. The original plant also incorporates anaerobic digestion and centrifuge solids handling system to meet agricultural land application disposal criteria, and it provides an energy recovery system for on-site generation of electrical power. The original plant layout resulted from a concern for a planned and orderly future growth of the treatment works. The WPCF was designed as the first stage of a regional treatment facility.

In 1987, process modifications to the original design were initiated for operational flexibility and maintainability. Specifically, the modifications provided for normal plant operation when units were out of service for normal maintenance or emergency work. The modifications did not affect the methods of operation, the treatment capacity volume (except for biosolids treatment), or the characteristics of the discharge. The modifications were completed in 1990.

Figure 5.1.3 Ina Road WPCF Site Plan



The second treatment train is a two-stage Biological Nutrient Removal (BNR) or BNRAS process operating in parallel with the existing train. This second train, a 12.5 MGD expansion, was designed in the late 1990s and will be placed in service in 2005. This train consists of primary clarification, biological nutrient removal via nitrification-denitrification using anoxic and aerobic basins, secondary clarification and disinfection. The site plan for the Ina Road WPCF is shown in Figure 5.1.3 and the process diagram for the facility in Figure 5.1.4.

Effluent Discharges

The Ina Road WPCF was constructed to treat sewerage in the Tucson Metropolitan Area north of the Rillito River. The discharge from the WPCF complies with the permit requirements of the Clean Water Act-Arizona Pollutant Discharge Elimination System (AZPDES) and the State of Arizona Aquifer Protection program permit.

Effluent Disposal

The majority of the effluent is discharged to the Santa Cruz River under AZPDES Permit Number AZ0020001. The remainder of the effluent is pumped to the Arthur Pack Golf Course for irrigation. A summary of the principal discharge limits for the plant is shown in Table 5.1.3.

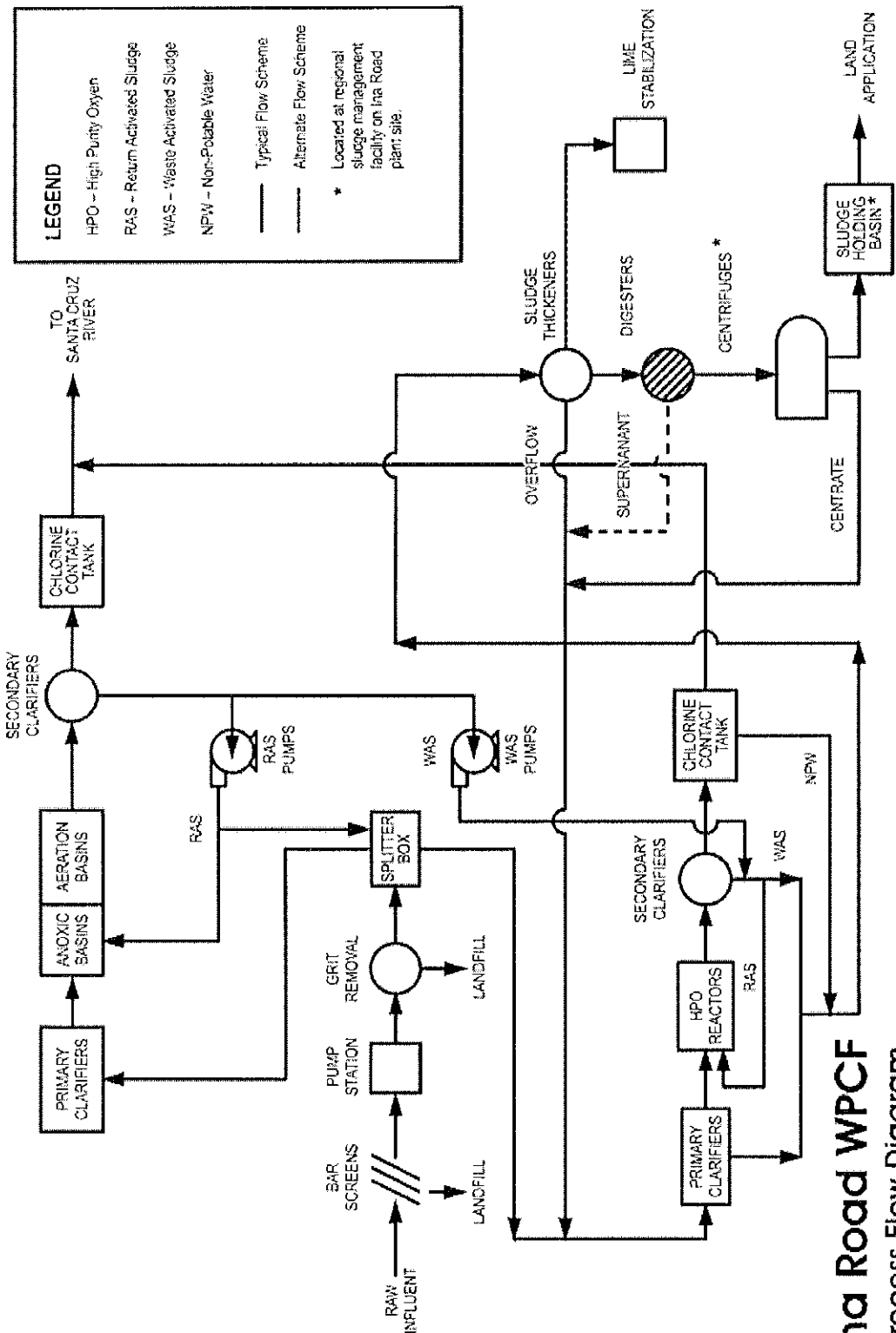
Table 5.1.3 Ina Road WPCF AZPDES Permit Discharge Limitation

Parameter	Avg. Monthly	Avg. Weekly	Daily Max
Effluent Flow, MGD	25	---	---
BOD (5 day), mg/l (kg/d)	30 (2,839)	45 (4,258)	(8,516)
Total Susp. Solids, mg/l (kg/d)	30 (2,839)	45 (4,258)	(8,516)
Fecal Coliform Bacteria	200/100 ml	---	800/100 ml
e-coli Bacteria	126 CFUs/100 ml	---	576 CFUs/100 ml
PH	Not less than 6.5 nor greater than 9.0		
Total Residual Chlorine			0.011 mg/l
Copper (as CU)			38 mg/l

Notes for Table 5.1.3:

1. Effective November 2, 1999 through November 2, 2004.
2. This is not a comprehensive list as the actual permit includes limitations and/or monitoring and reporting requirements for 22 additional effluent characteristics (microbiological, inorganic and organic trace substances).

The present process flow diagram for the Ina Road WPCF is presented in Figure 5.1.4.



Ina Road WPCF
Process Flow Diagram
FIGURE 5.1.4

Current Conditions

The existing facilities at Ina Road WPCF are divided into four parts for this presentation: General, Wet Stream Facilities, Sludge Stream Facilities and Other (Non-Process) Facilities.

The process description of the Ina Road WPCF is divided first into treatment trains and then into subsections for each treatment process. The subsections are Preliminary Treatment, Primary Treatment, Secondary Treatment, Disinfection and Dechlorination, and Sludge Stream and Solids Handling. Last is the discussion of Other (Non-process) Facilities including the power generation, electrical distribution and the Administration, Warehouse and Laboratory facilities.

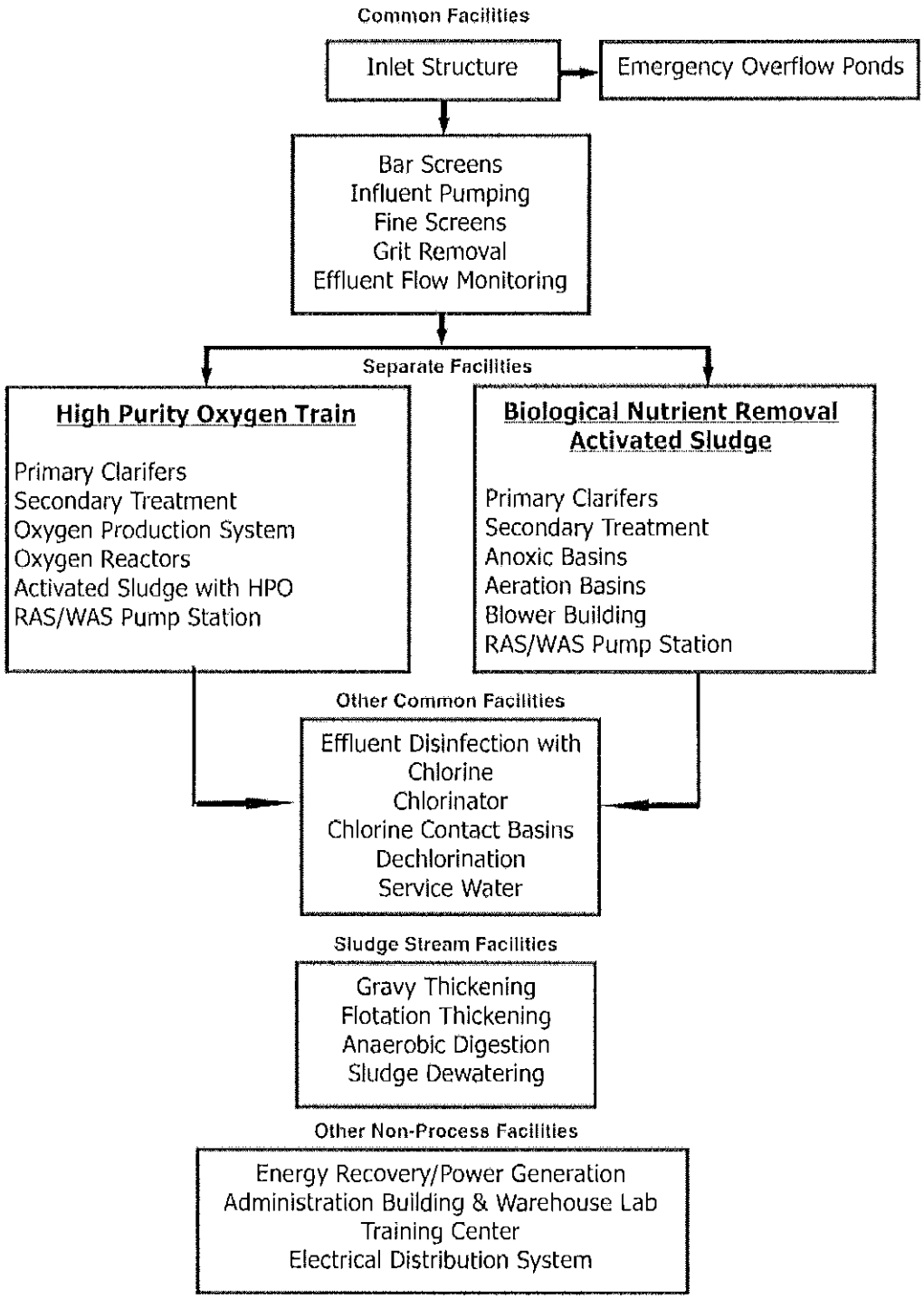
General

- Plant staff practice preventative maintenance on all major equipment. Pumps and small equipment tends to be reactive maintenance. A Computerized Maintenance Management System (CMMS), developed within the Synergen Asset Management system, is recommended.
- Enhanced physical barrier and a remote access control systems are desired to minimize public access to the site and reduce possible terrorism threats.
- New regulations for treatment and discharge are expected to require nitrification/denitrification of the 25 MGD HPO plant effluent. Funding from the 2004 Bond Authorization will provide a portion of the funding for this project.
- The regional Biosolids Facilities will be expanded to treat the combined sludge generated at the Roger Road WWTP. The combined sludge treatment facility will be upgraded to produce Class A biosolids.

Wet Stream

Preliminary Treatment

The preliminary treatment process consists of: Inlet Structure and Emergency Storage Basin; Bar Screens; Influent Pumps; Fine Screens (Headworks); Grit Removal; and Influent Flow Metering; Channel Aerators and a Splitter Structure. Each component is discussed on the following pages.



Headworks

A new headworks facility capable of handling 50 MGD average annual flow was constructed as part of the plant expansion. The new headworks includes larger grit chambers and bar screens, a larger and deeper influent pump station, improved odor control and improved and enlarged Emergency Overflow Basins. The new headworks are divided into three parallel trains of coarse bar screens, pumps, fine screens and grit chambers. This configuration allows one train to be taken out of service for maintenance. A Parshall flume is located in the single channel downstream of the grit chambers to measure total plant influent flow.

The headworks odor control system requires adjustment and balancing to better conduct odors in the area of the fine screens.

Inlet Structure and Emergency Overflow Basins

Wastewater is received via inlet sewers that discharge into a common inlet structure. The inlet structure, part of the original plant, was modified to feed the new headworks through a drop structure. Diversion to the Emergency Overflow Basins is through this structure. A new 72-inch pipe carries the coarse bar screens flow to the influent pumping station. The new headworks are 5 feet lower than the original plant inlet, which has improved the flow in the incoming sewers.

The Emergency Overflow Ponds are gravity fed with a total storage capacity of 18 million gallons (MG) at 2-feet of freeboard. There are three basins, the first of which is concrete lined. The remaining two are plastic lined with polypropylene sheets. If the basins are used, portable pumps deliver the contents of the basin back to the headworks.

Emergency Overflow Basin Number 2, presently plastic lined, should be re-lined with a hard surface to facilitate cleaning.

Bar Screens

Two mechanically cleaned bar screens remove large debris, such as rags, sticks, and various other items from the influent flow to prevent damage to downstream equipment. The bar screens consist of a series of parallel bar spaced 2-inch apart. Debris is trapped on the bars as wastewater passes through them. The bars are cleaned by a mechanical raking device, which carries the debris to a screening conveyor. The screenings are disposed of in the Tangerine Road Landfill owned by Pima County.

Influent Pumping Station

The influent pumps consist of three Archimedes constant-speed, inclined screw pumps. Each screw pump has a bottom bearing that is submerged and must be continuously lubricated during operation. The influent pumps are preceded by a raw wastewater forebay, which makes it possible to divert flow to a standby pump unit. Sluice gates installed in the forebay direct the influent flow to the active pumps. Each pump discharges to a fine bar screen for further removal of trash.

Fine Screening

The influent pumps discharge to three fine screens to complete the debris removal prior to entering the grit chambers. Sluice gates installed in the forebay divert flow to the active screens. The bars are cleaned by a mechanical raking device, which carries the debris to a screening conveyor. The screenings are washed to control odor and with fecal matter being wasted back into the flow stream before disposal at the Tangerine Road Landfill.

Grit Removal and Disposal

Grit removal is accomplished in three chambers. Sluice gates are installed to divert the flow to active grit tanks. Inlet velocity control gates provide a means to vary the flow speed from 0.7-1.3 feet per second (fps). The flow is aerated to keep organics in suspension and aid in sedimentation. While at this slower flow rate, the heavier inorganic solids (grit) will settle to the bottom where they are mechanically pushed to a sump. The grit is pumped to centrifugal grit separators with the grit deposited to a hopper and the water returning to the flow stream. The grit is then hauled to the Tangerine Road Landfill for disposal.

Influent Flow Monitoring

An ultrasonic flowmeter is installed in the conduit connecting the headworks and primary clarifiers. The flow information is transmitted to the WPCF monitoring and control center where the data are utilized for plant control.

Influent Conduit Blower (Channel Aerators)

This blower provides the air required to keep the solids in suspension in the influent channel, thereby preventing deposition, decomposition and odor.

Splitter Structure

The Splitter Structure allows for flow control and proper flow distribution between the new 12.5 MGD train and the existing 25 MGD train.

Headworks Odor Control Facilities

The Preliminary Treatment Section is new and has minimal problems. The presence of escaping odors throughout the facility requires correction by having the systems balanced and fine-tuned.

The following subsections detail the treatment process and components and are divided according to treatment train and further by processes within the trains.

Train A. High Purity Oxygen Activated Sludge (HPOAS) Process (25 MGD)

Primary Treatment

Primary Clarifiers

There are four rectangular, covered primary clarifiers. Primary Clarifiers are designed to retain the wastewater for several hours at minimum flows allowing solids to settle to the bottom for collection as primary sludge. Primary sludge is routed to the thickeners for further treatment. The primary clarifiers are covered to prevent odors and the gases generated are collected, treated and released to the atmosphere.

The clarifiers are designed to remove all the grit, a portion of the suspended solids, the settleable solids and the BOD_5 from the primary influent.

The Primary Clarifiers contain the following equipment aiding in the solids separation and handling:

- The influent baffle is a fiberglass unit that slows the flow and directs the flow downward, promoting settling.

- Collector mechanisms: each clarifier is equipped with drag chains to move the sludge to the sludge pit. A skimmer conveys the scum from the water surface into the scum trough.
- Effluent weirs are V-notched plates which control the wastewater level.
- Sludge pumps are used to pump to either the digesters or the sludge thickeners. There are six centrifugal sludge pumps for the four clarifiers of each train with four operating and two spares.
- Scum pumps are used to pump scum to either the digesters for further treatment or directly to trucks for removal to the landfill. There are two primary centrifugal scum pumps for each train.
- The dewatering pump is a single horizontal centrifugal pump, which drains the tanks. The pump suction can be valved into any of the four primary clarifiers while it discharges to the influent channel.

High levels of hydrogen sulfide, coupled with turbulence induced by the aeration, have caused corrosion in the primary clarifier influent channels. The concrete in this area is unprotected and showing signs of deterioration. Steel cover plates and frames are severely corroded and the inlet sluice gates are leaking.

The present odor control system design for the primary clarifiers requires improvement to efficiently control noxious fumes.

The building housing the scum collection equipment shows signs of corrosion accompanied by odor concerns. The doors and doorframes for the building are corroded to the point the doors are nearly inoperable. The areas around the primary thickeners require improvement to reduce the possibility of stormwater into the WPCF's tunnels during severe summer storms.

Secondary Treatment

Secondary treatment is accomplished by introducing pure oxygen into the primary clarifier effluent. A pressure swing adsorption (PSA) oxygen generation system supplies high purity oxygen. Four rectangular, three-stage, mechanically agitated oxygen reactor tanks provide aerobic conditions to ensure complete biological stabilization of the organic materials in the effluent.

Oxygen Production System

The oxygen production system has various components that are necessary to effectively produce and supply oxygen to the Secondary Reactors. These components are:

- Chilled water pumps.
- Instrument air compressors.
- Oxygen compressors.
- PSA skid.
- Liquid oxygen storage and vaporizer system.
- Storage Tanks for truck delivered oxygen for use during maintenance or emergencies.

The system is considered outdated and should be considered for upgrade.

Oxygen Reactors

There are four oxygen reactor tanks each consisting of three equally sized stages. The entire reactor deck is covered to maintain high purity oxygen in the vapor space for dissolution of oxygen into the mixed liquor, a combination of the primary effluent and return-activated sludge. Each reactor

stage has a surface mechanical aerator (mixer) to provide complete mixing and suspension of the contents and to dissolve the vapor space oxygen into solution. Each mixer includes a hydraulic vapor seal to prevent the loss of reactor oxygen to the atmosphere.

- Each reactor also has a Return Activated Sludge (RAS) line to convey return sludge from the secondary clarifier by way of the RAS/WAS pump station to each reactor first stage.
- The mixed liquor effluent leaving the reactor is designed so that a gas seal is created, preventing reactor vapor gas from escaping. The mixed liquor effluent flows to the secondary clarifiers.
- The individual reactor trains can be dewatered with the reactor dewatering system. The piping configuration at the dewatering pump provides the flexibility to dewater one reactor train and direct the flow to one or all of the other reactor trains.

The reactor concrete roof decks have numerous hairline cracks causing oxygen leakage from the tanks and the mixers need significant replacement/upgrades.

Secondary Clarifiers

There are four secondary clarifiers for the HPOAS process train. The clarifiers are circular tanks with a drive unit providing continuous rotation of the collection tubes and scum scraper arm. As the mixed liquor from the reactors enters the clarifier the solids settle to the floor of the tank. The collection draft tubes direct the settled sludge to the center collection pipe. This sludge is conveyed to the return and waste activated sludge pumps for return to the oxygen reactor inlet or directed to the sludge-thickener complex.

Clarifier scum (floating debris) is collected by a rotating arm that pushes surface scum to a collection trough for gravity flow to the RAS/WAS pumping station sump. It is pumped back to the primary influent channel.

The capacity of the scum and sludge equipment is limited. Operations have enlarged the sludge withdrawal pipes in one of the secondary clarifiers and plans to enlarge the same equipment in the other clarifiers. An engineering study of the capacities of the withdrawal systems should be undertaken.

Train B. Biological Nutrient Removal (BNR) Process (12.5 MGD)

The discussion of this train is limited, as this train is in the final construction stage and should have no repair issues.

Primary Treatment

The two primary clarifiers for train A and B operate similarly to those of the High Purity Oxygen Activated Sludge train.

Secondary Treatment

Secondary treatment in this train employs an anoxic/aerobic process to achieve nitrogen removal. The Modified Ludzack-Ettinger (MLE) is a two-stage nitrogen removal process that uses an anoxic reactor upstream of the BOD oxidation/nitrification reactor (aeration tanks). The MLE process recycles nitrates from the aerobic stage back to the anoxic stage.

Anoxic Basins

There are four equally sized, covered anoxic basins to remove naturally occurring nitrogen from the wastewater. Wastewater overflow from the primary thickeners is combined with Mixed Liquor Recycle (MLR) and RAS in an oxygen depleted environment.

Aeration Basins

The anoxic basin discharges flows to the aeration basins. Forced air is introduced into the five covered aeration basins to accomplish biological treatment of solids and wastewater in an activated sludge process.

Blower Building

The Blower Building is sized to handle the train expansion to 25 MGD. The blowers distribute forced air to the aeration tanks.

Mixed Liquor Suspended Solids (MLSS) Recycle

These horizontal centrifugal pumps collect transport flow from the aeration basin discharge, mix it with RAS flow from the RAS/WAS pump station, and pump it back to the anoxic basins.

Secondary Clarifiers

There are three new secondary clarifiers to service the BNR train, whose operation is the same as the secondary clarifiers for the HPOAS train.

Return and Waste-Activated Sludge Pumping Station

The RAS/WAS pump station is common to both Train A and Train B.

There are five RAS pumps to return clarifier sludge to the oxygen reactors and the anoxic basins. The basic purpose of returning clarifier sludge to the oxygen reactor and the anoxic tanks is to maintain an adequate quantity of microorganisms (biomass) to accomplish the incoming BOD removal.

RAS pumps, powered by a variable frequency drive (VFD) unit, allow the pump motor to vary its speed permitting the pump to maintain an optimum flow of return sludge.

The WAS pumps move activated sludge from the secondary treatment process to the sludge thickeners. The basic purposes of wasting sludge are to fine-tune the balance of a microorganism to the incoming BOD and to maintain a desired solids inventory concentration.

The remainder of the plant is either similar for Trains A and B or combines the flows from both trains, therefore will only be described once.

The existing WAS pumps are noisy and appear to vibrate excessively which could limit pump life. Operations staff had the pumps checked by the manufacturer who found no problems. Vibration mounting may help to limit noise and vibration. The condition assessment noted the crowded nature of this pump station.

Disinfection

The Ina Road WPCF, after a decision to move away from gaseous chlorine, uses liquid sodium hypochlorite for disinfection and liquid sodium bisulfite for chlorine neutralization to meet discharge limits for chlorine residual. The present system is classified as a "temporary system," which appears in good shape with no structural problems; however, permanent facilities should be planned.

The plant effluent flow is metered and sampled prior to final discharge to ensure its compliance with discharge permits.

Chlorine Contact Basins

There are two chlorine contact basins; each with baffles that direct flow in a serpentine pattern to prevent short-circuiting. Each tank holds approximately 283,550 gallons of water. The tanks receive the mixture of chlorine solution and final effluent and provide a 30-minute contact period.

Dechlorination

There is a single dechlorination facility that receives the effluent of both chlorine contact basins. Dechlorination is achieved by feeding a sufficient amount of sodium bisulfate solution to the effluent prior to discharge to meet permit requirements for chlorine residual. Factors affecting dechlorination are: other oxidants in the effluent, rate of discharge, and the concentration of chlorine in the effluent.

Service Water Building

This Service Water Building houses effluent heat exchangers and an open-mixing chamber where sodium hypochlorite is added. There is some minor corrosion of the steel cladding; however, the structural steel appears to be in good condition. The shell and tube heat exchangers are a maintenance problem and should be repaired.

Sludge Stream Facilities

Existing Conditions

The Solids Handling Process area consists of the following major components:

Dissolved Air Flotation Thickeners

There are three units which use dissolved air to thicken the organic solids causing them to float to the water surface of the thickeners. The sludge collector and float skimmer mechanism collects both the settleable solids and the floatable solids and conveys accumulated solids through discharge piping to the sump pit.

There is one gravity thickener that receives primary sludge only. Large irregular particle sizes of the primary sludge makes gravity thickening the most effective way to dewater these solids. Solids are pumped from the bottom of the thickener to the centrifuges.

The overflow weir collects the supernatant from the unit and conveys the flow to the primary clarifiers.

The thickened sludge pumps move the thickened sludge from the sludge wet wells to the anaerobic sludge digester.

There is some minor concrete corrosion in these units. The concern is unprotected concrete may experience further corrosion, especially if the thickeners are covered to reduce possible odor emissions.

Anaerobic Sludge Digesters

The four digesters stabilize the sludge for easier dewatering and disposal. The organic matter in the thickened sludge is biologically broken down in the absence of oxygen. The process converts approximately 50 percent of the organic solids to liquid and gas. This greatly reduces the volume of the stabilized sludge for disposal. There are mechanical mixers that mix the sludge to maintain sludge consistency. The four hot water heat exchangers control the temperature of the internal contents of the digesters. Four centrifugal pumps supply the hot water from the power production facility to the sludge heat exchangers. Four centrifugal pumps circulate digested sludge through the heat exchanger.

Four centrifugal compressors transport the methane gas, created during sludge digestion, to the power production facility. Pumps transport sludge to the Centrifuge Building for dewatering. The concentration of hydrogen sulfide in the seal water, draining from the compressors, is considered high. It is recommended that compressor seal water be chemically treated by the addition of equipment to reduce the hydrogen sulfide.

The mechanical mixers, while providing adequate mixing, have experienced high failure rates creating inordinate maintenance expenses. Operations staff is replacing the gas piping from the digesters to the Recovery Building that have developed pinhole corrosion leaks; however, an overall gas piping system renovation is required. There is a concern the piping is undersized. Operations staff report delivery pressure to the compressors of 25 psig. The compressed digester gas delivery piping between the Digester Control Building and the Energy Recovery Building requires a capacity increase. It is recommended ladder access to the digester roofs be replaced with stairways.

Centrifuge Facility

The digested sludge from the Ina Road WPCF is joined by the Roger Road WWTP digested sludge at the Centrifuge Building, where three centrifuges thicken the digested sludge. The thickened sludge is pumped to a bladder equipped storage basin. Thickened sludge is then delivered to a disposal firm that uses the sludge for crop fertilization.

Due to piping constraints at the centrifuge facility, only one of the three centrifuges can be used at any one time. This severely limits the quantity of solids that can be thickened. In addition, if the solids are not thickened enough, PCWMD is required to pay a premium to the disposal firm. During periods of high solids production, the centrifuge facility has, at times, been unable to thicken the solids to avoid this premium. Having two centrifuges available for use will greatly enhance solids handling capabilities, and help to minimize operational costs of the facility.

Besides the solids handling issues, the centrifuge facility is also in need of additional odor control facilities, as well as building maintenance (roof). In addition, gas collection under the sludge storage bladder needs to be investigated.

Other (Non-Process) Facilities

Energy Recovery Building

The WPCF generates a portion of its own electrical power from the waste gas produced in the digesters. The methane gas is captured and used as fuel for engine generators, which in turn produce the electricity needed to operate the plant equipment. Natural gas is used to supplement the methane gas as a fuel source. Waste heat from the engines is used to heat the digesters and run an absorption chiller for plant building and process cooling requirements.

The chiller is unable to be used to full capacity as the return water temperature is too high in the summer months. The lack of a suitable overhead crane causes maintenance problems with servicing the generators.

The engine generator facility presently uses 74 percent natural gas and 26 percent digester methane to produce 50 million Kilowatt-hours of power yearly. There is a present project in the 2004 Bond Authorization to expand the Central Plant facilities.

Administration and Maintenance Building (Warehouse)

The functioning of the HVAC system in the combined Administration/Laboratory Building and in the Maintenance Building (Warehouse) has been questioned. It is possible under certain conditions for fumes from the Laboratory to enter the Administration Building ventilation system. The fumes from testing for toxic substances are exhausted with the possibility of re-entry into the office section of

the building providing the opportunity for contamination. The present HVAC system is unable to adequately cool the Laboratory during the summer months.

The plasma and welding areas in the Maintenance Building do not have exhaust hoods positioned to carry the fumes outside. The paint booth exhaust is too close to the building's fresh air intake.

There is a need for additional office, locker room and lunchroom facilities at WPCF. There are proposals to renovate the old Training Center, Filter Building and portions of the warehouse and Administration Building to provide these facilities following relocation of the present scattered laboratory functions to the 2004 Bond Authorization Laboratory Building.

Laboratory

The present WPCF Laboratory space was designed to meet regulatory testing requirements in the 1970s. Testing requirements have greatly expanded since that time. The present laboratory testing requirements have been accommodated in the Administration Building leading to crowded, inadequate facilities. In recognition of this, a new Laboratory Building was included in the 2004 Bond Authorization. A problem with the present completed engineering design was realized. The design for the Laboratory was completed prior to 2000 and the Uniform Building Code. Pima County has adopted the International Building Code since then. The present design will have to be redone to meet the new code requirements.

In the event the Laboratory Building must be redesigned, the possibility of relocating the building to the area between the Sports Park and the new Outlying Facilities Building should be reviewed. New Training facilities are to be incorporated in this design. A design/build pre-engineered building may prove the most economically feasible solution.

Training Center

New Training Facilities will be included in the new Laboratory facility. The existing Training Facility could possibly be converted to lunch and locker room facilities.

Electrical Power Distribution

The 2004 Bond Authorization contains a project to upgrade the electrical distribution system within the WPCF site. In addition, a program to assess and replace deficient outdoor substations and motor control centers is recommended. A study to replace manual transfer switches between regular and emergency power sources is recommended. In general, an upgrading of the electrical and control system, not covered by the 2004 Bond Authorization, is recommended.

Continental Ranch Pump Station

The Continental Ranch Wastewater Pump Station (CRWWPS) is located approximately one half mile east of Silverbell Road, halfway between Twin Peaks and Avra Valley Road. This facility presently serves the area downstream of the Ina Road WPCF, that area being roughly from Ina Road North along both sides of Silverbell Road to one-half mile south of Avra Valley Road, the area west of Camino de Oeste and east of an extension of Blue Bonnet Road. The main population in the area is concentrated in the Continental Ranch area east of Silverbell Road with the major future expansion expected to be between Camino de Oeste and Interstate 10 (I-10). This area expansion involves large parcels of State land whose release for development is dependent upon the State Land Department.

The Dove Mountain development, located west of Camino de Oeste, flow can reach the CRWWPS by gravity and currently is pumped to the Camino de Oeste trunk sewer at Tangerine Road. The Camino de Oeste trunk sewer is presently flowing below 50 percent capacity while conveying flow, including Dove Mountain, directly to the Ina Road WPCF by gravity.

The Continental Ranch pump station delivers wastewater to the Ina Road WPCF by means of a 26-inch diameter (18-inch Internal Diameter) HDPE pipeline routed generally along the west bank of the Santa Cruz River to Cortaro Farms Road, then runs along Silverbell Road to Ina Road and then along Ina Road to the WPCF. The majority of the route is under the riverside park close to residential areas. The pump station presently has three motor driven pumps with provisions for a fourth pump. The principal area of concern, due to the limitations of on-site storage, is the handling of diurnal flow. Presently, during peak periods of gravity flow to the pump station, the limitations of the wet well, pumps and pipeline set pumping capacity to between 4,000 to 4,400 gallons per minute (GPM) or 5.76 to 6.34 MGD respectively, Peak Wet Weather flow.

The Continental Ranch Pump Station has issues principally caused by the pump feed wet well being undersized. The operational size of the wet well from pump start to overflow is approximately 8,000 gallons. This is a relatively small retention time given the present inflow rate of 2,400 GPM. This allows only 3.3 minutes (8,000/2,400) for the operators to react should a pump fail or to switch to emergency power in case of an outage. This does not give a comfortable margin of safety before a Sanitary Sewer Overflow (SSO)would commence. There is a proposed project to rehabilitate and update this facility that should be undertaken as soon as possible.

Conclusion and Recommendations

Based on the discussion in this Chapter, the following projects should be included in the Ina Road WPCF elements of the long-range Capital Improvement Plan (CIP) using either SDF or 2004 Bond Authorizations as available.

Table 5.1.4 Recommended Improvements and Conceptual Costs for Ina Road WPCF

Improvements	Conceptual Cost
Computerized Maintenance Management System Implementation	$1,500,000
Facility Security Improvements	$210,000
Drainage Improvements at Existing Primary Clarifiers	$50,000
Emergency Overflow Basin #2 Lining	$2,000,000
Headworks Ventilation/Odor Control Improvements (Allowance)	$500,000
New Sluice Gates at Existing Primary Clarifiers	$400,000
Replace Cover Plates/Seat Angles at Existing Primary Clarifiers	$50,000
Rehabilitate and Protect Concrete/Retrofit Odor Control at Existing Primary Clarifiers	$1,500,000
Replace Skimmer House Doors/Retrofit Ventilation and Odor Control Improvements	$1,000,000
Nitrification/Denitrification (Existing Plant)	$27,000,000
Rehabilitate Oxygen Reators Concrete Deck	$3,500,000
Secondary Clarifier/RAS Pump/WAS Pump Improvements	$2,500,000
Permanent Chlorination/Dechlorination Facilities	$5,000,000
Waste Heat Exchanger Improvements at Service Water Building	$990,000
Digester Gas Piping System Renovation	$520,000
Digester Gas Piping Capacity Expansion	$500,000
Digester Gas Compressor Seal Water Drains/H2S Treatment	$100,000
Digester Roof Access Improvements/Minor Insulation Repairs	$200,000
Biosolids Improvements	$42,000,000
Centrifuge Building Odor Control Improvements	$730,000
Roger Road Sludge Fine Screening	$500,000
Energy Recovery Building Crane/Monorail Improvements (Allowance)	$300,000
Administration/Maintenance Building HVAC Improvements	$1,000,000
Office/Locker Room/Lunchroom Renovation	2,800,000
Electrical Improvements (Allowance)	3,000,000
Total	**$97,850,000**

Appendix B

Condition Assessment Data

Electrical Field Assessment Ina Road

1998

HEADWORKS
US30-1,2
MCC 30A, 30B
ST-1

PLC-31

WAREHOUSE

SEC CLARIFIER

13.8KV OVERHEAD

OPERATIONS TRAILER

PLC-37

CHLORINE CONTACT BASIN

ENERGY RECOVERY BLDG

RAS/WAS P.S.
MCC 37A, 37B
ST-3

PROPANE TK

PLC-14

PRIMARY CLARIFIERS

ANOXIC AERATION BASINS

PLC-39

NOT BUILT
~~FUTURE~~

ENGINE BLDG

TRAINING CENTER

PLC-34

13.8KV O.H.

BLWR BLDG

US34-1,2

TUNNEL EW-3 WORKSTATION

ST-2

SWGR BB

PLC-8

PLC-12

CHLORINATION BLDG

CHLORINE RESIDUALS REDUCTION FACILITY

SULFUR DIOXIDE BLDG MCC A, B

MCC 33A, B, 34, 34C, D 35A, B

PRI CLARIFIERS

ACT SLUDGE REACTORS

SEC CLARIFIERS

RAS P.S.

SLUDGE DIGESTERS

SLUDGE DEWATERING

VACUUM EVAPORATION

DECHLORINATION

SERV WTR BLDG

SERV WTR BOOSTER STA

CHLORINE CONTACT

PLC-5

PLC-9

PLC-11

DIG CONTROL BLDG

CENTRIFUGE BLDG

PLC-23

MAINTENANCE COMMUNICATIONS ROOM

ADMINISTRATION CONTROL ROOM

CAMP DRESSER & McKEE

environ planners

REGISTERED PROFESSIONAL ENGINEER
CERTIFICATE NO. 29698
V. K. GUPTA

DESIGNED BY: L. REYNOLDS
DRAWN BY: A. MBROH
CHK'D BY DESIGN: O. NAJI

PIMA COUNTY
WASTEWATER MANAGEMENT
DEPARTMENT

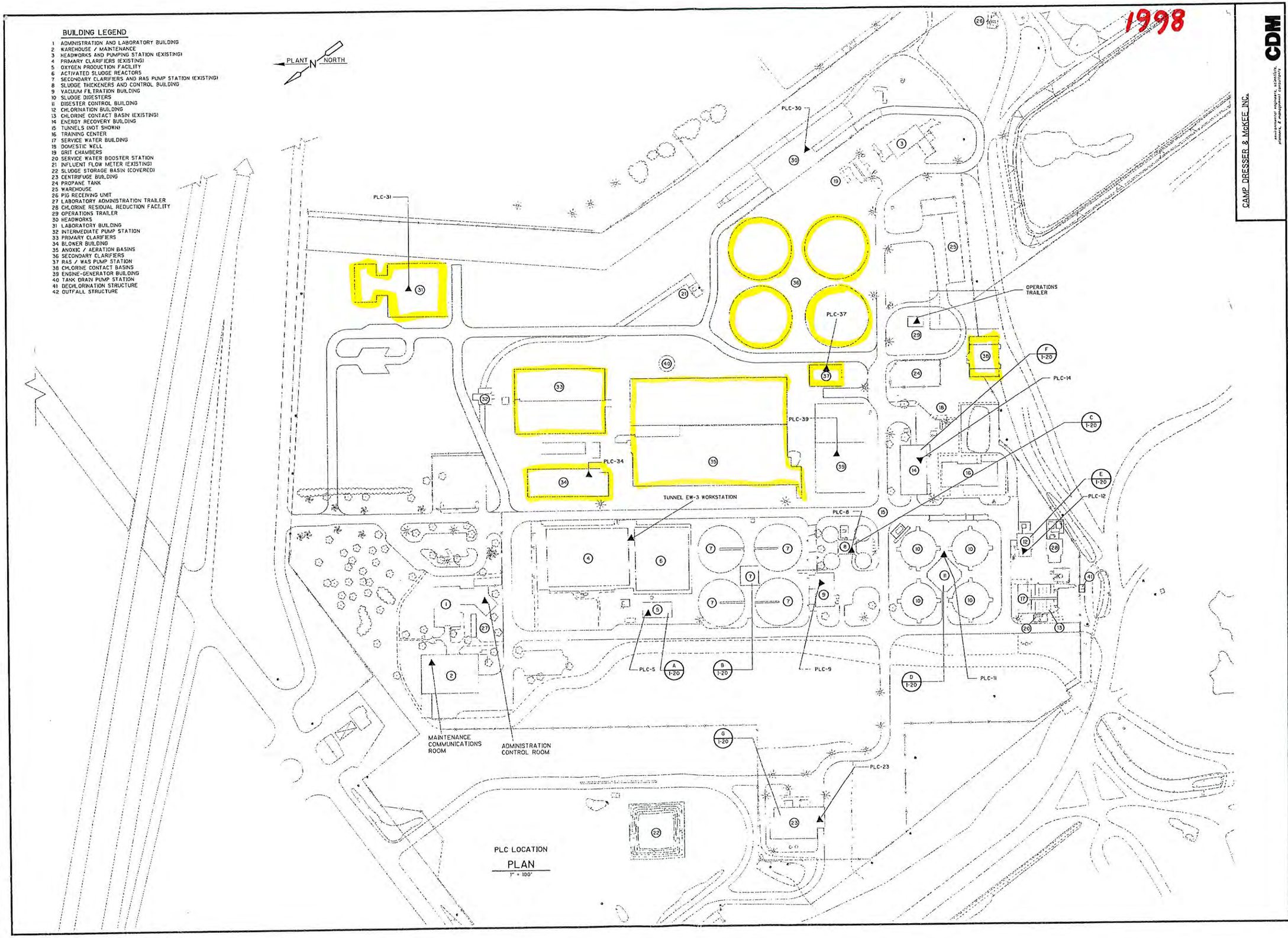
ROAD WATER POLLUTION CONTROL FACILITY
PROCESS CHANGE AND EXPANSION

PLANT WIDE
PLC COVERAGE
AND LOCATIONS

1998

BUILDING LEGEND

1 ADMINISTRATION AND LABORATORY BUILDING
2 WAREHOUSE / MAINTENANCE
3 HEADWORKS AND PUMPING STATION (EXISTING)
4 PRIMARY CLARIFIERS (EXISTING)
5 OXYGEN PRODUCTION FACILITY
6 ACTIVATED SLUDGE REACTORS
7 SECONDARY CLARIFIERS AND RAS PUMP STATION (EXISTING)
8 SLUDGE THICKENERS AND CONTROL BUILDING
9 VACUUM FILTRATION BUILDING
10 SLUDGE DIGESTERS
11 DIGESTER CONTROL BUILDING
12 CHLORINATION BUILDING
13 CHLORINE CONTACT BASIN (EXISTING)
14 ENERGY RECOVERY BUILDING
15 TUNNELS (NOT SHOWN)
16 TRAINING CENTER
17 SERVICE WATER BUILDING
18 DOMESTIC WELL
19 GRIT CHAMBERS
20 SERVICE WATER BOOSTER STATION
21 INFLUENT FLOW METER (EXISTING)
22 SLUDGE STORAGE BASIN (COVERED)
23 CENTRIFUGE BUILDING
24 PROPANE TANK
25 WAREHOUSE
26 PIG RECEIVING UNIT
27 LABORATORY ADMINISTRATION TRAILER
28 CHLORINE RESIDUAL REDUCTION FACILITY
29 OPERATIONS TRAILER
30 HEADWORKS
31 LABORATORY BUILDING
32 INTERMEDIATE PUMP STATION
33 PRIMARY CLARIFIERS
34 BLOWER BUILDING
35 ANOXIC / AERATION BASINS
36 SECONDARY CLARIFIERS
37 RAS / WAS PUMP STATION
38 CHLORINE CONTACT BASINS
39 ENGINE-GENERATOR BUILDING
40 TANK DRAIN PUMP STATION
41 DECHLORINATION STRUCTURE
42 OUTFALL STRUCTURE



PLC LOCATION
PLAN
1" = 100'

CAMP DRESSER & McKEE INC.
CDM
environmental engineers, scientists, planners, & management consultants

NO.	REVISION	APPV'D.	DATE

REGISTERED PROFESSIONAL ENGINEER (CIVIL) 29698 GUPTA 2/2/99 ARIZONA U.S.A.

DESIGNED BY: L. E. REYNOLDS
DRAWN BY: A. MBROH
CHK'D BY (DESIGN): G. NAJI
CHK'D BY FIELD ENGR.: V. K. GUPTA
FIELD BOOK NO.: -

PIMA COUNTY
WASTEWATER MANAGEMENT DEPARTMENT
201 North Stone Avenue Tucson, Arizona 85701-1207 Phone: (520)740-6500

INA ROAD WATER POLLUTION CONTROL FACILITY
PROCESS CHANGE AND EXPANSION

PLANT WIDE
PLC COVERAGE
AND LOCATIONS

I-19

C-293

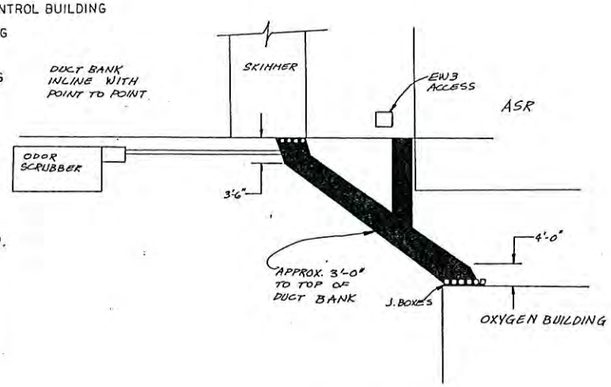
DATE : FEBRUARY 1999
SCALE: HORIZ. : AS NOTED
VERT. : AS NOTED
SHEET NO. : 367 OF 436

K:\2268 IFB\WS1\SHEET\IFB\PVC-2283R1.IFB 02/03/99 10:47:53 6-46.DS CROSS

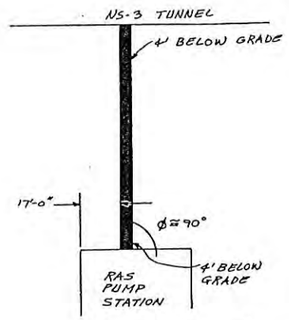
1986

LEGEND

NO.	FACILITY
01	ADMINISTRATION AND LABORATORY BLDG.
02	WAREHOUSE
03	HEADWORKS AND PUMPING STATION (NOT SHOWN)
04	PRIMARY CLARIFIERS
05	OXYGEN PRODUCTION FACILITY
06	ACTIVATED SLUDGE REACTORS
07	SECONDARY CLARIFIERS
08	SLUDGE THICKENERS AND CONTROL BUILDING
09	VACUUM FILTRATION BUILDING
10	SLUDGE DIGESTERS
11	DIGESTER CONTROL BUILDING
12	CHLORINATION BUILDING
13	CHLORINE CONTACT BASIN
14	ENERGY RECOVERY BUILDING
15	TUNNELS (SHOWN SHADED)
16	TRAINING CENTER
17	SERVICE WATER BUILDING
18	POTABLE WATER SYSTEM.
19	GRIT CHAMBERS
20	WAREHOUSE
21	INFLUENT FLOW METER
22	SLUDGE STORAGE BASIN
23	CENTRIFUGE BUILDING



DETAIL - LEFT △
N.T.S.



DETAIL - RIGHT △
N.T.S.

(21) EXISTING SIGNAL, POWER & SPARE CONDUIT TO HEADWORKS.

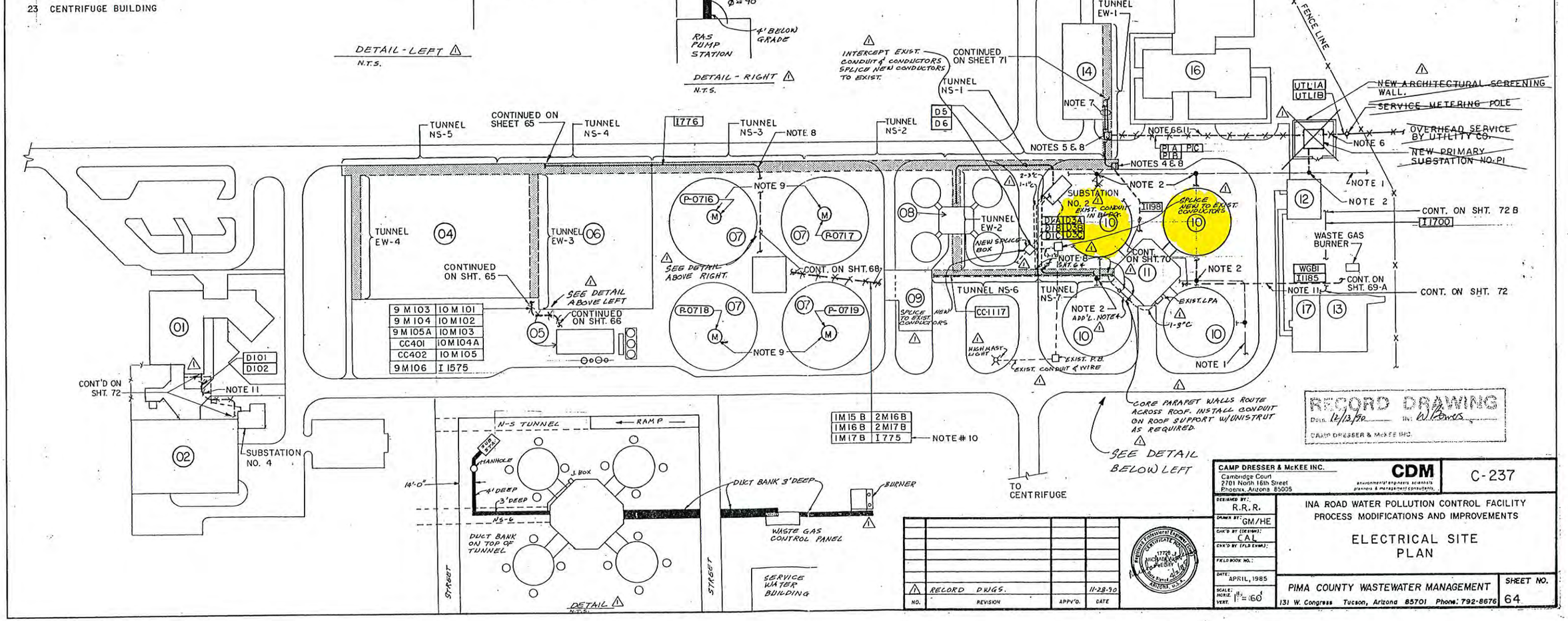
TO HEADWORKS

ADDITIONAL GENERAL NOTES: △

1. SEAL ALL BURIED CONDUIT WALL PENN W/ SEALANT ON BOTH SIDES OF WALL
2. ALL BURIED CONDUITS SHALL BE IN A CONCRETE DUCTBANK SEE DET. E, SHT. 57.
3. SPLICE BOX SHALL BE DESIGNED FOR FULL TRAFFIC H_2O LOADS 17"X34"X18" DEEP PLUS EXTENSIONS. MODULATE AS MANUFACTURED BY CDR SYSTEMS OR EQUAL.
4. INSTALL CONDUIT SEALS FOR CONDUIT ON ROOF. ROOF AREAS ARE NEMA 4X & 7.

NOTES:

1. APPROXIMATE LOCATION OF EXISTING 500 MCM BARE COPPER GROUND GRID.
2. EXOTHERMICALLY WELD NEW SUBSTATION 500 MCM BARE COPPER AND NEW DIGESTER 4/0 BARE COPPER TO EXIST. GROUND GRID.
3. DASHED CONDUIT LINES INDICATE UNDERGROUND RACEWAYS. SOLID CONDUIT LINES INDICATE RACEWAYS MOUNTED TO WALL OF EXISTING UTILITY TUNNELS (TYP.).
4. 18"H X 12"W X 6"D PULL BOX MOUNTED TO WALL IN TUNNEL NEAR CEILING.
5. APPROX. 24"H X 66"W X 24"D PULL BOX MOUNTED TO WALL IN TUNNEL NEAR CEILING, SEE DETAIL G / SHT 57. △
6. ~~36" MIN DEPTH TO TOP OF CONCRETE ENCASEMENT.~~
7. MOUNT TO TUNNEL WALL. ROUTE TO VERTICAL CONDUIT CHASE IN ENERGY RECOVERY BUILDING.
8. CORE WALL AS REQUIRED FOR INSTALLATION OF NEW CONDUITS (TYP.)
9. EXISTING 1 HP. SCUM PUMP REMOVED AND REPLACED WITH 1 1/2 HP. UNITS. EXISTING WIRE & CONDUIT TO BE REUSED. STARTER OVERLOADS TO BE REPLACED WITH CORRECTLY SIZED HEATERS. STARTERS LOCADED IN BLDG. (09) MCC ROOM.
10. ADD NEW CONDUIT ADJACENT TO EXISTING UNDERGROUND DUCT.
11. REFERENCE SHEET 4 FOR LOCATIONAL DETAILS OF SIDEWALKS, ROADS, ETC. (TYP.)



DETAIL △

RECORD DRAWING
Date 12/12/90 By: W. Bowers
CAMP DRESSER & McKEE INC.

NO.	REVISION	APPV'D.	DATE
△	RECORD DWGS.		11-28-90

CAMP DRESSER & McKEE INC.
Cambridge Court
2701 North 16th Street
Phoenix, Arizona 85005

CDM environmental engineers, scientists, planners & management consultants

C-237

DESIGNED BY: R.R.R.
DRAWN BY: GM/HE
CHK'D BY (DESIGN): CAL
CHK'D BY (FLD ENGR):
FIELD BOOK NO.:
DATE: APRIL, 1985
SCALE: HORIZ. 1" = 60' VERT.

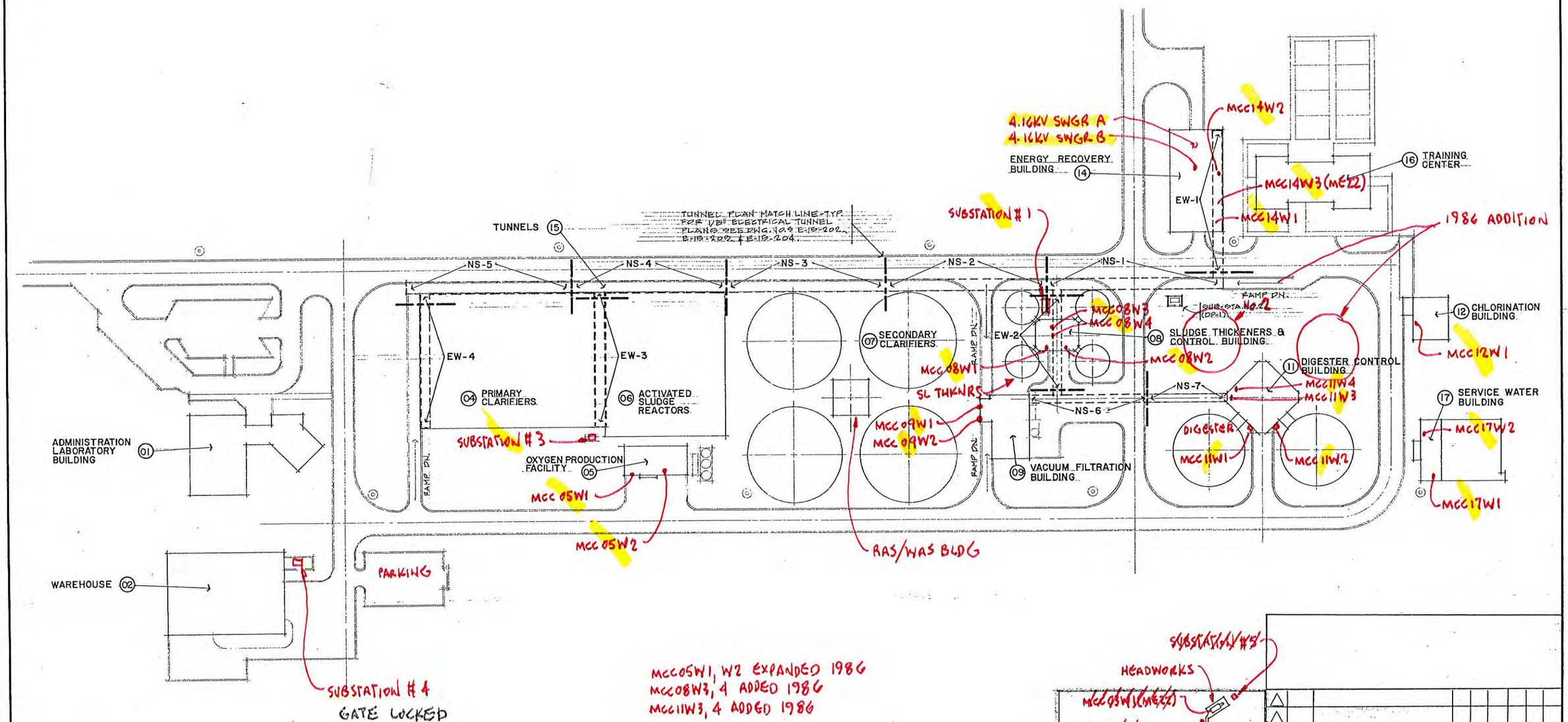
INA ROAD WATER POLLUTION CONTROL FACILITY
PROCESS MODIFICATIONS AND IMPROVEMENTS

ELECTRICAL SITE PLAN

PIMA COUNTY WASTEWATER MANAGEMENT
131 W. Congress Tucson, Arizona 85701 Phone: 792-8676

SHEET NO. 64

1975



ELECTRICAL SITE PLAN

NOTES:

1. FOR LARGE SCALE TUNNEL FLOOR PLANS SEE DWG. NOS E-15-202 THRU E-15-204.
2. SEE HANDHOLE DETAILS DWGS EF-10058-114-5-0 THRU -114-8-0 EF-10058-114-86-1 & -114-87-0

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV	ENGR	PROJ ENGR	APPR
3								
2		RECORD DRAWINGS UPDATED BY CDM	RWR					
1	1-14-80	AS BUILT	VS					
0	8/31/75	ISSUED FOR PREPARATION OF PROPOSALS	R.N.	R.N.				

SCALE 1"=60'-0" DESIGNED REN DRAWN MAW CHIEF ENGR

FIELD REVISIONS NOTED ON THIS DRAWING PER PIMA COUNTY CONTRACT 07-03-C-103333-0133 AMENDMENT NO. 1 DATED SEP 6, 1983

Robert Eugene Nabors 6214 Registered Engineer (Civil) State of Arizona

BECHTEL
SAN FRANCISCO

PIMA COUNTY, ARIZONA
INA ROAD WATER POLLUTION CONTROL FACILITIES

UTILITY TUNNELS
ELECTRICAL SITE PLAN

FINICAL AND DOMBROWSKI
CONSULTING ARCHITECTS - ENGINEERS TUCSON ARIZONA

DATE	DRWN	CHKD R.A.P.	ARCH/ENGR I.F.

JOB No.	DRAWING No.	REV.
10058	E-15-201	2

22 x 34 "D" SIZE

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1995

FROM POWER CO. POLE MTD. XFMR. 480V, 60 HZ, 3Ø

DISTRIBUTION PANEL "3E" (AT SEPTAGE RECEIVING STATION)

PUMP STATION NO. 13

MCC "P"

2400V, 60 HZ, 3Ø

FROM POWER CO. SUBSTATION

SEE NOTE 1

PLANT SWITCHGEAR

POWER CO. METERING

EXISTING CIRCUIT NO. (TYP.)

EXIST. SERVICE: 1500 KVA
UPGRADED SERVICE: 2500 KVA

EXIST. DEMAND: 1525 KVA
ADDED DEMAND: 585 KVA
TOTAL PK. DEMAND: 2110 KVA

56 55 54 53 52 51

TRANSFORMER "C"
500 KVA
(NEAR PROCESS WATER PUMP STA.)
EXIST. DEMAND: 180 KVA
ADDED DEMAND: 265 KVA
DEMAND: 445 KVA

2400V 480V SEE NOTE 1

EMERG. GEN. 80 KW

MCC "CCE"
PK. DEMAND: 40 KVA

CHLOR. BLDG.

MCC "C"

EXIST. DEMAND: 180 KVA
ADDED DEMAND: 100 KVA
PK. DEMAND: 280 KVA

MCC "CB"
PK. DEMAND: 125 KVA

80 KW EMERG. GEN.

PROCESS WATER PUMP STATION

MCC "CBE"
PK. DEMAND: 45 KVA
DECHLORINATION

MCC "CA"
EXIST. DEMAND: 90 KVA
ADDED DEMAND: 75 KVA
PK. DEMAND 165 KVA
EFFLUENT PUMP STATION

MCC "3A"
PK. DEMAND: 45 KVA
PUMP STATION NO. 2

2400 V 480 V SEE NOTE. 1

POWER CENTER 3
500 KVA
(AT PUMP STATION 2)
EXIST. DEMAND: 180 KVA
ADDED DEMAND: 110 KVA
PK. DEMAND: 290 KVA

MCC "3D"
DEMAND: 45 KVA
PUMP STATION NO. 10

MCC "3B"
PK. DEMAND: 50 KVA
PUMP STATION NO. 8

PWR CTR 4

MCC "3E"
PK. DEMAND: 100 KVA
GRAVITY THKNER. NO. 3

MCC "3C"
EXIST. DEMAND: 40 KVA
ADDED DEMAND: 10 KVA
PK. DEMAND: 50 KVA
MECHANICAL BUILDING

EXIST. DEMAND: 150 KVA
ADDED DEMAND: 100 KVA
PK. DEMAND: 250 KVA

BLOWER BUILDING
MCC "2"

MCC "2A"
PK. DEMAND: 30 KVA
HEADWORKS

POWER CENTER 2
500 KVA
(AT BLOWER BUILDING)

2400V 480V 125E 600/3 SEE NOTE. 1

2400V, 600/3 Ø

MCC "2D"
EXIST. DEMAND: 25 KVA
PUMP STATION NO. 12

MCC "2B"
EXIST. DEMAND: 40 KVA
ADDED DEMAND: 25 KVA
PK. DEMAND: 65 KVA
CHLORINE BUILDING

MCC "2C"
EXIST. DEMAND: 25 KVA
PUMP STATION NO. 9

MCC "4A"
PK. DEMAND: 25 KVA
DIGESTER NO.5

MCC "4B"
PK. DEMAND: 100 KVA
DIGESTER NO.6

MCC "B"
PK. DEMAND: 70 KVA
DIGESTER NO. 3

1B

POWER CENTER 4
500 KVA
PK. DEMAND: 110 KVA

SEE NOTE 1

FLOTATION THICKENER BUILDING

MCC "1"
PK. DEMAND: 135 KVA

POWER CENTER 1
500 KVA
(AT FLOTATION THICKENER BUILDING)
PK. DEMAND: 135 KVA

MCC "C"
PK. DEMAND: 25 KVA
PUMP STATION NO. 1

2400V 480V SEE NOTE 1

POWER CENTER B
750 KVA
(NEAR PUMP STATION 7)
PK. DEMAND: 685 KVA

MCC "BH"
PK. DEMAND: 85 KVA
PUMP STATION NO. 4

?

MCC "BC"
PK. DEMAND: 475 KVA
PUMP STATION NO. 4

BIO BLDG

MCC "AB"
PK. DEMAND: 75 KVA
PUMP STATION NO. 14

MCC "AA"
PK. DEMAND: 85 KVA
ADMINSTRATION BUILDING

MCC "BF"
PK. DEMAND: 35 KVA
PUMP STATION NO. 7

MCC "BG"
PK. DEMAND: 105 KVA
DIGESTERS NO. 1 & 2

POWER CENTER A
300 KVA
(AT ADMINSTRATION BUILDING)

EXIST. DEMAND: 85 KVA
ADDED DEMAND: 80 KVA
PK. DEMAND: 165 KVA

GENERATOR DISTRIBUTION CENTER NO.3

GENERATOR DISTRIBUTION CENTER NO.2

MECHANICAL BUILDING

GENERATOR DISTRIBUTION CENTER NO.1

FUTURE GEN. #4 — 400 KW GEN. #3 — 400 KW GEN. #2 — 400 KW GEN. #1

VOID
SEE SHT 122 OF 143
WITH REVISIONS
DATED 5/20/1996

NOTES:

1. MAXIMUM AVAILABLE FAULT CURRENT (AFTER PLANNED POWER CO. UPGRADE) AT THE FOLLOWING POINTS:
   - (1) 12,990 SYMMETRICAL RMS AMPERES
   - (2) 8,600 SYMMETRICAL RMS AMPERES 12,500 ASYMMETRICAL INCLUDING MOTOR CONTRIBUTION.
   - (3) 14,100 SUMMETRICAL RMS AMPERES 17,700 ASYMMETRICAL INCLUDING MOTOR CONTRIBUTION.
   - (4) 6,700 SYMMETRICAL RMS AMPERES 9,300 ASYMMETRICAL INCLUDING MOTOR CONTRIBUTION.
2. ALL PROPOSED 480V CIRCUIT BREAKERS TO HAVE MINIMUM INTERRUPTING RATING OF 22,000 SYMMETRICAL RMS AMPERES.

NO	REVISION	APPV'D.	DATE

CT&A CONSOER, TOWNSEND & ASSOCIATES, INC. CONSULTING ENGINEERS
Nashville, Tennessee Tucson, Arizona

DRAWING NO. XE-1

C - 261

DESIGNED BY: DAD
DRAWN BY: KH
CHK'D BY (DESIGN): KAR
CHK'D BY (FLD ENGR):
FIELD BOOK NO.:
DATE: 8-1-94
SCALE: NONE HORZ. VERT.

ROGER ROAD WWTP 11 MGD EXPANSION PHASE III

ELECTRICAL OVERALL ONE LINE DIAGRAM

PIMA COUNTY WASTEWATER MANAGEMENT
130 W. Congress Tucson, Arizona 85701 Phone: 792-8676

SHEET NO. 122 OF 143

3066

05/19/95 C:\ACAD20\DWG\95RDP-3\3066GS.2 19:52 KH

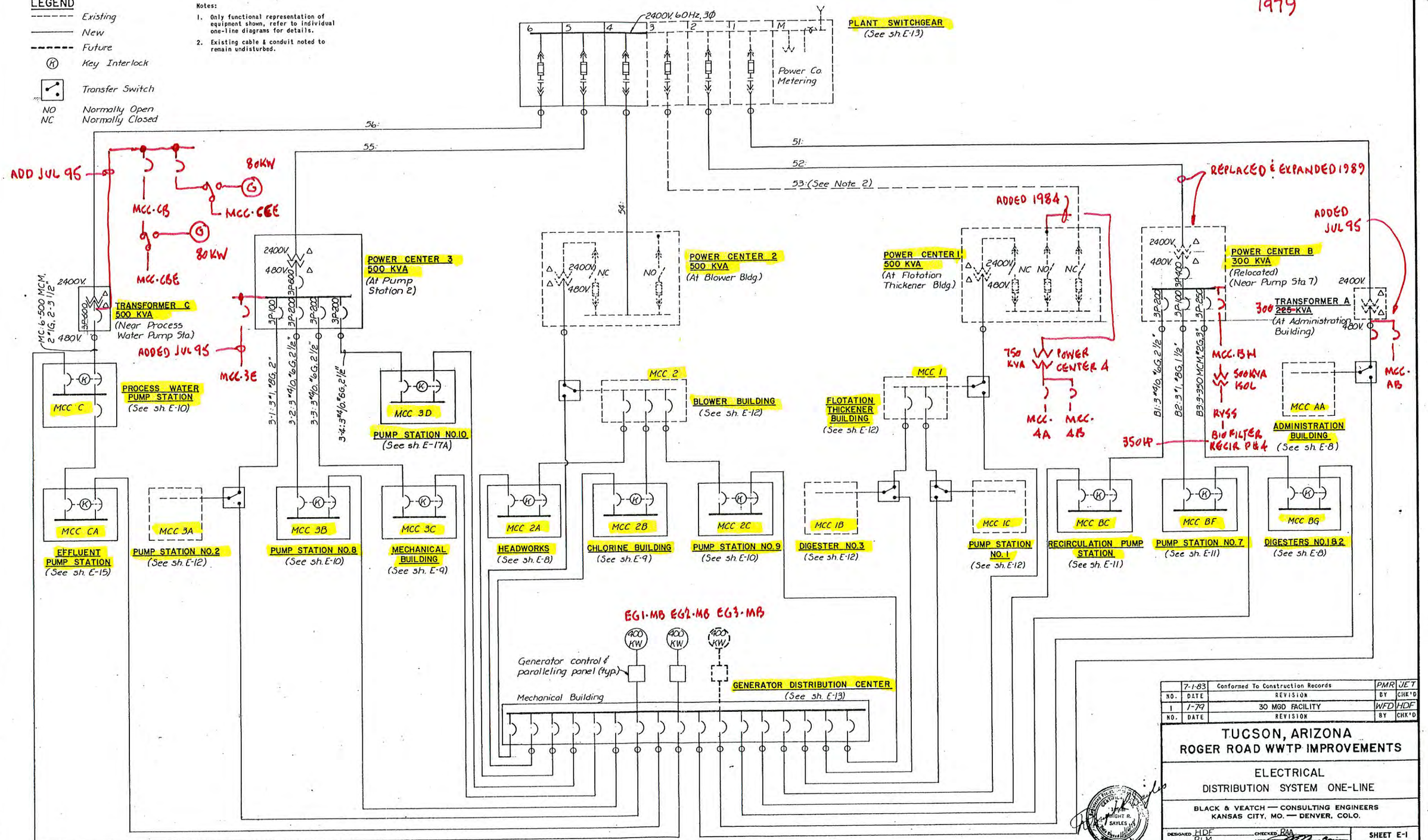
1979

LEGEND

- Existing
- New
- Future
- (K) Key Interlock
- Transfer Switch
- NO Normally Open
- NC Normally Closed

Notes:

1. Only functional representation of equipment shown, refer to individual one-line diagrams for details.
2. Existing cable & conduit noted to remain undisturbed.



NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET
1	1-79	30 MGD FACILITY	WFD	HDF

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

ELECTRICAL
DISTRIBUTION SYSTEM ONE-LINE

BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED HDF
DETAILED RLM
CHECKED RAA
APPROVED
DATE 12/13/78

SHEET E-1
150 OF 179

PICTURE	DESCRIPTION
DSC00001	3-500 KVA TRANSFORMERS, 13.2KV-2400V, 3 PHASE, UTILITY OWNED
DSC00002	2300V SWITCHGEAR
DSC00003	2300V SPLICE PEDESTAL
DSC00004	POWER CENTER A, 500KVA, 2400-480V, 3 PHASE
DSC00005	MCC-AA
DSC00006	MCC-AA
DSC00007	MCC-AA
DSC00008	MCC-3E
DSC00009	EG-1, 2, 3
DSC00010	EG-3
DSC00011	MCC-3C
DSC00012	GENERATOR DISTRIBUTION CENTER, GENERATOR MAIN BREAKERS
DSC00013	GENERATOR DISTRIBUTION CENTER, GENERATOR MAIN BREAKERS
DSC00014	NEW GDC
DSC00015	GENERATOR PARALLELING CONTROL PANEL
DSC00016	MCC-4A - DIGESTER NO. 5
DSC00017	MCC-1B
DSC00018	SLUDGE GAS COMPRESSOR STARTERS AT MCC-1B
DSC00019	MCC-BG - DIGESTOR NOS. 1 AND 2
DSC00020	POWER CENTER 1
DSC00021	POWER CENTER 1
DSC00022	POWER CENTER 4
DSC00023	POWER CENTER 4
DSC00024	MCC-1 - FLOTATION THICKENER BUILDING
DSC00025	MCC-1 - FLOTATION THICKENER BUILDING
DSC00026	MCC-1 - FLOTATION THICKENER BUILDING
DSC00027	POWER CENTER 3
DSC00028	POWER CENTER 3
DSC00029	MCC-3A
DSC00030	MCC-4B
DSC00031	MCC-3D - PUMP STATION 10
DSC00032	TYPICAL MCC DUAL FEED WITH KEY INTERLOCK
DSC00033	MCC-2C - PUMP STATION 9
DSC00034	MCC-1C - PUMP STATION 1
DSC00035	MCC-BF - PUMP STATION 7
DSC00036	POWER CENTER B
DSC00037	MCC-3B - PUMP STATION 8
DSC00038	MCC-AB - PUMP STATION 14
DSC00039	MCC-BC - BRP-4BR
DSC00040	RVSS FOR BRP-4BR
DSC00041	ENGINE DRIVEN BIO RECIRCULATING PUMPS
DSC00042	POWER CENTER 2 - BLOWER BUILDING
DSC00043	MCC-2 - BLOWER BUILDING
DSC00044	LCP-3 - BLOWER CONTROL PANEL
DSC00045	MCC-2A - HEADWORKS
DSC00046	MCC-2A - HEADWORKS
DSC00047	MCC-2A - HEADWORKS
DSC00048	MCC-2B - CHLORINE FACILITY
DSC00049	MCC-2BE - CHLORINE FACILITY
DSC00050	TRANSFORMER C
DSC00051	MCC-C

DSC00052	MCC-CA - EFFLUENT PUMP STATION
DSC00053	MCC-CA - EFFLUENT PUMP STATION
DSC00054	MCC-CBE - DECHLORINATION FACILITY
DSC00055	MCC-CB - DECHLORINATION FACILITY
DSC00056	MCC-2D - PUMP STATION 12

Rogue Road WWTP

(1)

PICTURES

1 3-500 KVA XFMRS 13.2 KV - 2400V, 3Ø
UTILITY OWNED

2. 2300V SWGR

3. 2300V SPLICE PEDESTAL

4. POWER CENTER A 500 KVA 2400 - 480V, 3Ø

5,6,7 MCC-AA
8 MCC-3E
9 EG-1,2,3
10 EG-3
11 MCC-3C
12,13 GEN DISTRIBUTION CENTER, GEN MAIN BRKRS
14 NEW GDC
15 GEN PARALLELING CONTROL PANEL
16 MCC 4A ~~SLUDGE PUMP STATION~~ DIGESTER NO. 5
17,18 MCC 1B, SL GAS COMPRESSORS STARTERS @ MCC 1B
19 MCC BG, DIG #1 & 2
20,21 POWER CENTER 1
22,23 " " 4
24,25,26 MCC 1 - FLOTATION THKNR BLDG
27,28 POWER CENTER 3
29 MCC 3A
30 MCC 4B

PICTURES

31 MCC 3D P.S. #10
32 TYP MCC DUAL FEED W/ KEY INTERLOCK
33 MCC 2C PS #~~16~~ 9
34 MCC 1C PS #1
35 MCC BF PS #7
36 POWER CENTER B
37 MCC 3B PS #8
38 MCC AB PS #4
39 MCC-BC BRP-4BR
40 RVSS FOR BRP-4BR
41 Engine DRIVEN ~~BLOWE~~ BIO RECIRC PUMPS
42 POWER CENTER 2-BLOWER BLDG
43 MCC-2-BLWR BLDG
44 LCP-3 BLWR CONTROL PANEL
45, 46, 47 MCC 2A - HEADWORKS
48 MCC 2B - CHLORINE FAC.
49 MCC 2BC - " "
50 TRANSFORMER C
51 MCC-C
52, 53 MCC ~~3~~A C EFF P.S.
54 MCC CBE DECHL FAC.
55 MCC CB " " "
56 MCC 2D P.S. #12

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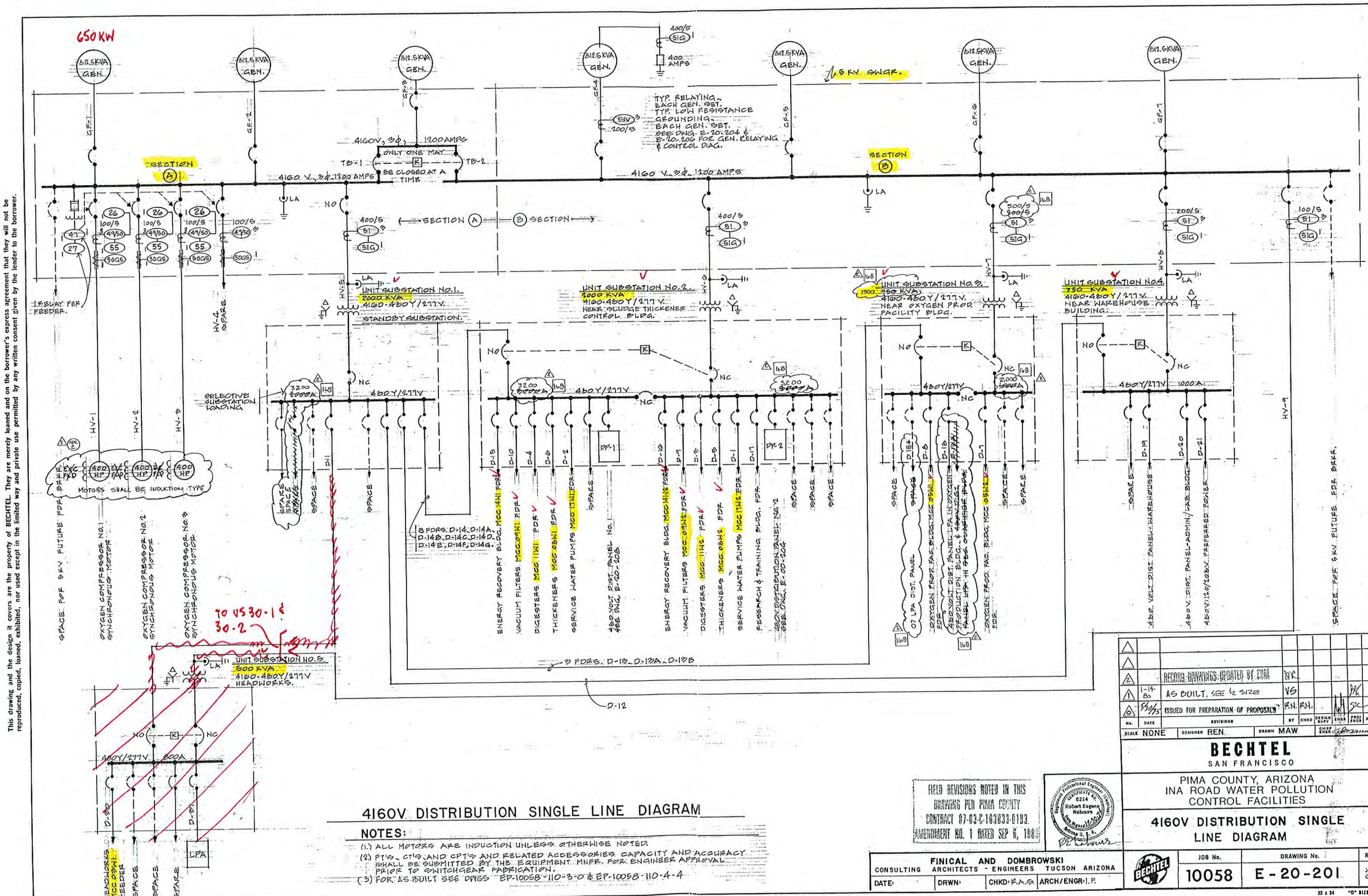


4160V DISTRIBUTION SINGLE LINE DIAGRAM

NOTES:

(1.) ALL MOTORS ARE INDUCTION UNLESS OTHERWISE NOTED.

(2) PT'S, CT'S, AND CPT'S AND RELATED ACCESSORIES CAPACITY AND ACCURACY SHALL BE SUBMITTED BY THE EQUIPMENT MNFR. FOR ENGINEER APPROVAL PRIOR TO SWITCHGEAR FABRICATION.

(3) FOR AS BUILT SEE DWGS EP-10058-110-3-0 & EP-10058-110-4-4

FIELD REVISIONS NOTED IN THIS DRAWING PER PIMA COUNTY CONTRACT 07-03-C-103033-0103 AMENDMENT NO. 1 DATED SEP 6, 1983

Registered Professional Engineer (Electrical) Certificate No. 6214 Robert Eugene Nabours Date Signed 12-8-83 Arizona U.S.A.

No.	Date	Revisions	By	Chkd	Design Supv	Engr	Proj Engr	Appr
3		RECORD DRAWINGS-UPDATED BY CMM	BRC					
1	1-14-80	AS BUILT, SEE ½ SIZE	VS					
0	5/30/75	ISSUED FOR PREPARATION OF PROPOSALS	R.N.	R.N.				

Scale NONE | Designed REN. | Drawn MAW. | Chief Engr.

BECHTEL
SAN FRANCISCO

PIMA COUNTY, ARIZONA
INA ROAD WATER POLLUTION CONTROL FACILITIES

4160V DISTRIBUTION SINGLE LINE DIAGRAM

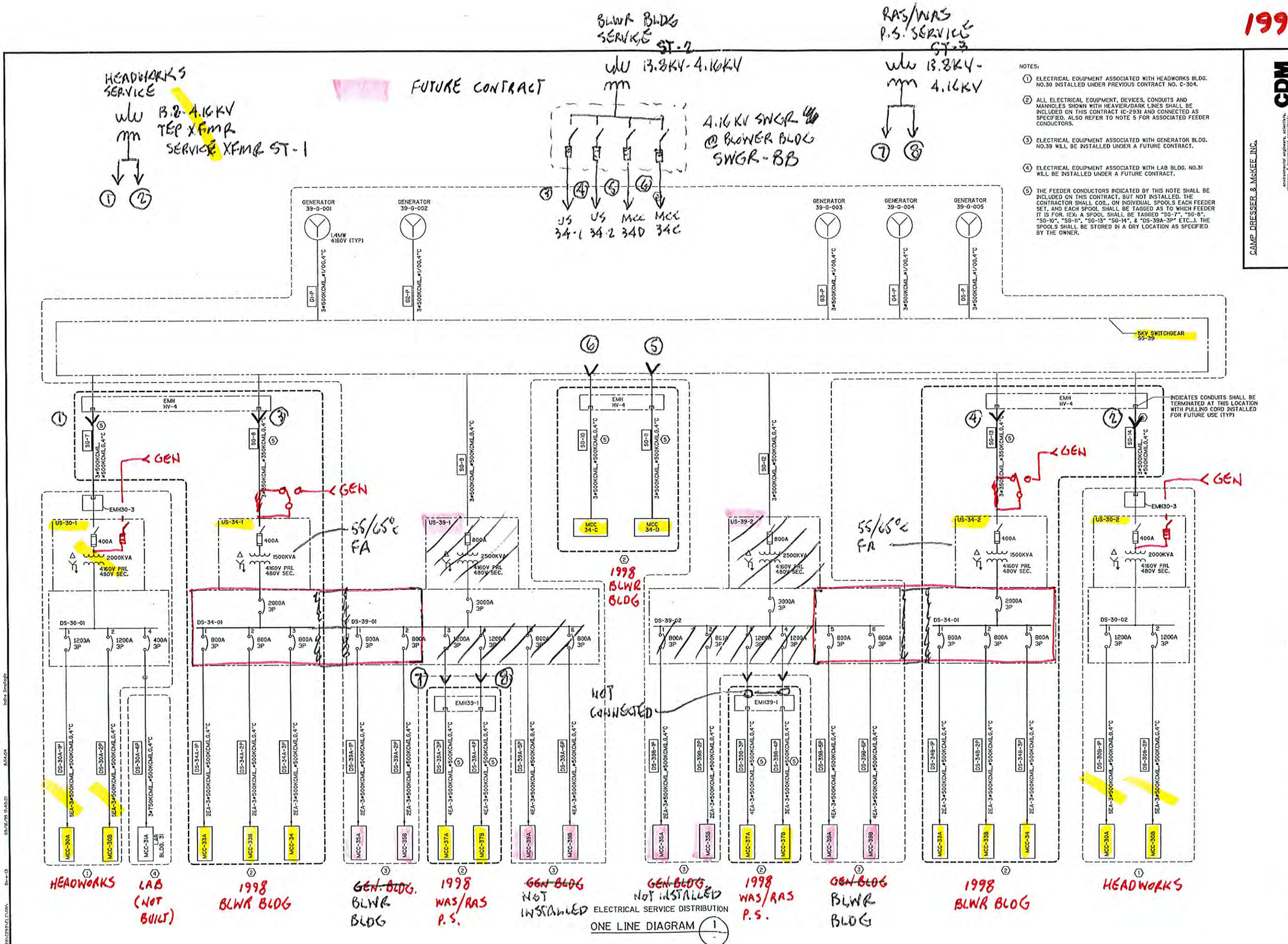
Job No.	Drawing No.	Rev.
10058	E-20-201	2

22 x 34 "D" SIZE

Consulting Architects - Engineers: FINICAL AND DOMBROWSKI, Tucson Arizona

Date	Drwn.	Chkd. R.A.G.	Arch/Engr. I.F.

1998



NOTES:

1. ELECTRICAL EQUIPMENT ASSOCIATED WITH HEADWORKS BLDG. NO.30 INSTALLED UNDER PREVIOUS CONTRACT NO. C-304.
2. ALL ELECTRICAL EQUIPMENT, DEVICES, CONDUITS AND MANHOLES SHOWN WITH HEAVIER/DARK LINES SHALL BE INCLUDED ON THIS CONTRACT (C-293) AND CONNECTED AS SPECIFIED. ALSO REFER TO NOTE 5 FOR ASSOCIATED FEEDER CONDUCTORS.
3. ELECTRICAL EQUIPMENT ASSOCIATED WITH GENERATOR BLDG. NO.39 WILL BE INSTALLED UNDER A FUTURE CONTRACT.
4. ELECTRICAL EQUIPMENT ASSOCIATED WITH LAB BLDG. NO.31 WILL BE INSTALLED UNDER A FUTURE CONTRACT.
5. THE FEEDER CONDUCTORS INDICATED BY THIS NOTE SHALL BE INCLUDED ON THIS CONTRACT, BUT NOT INSTALLED. THE CONTRACTOR SHALL COIL, ON INDIVIDUAL SPOOLS EACH FEEDER SET, AND EACH SPOOL SHALL BE TAGGED AS TO WHICH FEEDER IT IS FOR. (EX: A SPOOL SHALL BE TAGGED "SG-7", "SG-8", "SG-10", "SG-11", "SG-13" "SG-14", & "DS-39A-3P" ETC...). THE SPOOLS SHALL BE STORED IN A DRY LOCATION AS SPECIFIED BY THE OWNER.

CAMP DRESSER & McKEE INC.

CDM

environmental engineers, scientists, planners, & management consultants

NO.	REVISION	APPVD.	DATE

REGISTERED PROFESSIONAL ENGINEER (ELECTRICAL) 29698 STATE OF ARIZONA 1/11/99

DESIGNED BY: A. NIZOV
DRAWN BY: E. CLEMENT
CHK'D BY (DESIGN): V.K. GUTA
CHK'D BY (FIELD DWG): V.K. GUTA
FIELD BOOK NO.:

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

201 North Stone Avenue Tucson, Arizona 85701-1207 Phone: (520)740-6500

INA ROAD WATER POLLUTION CONTROL FACILITY PROCESS CHANGE AND EXPANSION

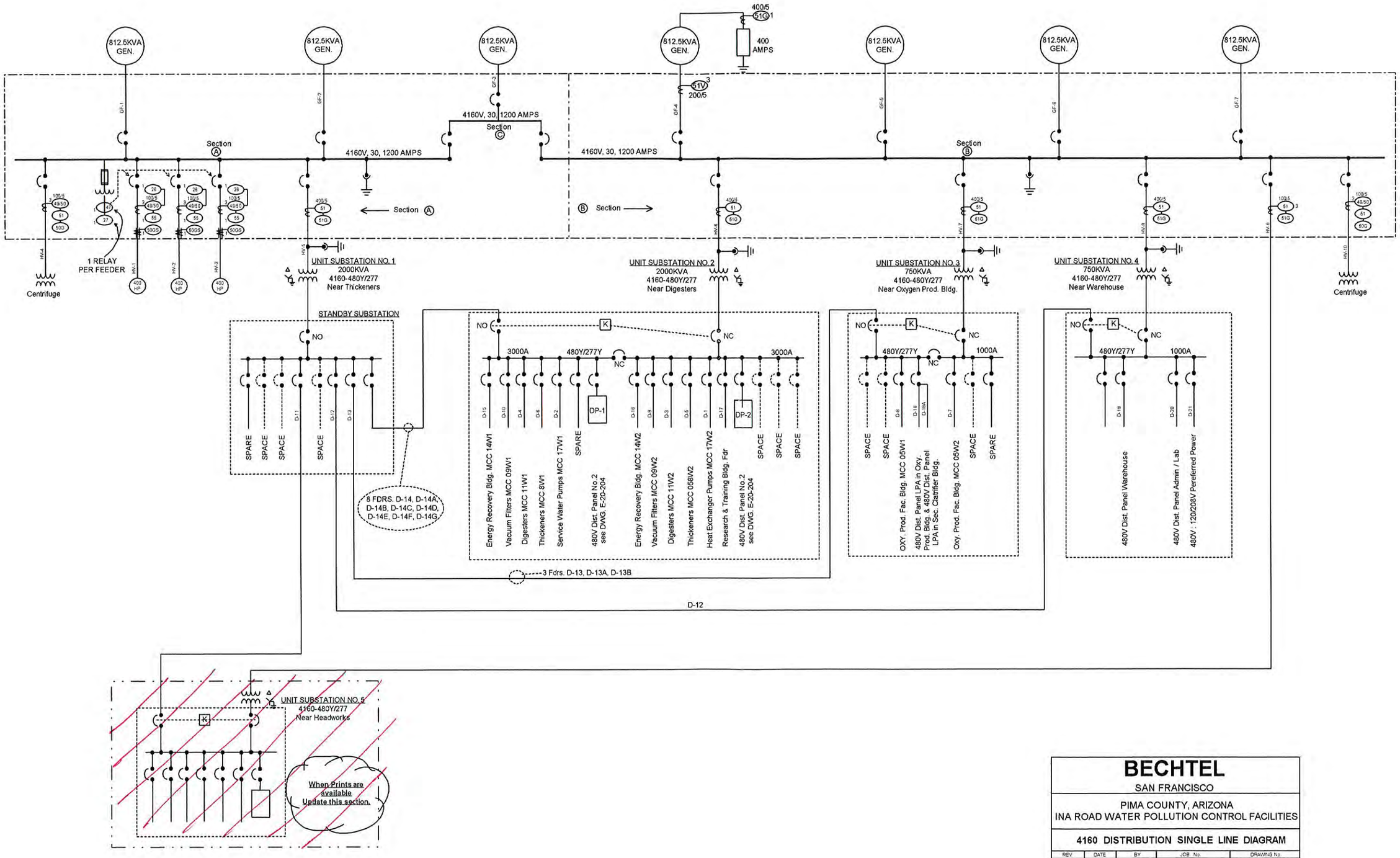
EXISTING PLANT FACILITY ELECTRICAL POWER DISTRIBUTION ONE LINE DIAGRAM GN-E-13

C-293

DATE: FEBRUARY 1999

HORIZ.: AS NOTED
VERT.: AS NOTED

SHEET NO.: 245 OF 436



BECHTEL

SAN FRANCISCO

PIMA COUNTY, ARIZONA
INA ROAD WATER POLLUTION CONTROL FACILITIES

4160 DISTRIBUTION SINGLE LINE DIAGRAM

REV	DATE	BY	JOB No.	DRAWING No.
1	2/26/03	A.R.B.	10058	E - 20 - 201

(1)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: New Headworks / Service Transformer ST-1

Electrical Rating: 13.8KV - 4.16 KV 3φ

Manufacturer / Model: UNK/UNK (Provide by TEP)

Age of equipment: > 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Transformer owned by Plant. No secondary protection. Feeds Unit Substations US 30-1, US 30-2.

(2)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: US 30-1 / New Headworks

Electrical Rating: 2000/2340KVA - 2300/2676 4160 - 480Y,3Ø ΔY 5.86Z FANS INSTALLED

Manufacturer / Model: C-H

Age of equipment: 1/2000 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	(1)
Electrical	4	3	2	1

Additional Comments: Secondary line up C-H Pow-R-Line Switch board non W/I aisle. Dusty door filters.
Primary arranged w/ dual fused switches key inter locked. Second feed from generator
Front working pad 3'-0" deep.

(3)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: US 30-2 / New Headworks

Electrical Rating: 2000/2340KVA - 2300/2576KVA 4160V - 480V, 3ϕ ΔY 5.86Z

Manufacturer / Model: C-H

Age of equipment: 1/2000 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	(1)
Electrical	4	3	2	1

Additional Comments: Same as US 30-1

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: MARTY (SUPER) & ALLEN (ELECTRICIAN)

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: 4.16KV SWGR "A" / Energy Recovery Bldg

Electrical Rating: 4160V, 3Ø, 1200A

Manufacturer / Model: Nankisoka Power Systems / ITE O.O. Breakers

Age of equipment: 1975 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Generators manually synched to bus. Analog meters replaced with digital. Governors updated to Woodward electronic. Exciter controls updated to Basler Electric. Eqpt in very good condition for age. Gen EG3 can be synched to either BUS A or B. Current operation is with all ties closed and generators paralleled. Located in A/C space. Generator data sent to SCADA system

7

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: 4.16 KV SWGR "B" / Energy Recovery Bldg

Electrical Rating: _____

Manufacturer / Model: _____

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments:

See 4KOV SWGR "A"

11

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: US-CEN 1 / Centrifuge Bldg

Electrical Rating: 1500 KVA 55°C 4160-480/277V, 3φ OA

Manufacturer / Model: GE Substation Transformer

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Some corrosion secondary transition Bus duct connected on secondary. No sec protection Primary may have protection. Couldn't open, Similar for US-CEN 2

16

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: Substation No. 2 / Digester Tanks

Electrical Rating: 2000 KVA, 65°C 4160-480V, 3Ø ΔY

Manufacturer / Model: (W)

Age of equipment: 1996 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: No primary o/c or disconnect. Secondary W/I aisle blocked. N.P. on fuses missing. Transformer oil hot.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: SUBSTATION NO. 3 / Oxygen Production Bldg

Electrical Rating: 1500 KVA 65°C 4160-480V, 3φ Δ-Y

Manufacturer / Model: Westinghouse

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Exterior very corrosion. Secondary W/I surge. No N.P. on surge breakers. Transformer liquid temp hot. Fan being used to cool.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: Substation No. 1 / Sludge Thickeners

Electrical Rating: 2000KVA, 65°c 4160-480V, 3Ø ΔY

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	(4)	3	2	1

Additional Comments: No primary o/c protection or disconnect. Secondary 4/1 aisle bwbd. Extremely crowded. Door filters missing.

30

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: Service Transformer ST-2 / New Blower Bldg.

Electrical Rating: 5000/7000KVA, 65°C, 13.8KV-4160V, 3Ø FUTURE FAN 3, 5,682

Manufacturer / Model: GE / Silicone Fluid Transformer

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Transformer purchased used. Served o/H @ 13.8KV from TEP. Secondary serves new sw/fuse switchgear w/ 4 feeder switches, no main disconnect (SWGR-BB) HV & LV compartments of xfmr locked. Appears there is no o/c protection or disconnects.

31

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: SWGR-BB / New Blower Bldg

Electrical Rating: 4.16KV, 3Ø

Manufacturer / Model: SSG ~~UNK~~ / UNK (No nameplate)

Age of equipment: ~~6~~ < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Pad is to small in front for performing maintenance. NEMA 3R construction 4-600A fusible switches w/ 300E SM-55 snuffler fuses.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: US 34-2 / BLOWER BLDG

Electrical Rating: 1500/1680/1728/1932 55°C 4160-480V, 3φ ΔY

Manufacturer / Model: SQUARE D

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Front pad appears short. Primary line selector sw. 600A, HVL Load Interrupter Main switch; Sec. Main Brk PEL Type 2000A, 480V 3φ 3W, 2000A secondary sections. NEMA 3R Switch board enclosure on secondary.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: US 34-1 / BLOWER BLDG

Electrical Rating: 1500/1680/1725/1932 55°C 4160-480V, 3Ø 3W ΔY

Manufacturer / Model: Square D

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Same as US 34-2

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: Substation Transformer ST-3 / RAS/WAS P.S.

Electrical Rating: 1000KVA, 65°C 13.8KV-480V 3φ ΔY 5.87% Z

Manufacturer / Model: (WS) / Insulated Unit Substation

Age of equipment: UNK years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Purchased used. Pri & sec compartments locked. Liquid temp gauge alarm level not set. Spill containment curb below grade. Potential flooding problem.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: SUBSTATION NO. 4 / WAREHOUSE BLDG

Electrical Rating: _____

Manufacturer / Model: _____

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Gate locked. Not assessed.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 05W1 / Oxygen Production Bldg

Electrical Rating: 800A, 480V, 3Ø, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 9 sections. 1 new section (W) 2100 series
Needs new N.P. Located in process area.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 05W2 / Oxygen Production Bldg.

Electrical Rating: 600A, 480V, 3Φ, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 5 sections. Located in process area.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 08W1 / Sludge Thickener Control Bldg

Electrical Rating: 600A 480V, 3Φ, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 2 sections. Located in process area. ~~Some dripping condensation from above.~~

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 08W2 / Sludge Thkns Control Bldg

Electrical Rating: 600A, 480V 3ϕ, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 2 sections located in process area.

~~Some dripping condition from above.~~

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 08W3 / Sludge Thickener Control Bldg

Electrical Rating: 400A M.B. 480V, 3φ, 4W

Manufacturer / Model: (W) 2100 Line

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: Corrosive area. Some dripping corrosion from above. Some N.P. missing. 3 sections

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 08W4 / Sludge Thkns Control Bldg.

Electrical Rating: _____

Manufacturer / Model: (W) 2100 Line

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: Corrosive area. Some dripping corrosion from above. 2 sections. Some W.P. missing.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 09W1 / Vacuum Filtration Bldg

Electrical Rating: 600A, 480V, 3φ, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 4 sections. Located in decommissioned process area which is A/C. Fronts have been repainted. Some N.P. missing. Feeds RAS Pumps VFDs & Mixed Liquor Pumps VFD's. VFD's located in adjacent unclean space.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 09W2 / Vacuum Filtration Bldg

Electrical Rating: 600A, 480V, 3Ø, 4W

Manufacturer / Model: WM

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 5 sections. Adjacent to MCC 09W1. Fronts have been repainted. Some H.P. missing. Feeds RAS Pumps VFD's & Mixed Liquor Pumps VFD's.

16A

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 11W1 / Digester Tanks

Electrical Rating: 480V 3φ, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: NEMA 3R NON W/1 aisle enclosure. N.P. missing. Dusty inside. Doors need lube.

17A

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 11W2 / Digester Tanks

Electrical Rating: 480V, 3Ø, 4W

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: Same as MCC 11W1

KB

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 11W3 / Digester Tanks

Electrical Rating: 480V, 3φ, 4W

Manufacturer / Model: (W) 2100 Line

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2-)	1

Additional Comments: 6 sections. NEMA 4X SS non W/I enclosure.

17B

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 11W4 / Digester Tanks

Electrical Rating: 480V, 3φ, 4W

Manufacturer / Model: (W) 2100 Line

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Same as MCC 11W3.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 12W1 / Chlorination Bldg

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: 2 sections. Corrosion on exterior. Very lightly loaded Chlorine Evaporators no longer in service. Located in conditioned space.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC14W1 / Energy Recovery Bldg

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Located in Generator Room Section.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 14W2 / Energy Recovery Bldg

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Located in Generator Room.
4 sections.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC14W/3 / Energy Recovery Bldg

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: Westinghouse

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 3 sections. Located in A/C space with generator Sings "A" and "B".

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 17W1 / Service Water Bldg

Electrical Rating: Not N.P.

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	(4)	3	2	1

Additional Comments: 4 sections located in process area. 2 doors with brackets for starters for service water pumps replaced. Corrosion on exterior.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 17W2/ Service Water Bldg

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: (W)

Age of equipment: 1976 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	(4)	3	2	1

Additional Comments: 2 sections. Located in process area. Corrosion on exterior.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC A / Sulfur Dioxide Bldg

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: Square D / Model 6

Age of equipment: < 5 yrs years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 3 sections, Located in conditioned space.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC B / Sulfur Dioxide Bldg

Electrical Rating: 600A, 480V 3ϕ

Manufacturer / Model: Square D / Model 6

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 4 section, Located in conditioned space.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-CEN / Centrifuge Bldg

Electrical Rating: 2000A, 480V, 3φ, 4W

Manufacturer / Model: GE/8000 Line

Age of equipment: 1986 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Arranged M-T-M. Located in conditioned space. Main & tie breakers: GE Power Break. M-T-M key interlocked. Bus duct fed from Ina Substations.

(4)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-30A / New Headworks

Electrical Rating: 1200A, 480V, 3φ, 3W

Manufacturer / Model: C-H Freedom Series 2100

Age of equipment: 1/2000 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	(1)
Electrical	4	3	2	1

Additional Comments: Dual main breakers w/ key interlocks. 12 sections. Individual PFC capacitors mounted on top of line up. HVAC duct routed directly above with approx 1'-0" clearance above capacitors.

(5)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC. 30B / New Headworks

Electrical Rating: 1200A, 480V, 3φ, 3W

Manufacturer / Model: C-H Freedom Series 2100

Age of equipment: 1/2000 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	(1)
Electrical	4	3	2	1

Additional Comments: Dual main breakers w/ key interlocks. 12 sections. Individual PFC capacitors mounted on top of line up.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 33A / Blower Bldg

Electrical Rating: 600A, 480 V, 3Φ, 3W

Manufacturer / Model: Square D / Model 6

Age of equipment: <5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Dual main breakers key interlocked. 13 sections. Has VFD w/ bypass for HE-PMP's. Power Logic Circuit Monitor on main.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 33B / Blower Bldg

Electrical Rating: 600A, 480V, 3ϕ, 3W

Manufacturer / Model: Square D / Model 6

Age of equipment: < 6 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: N.P. missing. Same as MCC 33A 12 sections.

36

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 34 / Blower Bldg

Electrical Rating: 800A, 480V, 3ϕ, 3W

Manufacturer / Model: Square D / Model 6

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 9 sections. Dual main breakers key interlocked. Has VFDs for ventilation equipment. Power Logic Circuit Monitor on main.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 34C, D (BLOWER BLDG)

Electrical Rating: 4160V 3ϕ, 600A

Manufacturer / Model: SQUARE D ISO-FLEX Model 4

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Type MVL main interrupter sw. Blower starters: MV Controller Class E2. MCC 34C, D sit side by side w/ each feeding two Blowers. No MCC main N.P.S. G.E. 469 MMR on all Blower starters. All 30 series MCC's in Blower Bldg in 2nd floor A/E Electrical Room.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 35A / Blower Bldg.

Electrical Rating: 800A, 480V, 3φ 3W

Manufacturer / Model: Square D / Model 6

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 5 sections. Dual main breakers key interlocked. Has VFD for Mixer. Power Logic Circuit Monitor on Main.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 35B / Blower Bldg

Electrical Rating: 800A, 480V, 3φ, 3W

Manufacturer / Model: Square D / Model 6

Age of equipment: <5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Same as MCC 35A.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 37A / RAS/WAS P.S.

Electrical Rating: 1200A, 480V, 3φ, W

Manufacturer / Model: Square D / Model C

Age of equipment: < 5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Located below grade in Elect Room at Mezz level above P.R. floor. 12 sections Dual main breakers key interlocked. VFD's for WAS pumps. Room has temp A/C. Doors too short to remove equipment. Second power source not apparent.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☐ Ina Road WPCF X

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 6/13 thru 6/15 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 37B / RAS/WAS P.S.

Electrical Rating: A, 480V, 3Φ, W

Manufacturer / Model: Square D / Model 6

Age of equipment: <5 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 10 Sections, Same as MCC 37A.

Appendix B

Condition Assessment Data

Electrical Field Assessment Roger Road

Rogue Road WWTP
5/25/06

(1)

Notes Consolidation

1. Thermal imaging of all electrical equipment performed annually.

2. Current electric rate is approx $.16 KWH.

3. Biggest concern on electrical is replacing the existing 2400V ungrounded system with a grounded system.

4. At the Bio Filter Facility under a JOC, Kennedy Jenks is doing the design to provide a VFD for the existing motor driven Bio recirc. pump. Existing RVSS starter will be used as VFD bypass. Plans underway to add second motor driven Bio recirc pump with VFD. Existing pad mount transformer serving first pump is not large enough for second pump.

5. TVSS provided in some but not all MCC's to enable use of sensitive electrical equipment and protect from surges on ungrounded power system.

6. 2400V plant switchgear fused contactor units were serviced professionally approx. 3 years ago. Switchgear is otherwise due for replacement

7. There are plans to add 4-200HP motor driven Blowers (2@ each end of plant) to allow the engine driven blowers to be taken down for maintenance.

8. There are plans to replace the MCC line up at the Effluent Pump Station. Existing line up has obsolete GE VFDs and two of the three pumps is out of service.

9. The Chlorine and Dechlorination Facilities are not in service. Alternative chemicals are used. MCC line ups are very lightly loaded with the Chlorine facility backed up with dedicated 80KW generator. Dechlorination Facility dedicated 80KW generator has been removed and installed on a trailer for portable use.

10. All MCC's, swgr and transformers outdoors show different degrees of surface corrosion. Paint finish on all typically sun damaged.

11. Doors on outdoor swgrs and W/I aisle MCC's in some cases require lubrication.

12. Visible case grounds on transformers and bare cables show noticeable H_2S corrosion.

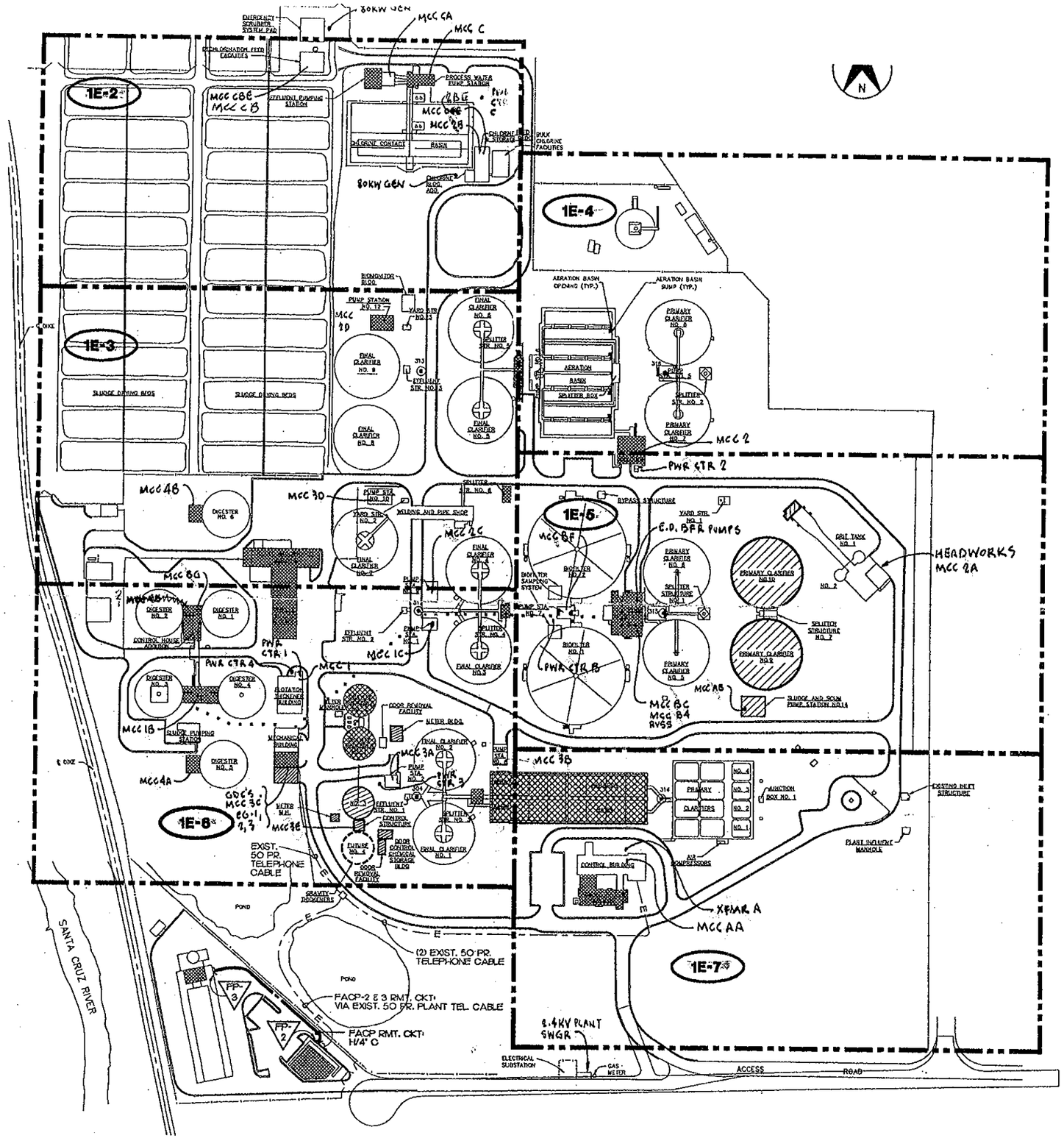
13. Some outdoor MCC enclosures have roof top ventilators and others don't. Surface corrosion on underside of all enclosures roofs.

14. All MCC's with dual feeds (TEP / GEN) have key interlocks on associated breakers.

15. Kennedy Jenks has performed the following:
- Draft Tech Memorandum No. 1 Nov 14, 2002
  - Plant Condition Assessment
- Technical Memorandum 1 Jul 2, 2003
  - Electrical Service Improvement Project
- Electrical System Improvement Design
  - Solicitation 87969
  - Deliverable due Aug 2006

a. Draft Tech mems 1 describes the electrical system in broad terms with recommendations
b. Tech Mems 1 is a detailed report with equipment assessments, cable test data and three service upgrade alternatives with a single upgraded TEP incoming line feeding a customer owned 13.8-480/277V 3Φ transformer.
c. The ESID will look at additional service alternatives and all energy costs from electric, natural gas and methane gas.

16. Maria Hollings with indicated that some MCCs could be replaced under SOC's.



NOTES:
1. SEE LEGEND ON DRAWING ISD-1.
2. UPON COMPLETION OF ELECTRICAL DUCT BANK SYSTEM, REPAIR DAMAGE TO EXISTING IRRIGATION SYSTEM TO THE SATISFACTION OF THE OWNER. THE OWNER WILL PROVIDE

SCALE IN FEET
0 50' 100' 150'

PIMA COUNTY ~~ROBERTS~~ ROGER R.D. WWTP

Notes:

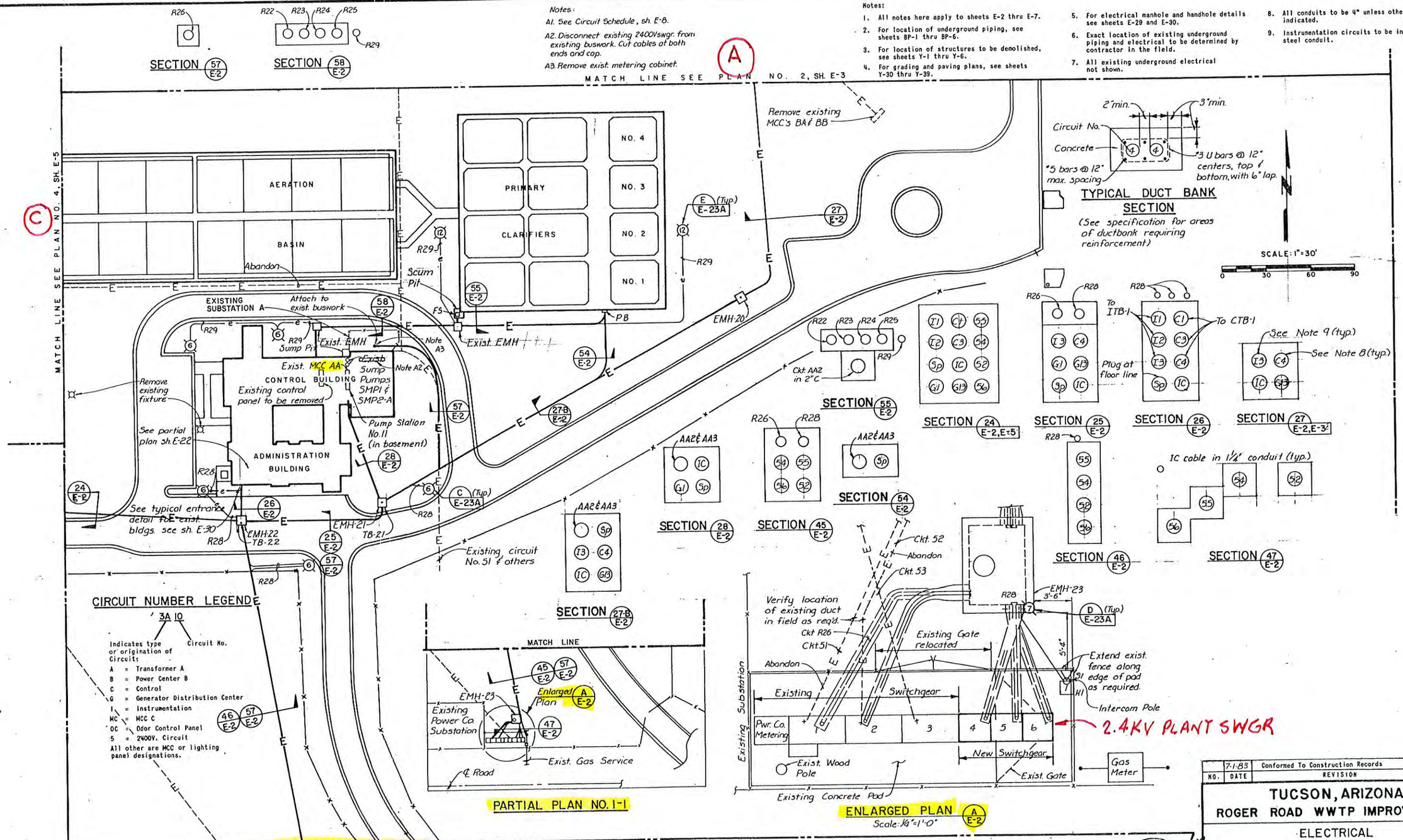
A1. See Circuit Schedule, sh. E-8.

A2. Disconnect existing 2400V swgr. from existing buswork. Cut cables of both ends and cap.

A3. Remove exist. metering cabinet.

Notes:

1. All notes here apply to sheets E-2 thru E-7.
2. For location of underground piping, see sheets BP-1 thru BP-6.
3. For location of structures to be demolished, see sheets Y-1 thru Y-6.
4. For grading and paving plans, see sheets Y-30 thru Y-39.
5. For electrical manhole and handhole details see sheets E-29 and E-30.
6. Exact location of existing underground piping and electrical to be determined by contractor in the field.
7. All existing underground electrical not shown.
8. All conduits to be 4" unless otherwise indicated.
9. Instrumentation circuits to be in steel conduit.



AREA 1E-7

NO.	DATE	REVISION	BY	CHK'D
1	1-79	30 MGD FACILITY	WFD	HDF

NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

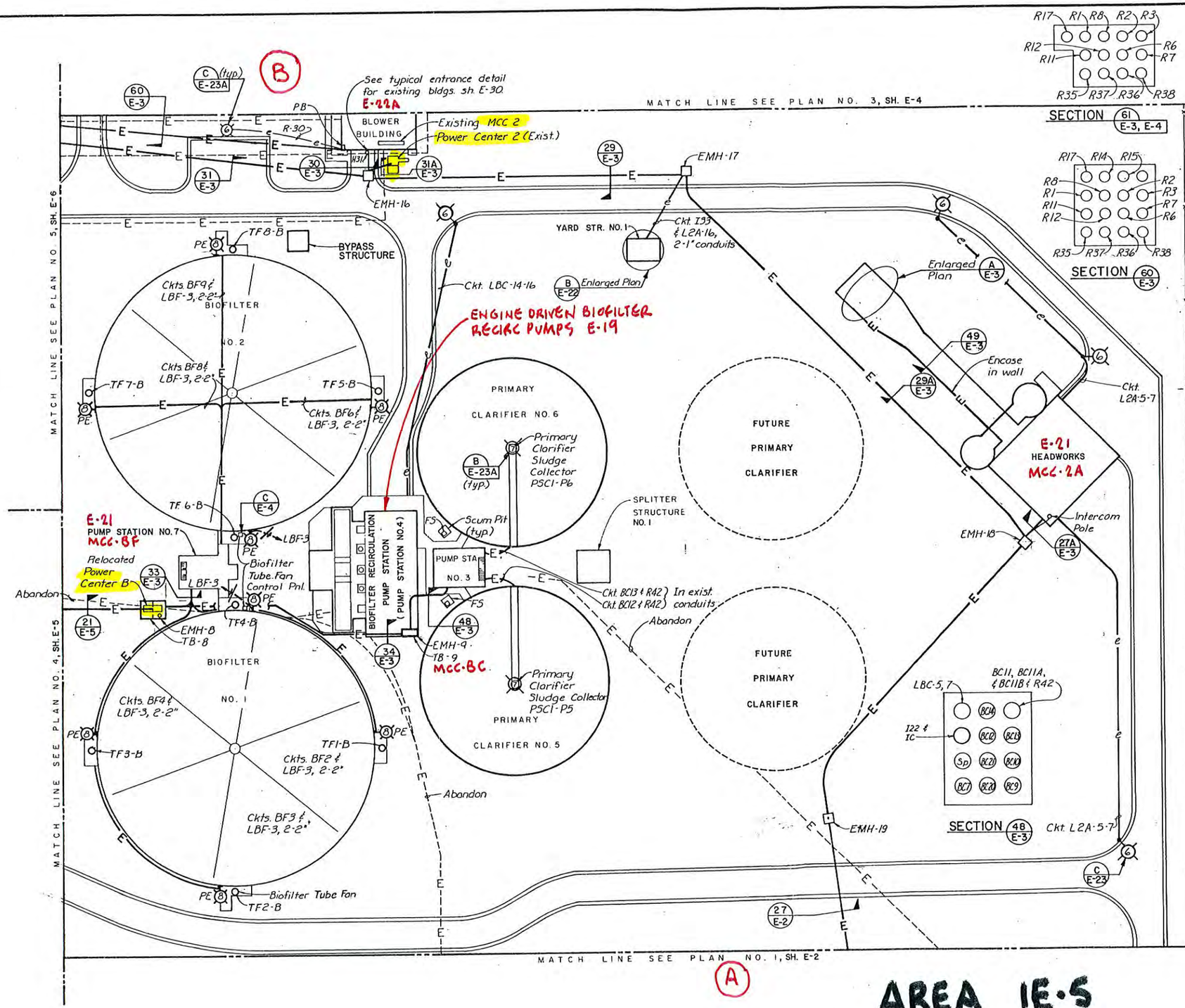
ELECTRICAL
SITE PLAN NO. 1

BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED BFR, HDF CHECKED PAA
DETAILED RLM, JKE APPROVED
DATE 12-14-78

SHEET E-2
151 OF 179

Notes:
1. All conduits shown to be 4" unless otherwise indicated.
2. See Circuit No. Legend, sh. E-2.



NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

ELECTRICAL
SITE PLAN NO. 2

BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED BFR, HDF CHECKED RAA
DETAILED RLM, JKE APPROVED
DATE 12/18/78

SHEET E-3
152 OF 179

CONDUIT & WIRING INSTALLATION LEGEND

- Conduit exposed
- Conduit concealed at ceiling & wall
- Conduit concealed at floor & wall
- Conduit turning up. Conduit turning down.
- Conduit continuing up, down, or through
- Conduit plugged flush. Conduit capped
- Short dash for each phase conductor. Long dash for neutral conductor. Circular dash for ground wire. Each dash No. 12 wire, typical. Typical for home run to be routed to lighting panel #2 & connected to circuit #5 (L2-5). Lighting fixture. Refer to number in fixture schedule (4)
- E — New concrete encased ductbank
- C — New direct buried conduit
- E — Existing ductbank

Mounting Flush	Mounting Surface	
$	S	Single Pole Switch
$2	S2	Two Pole Switch
$3	S3	Three-way Switch
$W	SW	Weatherproof Switch
$C3	SC3	Switch on Contactor No. 3
		Duplex Receptacle, 120 Volt
		Simplex Receptacle, 120 Volt

ONE-LINE DIAGRAM LEGEND

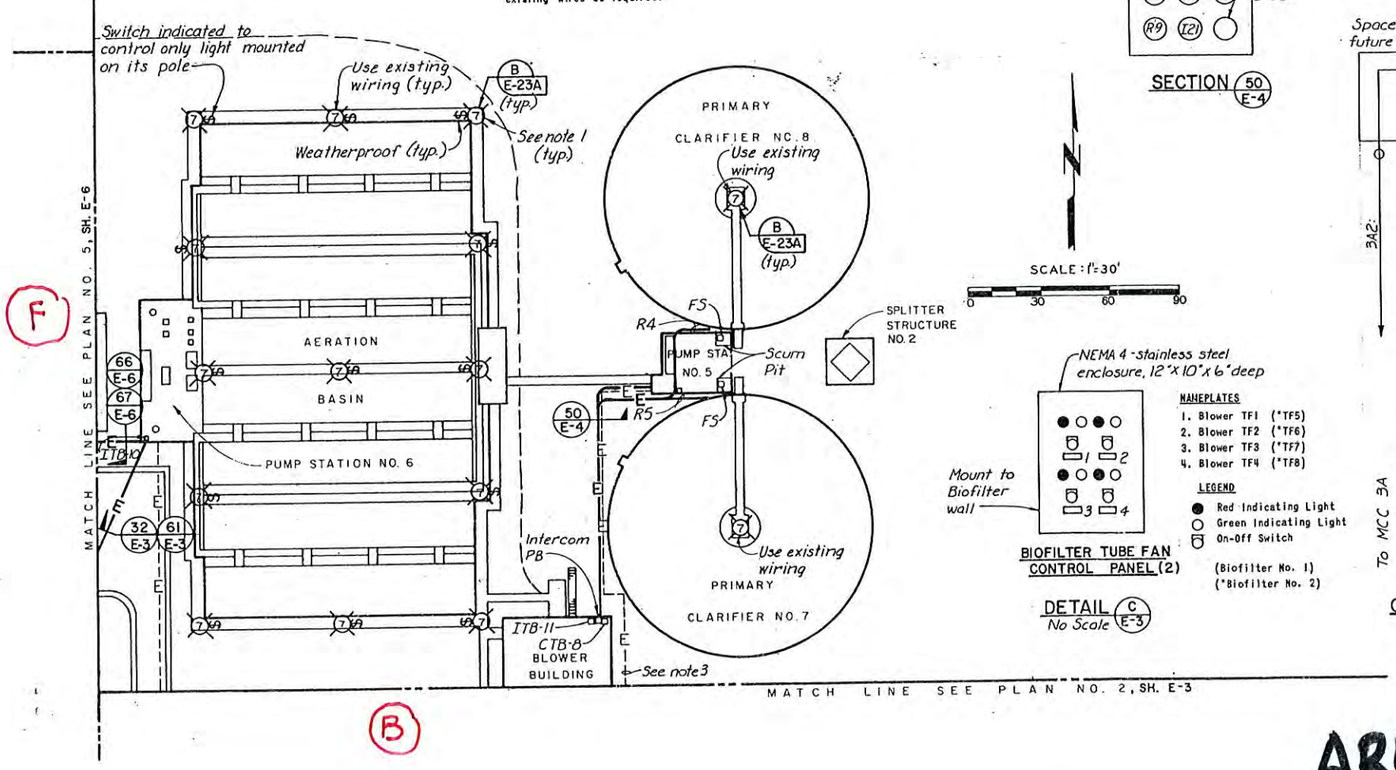
- 15 KVA, 120/240V > 480V — Transformer with primary & Secondary Voltage, and KVA rating
- (20) 22-3#8, #10G, 2" — Circuit No. 22, with 3#8 insulated conductors, 1#10 bare ground wire all in 2" conduit to 20 HP motor. (see note 2)
- (HP) (KW) — Loads as indicated in HP or KW are expected, but may vary with the equipment furnished. If equipment has larger load the cable, conduit, and electrical equipment shall be enlarged as required.
- (15) Auxiliary items may not be shown completely — One-line showing power & control to a package unit, as for example a steam Generator or an Air Conditioning Unit, shall imply that any and all associated equipment shall also be installed and wired as required by the equipment furnished.
- Indicates that all or part of circuit may be routed in duct bank or underground. May not be used for obvious underground circuits
- 3P-20 — Low Voltage Air Circuit Breaker, 3 pole 20 Ampere
- S-4 — Size 4 Combination Magnetic motor starter
- Low Voltage Drawout Air Circuit Breaker
- High Voltage Drawout Fused Motor Starter
- Fuse & Disconnect Switch
- S-2 — Size 2 Combination Magnetic Motor Starter, Reversing or Two Speed
- Manual Motor Starter

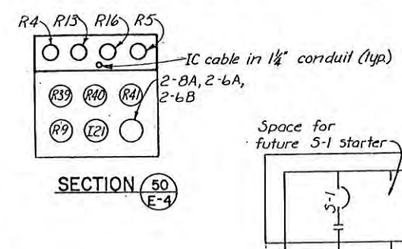
ABBREVIATIONS

A	Amber or Auto
AM	Ammeter
AS	Ammeter Switch
ATS	Air Temperature Switch
Ann.	Annunciator
Auto	Automatic
B	Blue
C	Contactor or Capacitor
℄	Centerline
CR	Control Relay
CS	Control Station
CT	Current Transformer
CTB	Control Terminal Box
CPT	Control Power Transformer
Ckt	Circuit
DC	Direct Current
DM	Damper Motor
DPS	Differential Pressure Switch
DPDT	Double Pole Double Throw
DPST	Double Pole Single Throw
DS	Drum Controller Switch
Decr	Decreasing
EC	Empty Conduit
EHH	Electrical Handhole
EL	Emergency Light
EMH	Electrical Manhole
El	Elevation
Exist.	Existing
EPS	Engine Speed Switch
FM	Frequency Meter
FS	Float Switch
Fut.	Future
FT	Flow Transmitter
G	Green
GDC	Generator Distribution Center
H	High
HC	Hot Circuit
HP	Horsepower
HR	Hand Reset
HFS	High Level Float Switch
HZ	Hertz (Cycle)
I	Indicator
I/I	Current to Current Transducer
IR	Indicating Recorder
ITB	Instrumentation Terminal Box
Incr	Increasing
Int	Integrator
JB	Junction Box
K	Key Interlock
KW	Kilowatt
KVA	Kilovolt Ampere
L	Low or Latching coil
LA	Lightning Arrester
LC	Level Controller
LS	Limit Switch
LR	Latching Relay
LWCO	Low Water Cutoff
LT	Level Transmitter
M	Magnetic Motor Starter
M.H.	Mounting Height
MS	Manual Motor Starter
MCC	Motor Control Center
MCM	Thousand Circular Mil
MCP	Main Control Panel
MR	Meter Relay
mA	Milliampere
mV/I	Magnetic Flowmeter Signal Converter
NC	Normally Closed
NO	Normally Open
No.	Number
OL	Overload
OPS	Oil Pressure Switch
PB	Pull Box
PE	Photoelectric Control
PS	Pressure Switch
PT	Program Timer or Potential Transformer
PSI	Pounds Per Square Inch
Ph	Phase
R	Red
RCT	Repeat Cycle Timer
S/N	Solid Neutral
SV	Solenoid Valve
SPST	Single Pole Single Throw
SPDT	Single Pole Double Throw
Sh.	Sheet
Sec.	Seconds
Sta	Station
Sum	Signal summer
Sp	Spare
T	Thermostat or Totalizer
TC	Time Closing
TD	Time Delay Relay
TO	Time Opening
Tq	Torque Switch
Typ	Typical
U	Unlatching Coil
UG	Underground or Ultrasonic Generator
UGC	Ultrasonic Generator Connector
V	Volts
VM	Voltmeter
VS	Voltmeter Switch
W	White, Watts, or Weatherproof
WH	Watthour Demand Meter
WM	Watt Meter
WX	Watt Transducer
X	Auxiliary Relay
Z	Auxiliary Relay
ZR	Zero Return Device
ϕ	Phase
67	Reverse Power Relay
74	Alarm Relay
2S	Two conductor shielded Instrument Cable
(4-2S)	Four 2S in a single cable.
(12#12)	Twelve #12 conductors in a single cable

Notes:

1. Abandon existing 30A outlets in poles, splice or dead end existing wires as required.

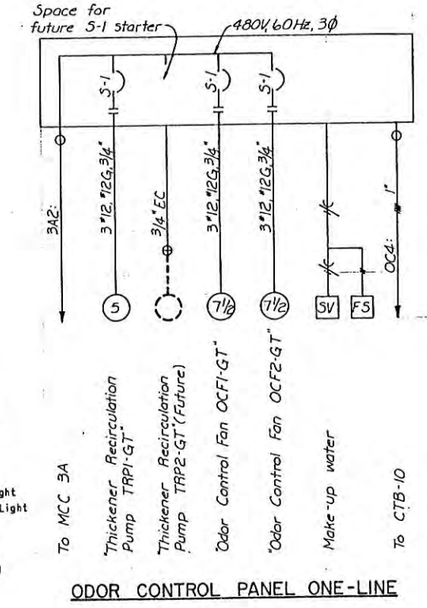




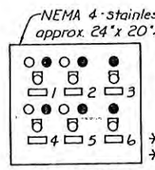
SECTION 50/E-4

BIOFILTER TUBE FAN CONTROL PANEL (2)

DETAIL C/E-3 No Scale



ODOR CONTROL PANEL ONE-LINE



NAMEPLATES (✱= Future)

1. Odor Control Fan OCF1-GT
2. Odor Control Fan OCF2-GT
3. Chemical Metering Pump CMP1-GT
4. Thickener Recirculation Pump TRP1-GT
✱5. Thickener Recirculation Pump TRP2-GT
✱6. Chemical Metering Pump CMP2-GT

ODOR CONTROL PANEL

LEGEND
- Green Indicating Light
- Red Indicating Light
- On-Off Selector Switch

DETAIL C/E-6 No Scale

Notes:

1. See sheet GL-1 for structure and equipment designation abbreviations and symbols.
2. Conduit size shown on one-line diagrams only for portions of circuit not in underground ductbank. For portions underground, see sh's. E-2 thru E-7.
3. Reroute circuits in existing ductbank from blower bldg. to pump sta. 5 in new ductbank as indicated.

NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

ELECTRICAL
SITE PLAN NO.3 & LEGEND

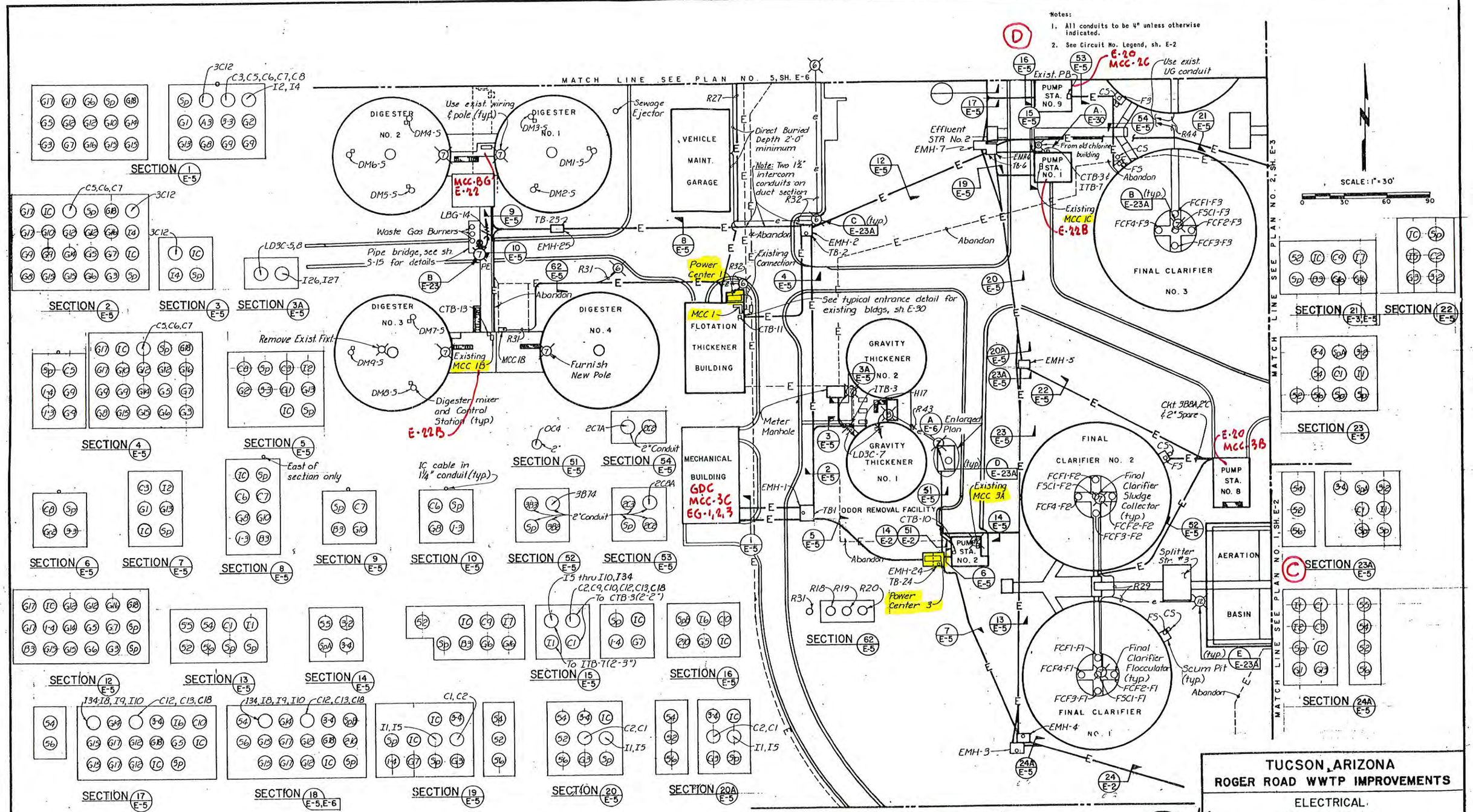
BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED HDF, BFR CHECKED RAA
DETAILED RLM, JKF APPROVED
DATE 7/12/78

SHEET E-4
153 OF 179

AREA 1E-4

Notes:
1. All conduits to be 4" unless otherwise indicated.
2. See Circuit No. Legend, sh. E-2



NO.	DATE	REVISION	BY	CHK'D	NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JEF	1	1-79	30 MGD FACILITY	WFD	HDF

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

ELECTRICAL
SITE PLAN NO. 4

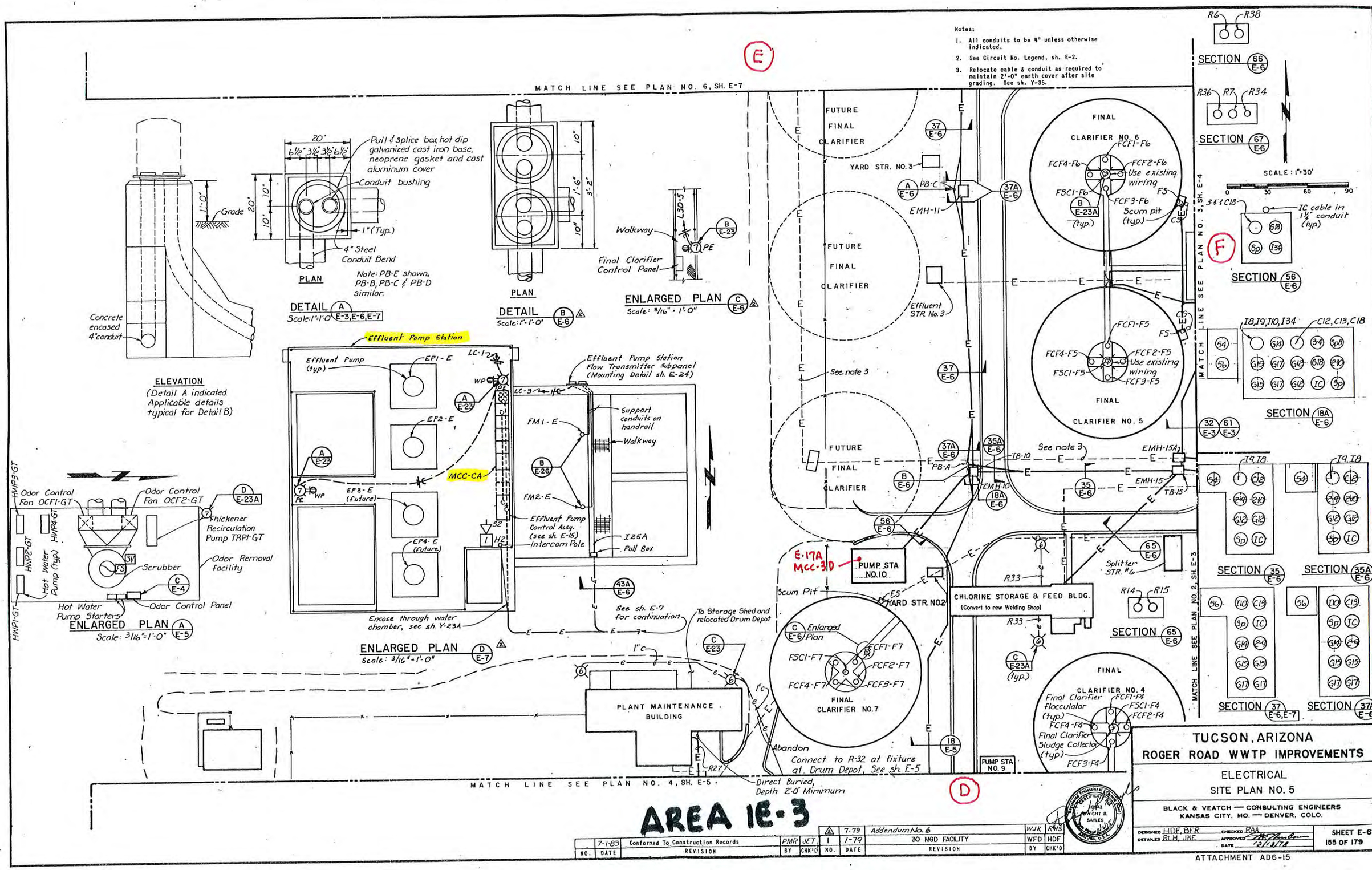
BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED BER, HDF — CHECKED RAA
DETAILED JKE, RLM — APPROVED
DATE 12/12/78

SHEET E-5
154 OF 179

Notes:

1. All conduits to be 4" unless otherwise indicated.
2. See Circuit No. Legend, sh. E-2.
3. Relocate cable & conduit as required to maintain 2'-0" earth cover after site grading. See sh. Y-35.



AREA 1E-3

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS
ELECTRICAL
SITE PLAN NO. 5

BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED HDF, BFR CHECKED RAA
DETAILED RLM, JKF APPROVED
DATE 2/13/78

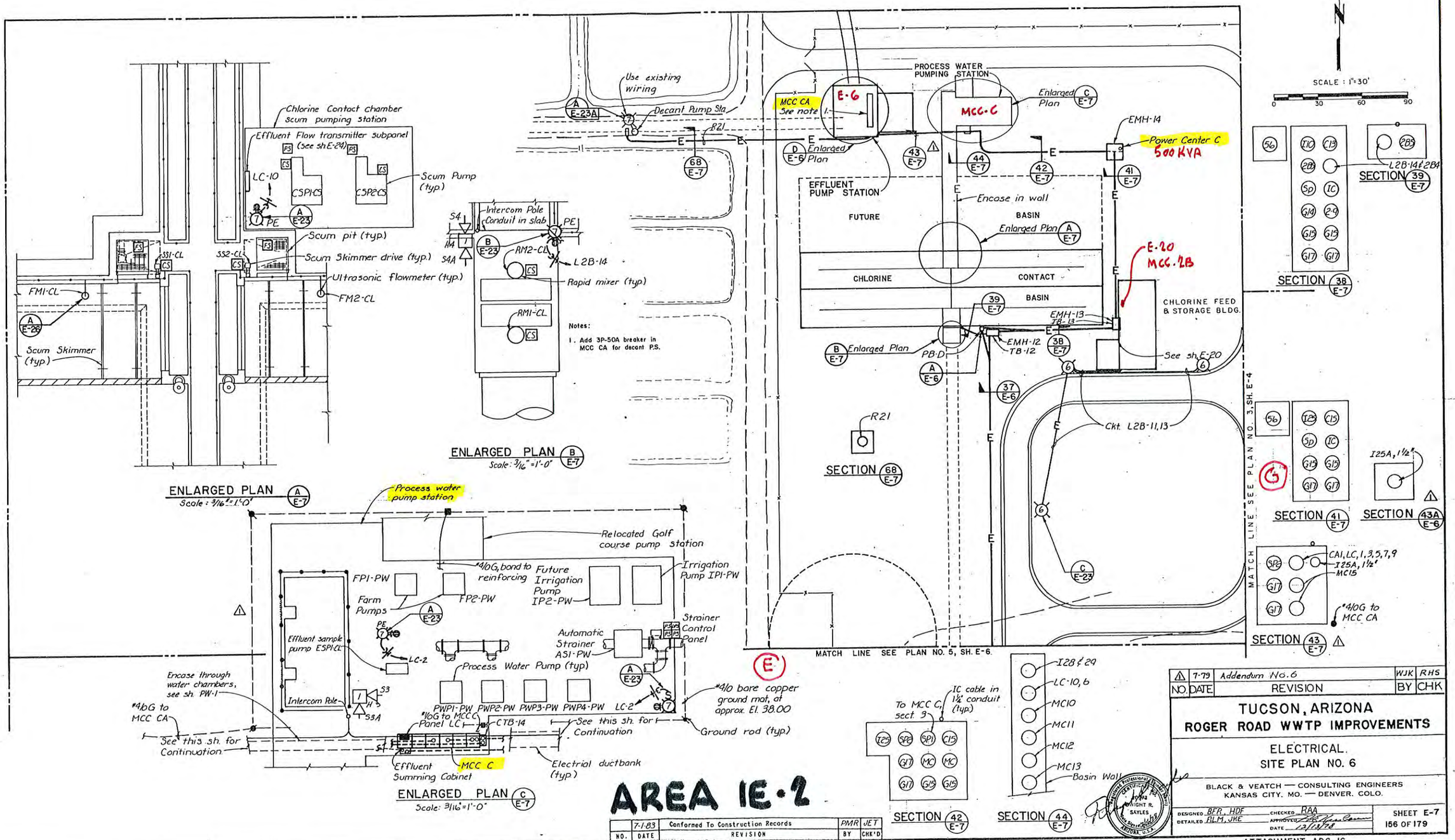
SHEET E-6
155 OF 179

NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET
1	1-79	30 MGD FACILITY	WFD	HDF
2	7-79	Addendum No. 6	WJK	RHS

ATTACHMENT AD6-15

Notes:

1. All conduits to be 4" unless otherwise indicated.
2. See Circuit No. Legend, sh. E-2.



AREA 1E-2

NO.	DATE	REVISION	BY	CHK'D
	7-1-83	Conformed To Construction Records	PMR	JET

NO.	DATE	REVISION	BY	CHK
1	7-79	Addendum No. 6	WJK	RHS

TUCSON, ARIZONA
ROGER ROAD WWTP IMPROVEMENTS

ELECTRICAL.
SITE PLAN NO. 6

BLACK & VEATCH — CONSULTING ENGINEERS
KANSAS CITY, MO. — DENVER, COLO.

DESIGNED BFR, HDF CHECKED RAA
DETAILED RLM, JKE APPROVED
DATE 12/12/78

SHEET E-7
156 OF 179

ATTACHMENT AD6-16

(1)

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: 2400V PLANT SWGR / PLANT ENTRANCE

Electrical Rating: NO EXTERIOR NAMEPLATES

Manufacturer / Model: G.E. LIMIT AMP NEMA 3R ~~NON~~ ~~[illegible]~~ ~~[illegible]~~ NO AISLE

Age of equipment: 26 years 63' 79'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	~~2~~	1

Additional Comments: SW/FU/CONTACTOR UNITS SERVICED APPROX 3 YEARS AGO, EXTERIOR HAS SOME SURFACE RUST. INSUFFICIENT FRONT CLEARANCE TO FENCE.

UNIT 1 FEEDER POWER XFMR A ADMIN BLDG
2 POWER CENTER B PUMP STA #7
3 " " 1 FLOTATION THICKENER BLDG
4 2 BLOWER BLDG
5 3 PUMP STA #2
6 POWER XFMR C PROCESS WATER P.S.

(2)

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

UNIT CONTROL & AMMETER SWS POOR CONDITION

IND, LIGHTS BURNED OUT

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

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EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER 1 / FLOTATION THKNR BLDG

Electrical Rating: 500 KVA, 2400 - 480V, 3Ø, 65°C RISE

Manufacturer / Model: GE Δ Δ

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 3 - 2400V fused switches in primary switchgear. (1) Main from PLANT SWGR (2) (3) Power centers 1 & 4 primary feeds. Exterior paint chalky. Primary swgr doors need lubrication, Insufficient rear clearance.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
32 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER 2 / BLOWER BLDG

Electrical Rating: 500KVA, 2400 - 480V 3ϕ 65°C

Manufacturer / Model: GE Δ Δ

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: EXTERIOR FINISH CHALKING. Some serious rust. Bolts missing for secondary compartment top cover. GE Primary 2400V Swgr. 2 sw/fuse units and 1 space. Lx. sufficient clearance @ rear of primary swgr.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER 3 / PUMP STATION NO. 2

Electrical Rating: 500 KVA 2400-480V 3φ 55°/65°C OA (560KVA)

Manufacturer / Model: GE

Age of equipment: _____ years 58'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Chalky finish, H2S corrosion on enclosure ground. Secondary compartment 600A secondary main brk. Feeder breakers:

MCC 3A 100A

3B 225A

3C 225A

3D 225A

Door gasket poor condition

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER 4 / FLOTATION THKNR BLDG

Electrical Rating: 750 KVA, 2400-480V 3φ 55°C RISE (FUTURE FANS 262 KVA)

Manufacturer / Model: GE

Age of equipment: _____ years 96' ΔY

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 1000A SEC MAIN BKRK, MCC 4B, MCC 3E MCC 4A feeder breakers. Exterior paint chalky

2

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER A / ADMIN BLDG

Electrical Rating: 2400 - 480V, 3ϕ 500KVA OA, 65°C RISE

Manufacturer / Model: G.E.

Age of equipment: 1965 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Some exterior rust. Secondary compartment door bottom clasp broken.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
27 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP X Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER B / PUMP STATION NO. 7

Electrical Rating: 2400-480/277V 3Ø 750KVA 65°C (862KVA FUTURE FA)

Manufacturer / Model: GE

Age of equipment: _____ years 96'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Serves 55 starter for motor driven Bio Tower Pump 350 HP. Secondary compartment door is jammed. Couldn't open.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

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PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: POWER CENTER C / CHLORINE FACILITY (XFMR C)

Electrical Rating: 500KVA 2400-480Y, 3φ 55/65°C (560 KVA)

Manufacturer / Model: GE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: Old transformer. Some rust. Secondary compartment, 3 breakers (2 new).

(1) MCC CB 200A

(2) PROCESS WATER 200A

(3) SPARE 100A (ON POSITION)

Chalky paint finish

3

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-AA / ADMIN BLDG

Electrical Rating: 600A 480V, 3φ

Manufacturer / Model: GE 8000 LINE W/I AISLE NEMA 3R

Age of equipment: 1996 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 3 Sections, space for 1 future section. Very good condition overall. Some minor rust on exterior.

4

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-3E / GRAVITY THICKENER #3

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: GE 8000 LINE W/I AISLE NEMA 3R

Age of equipment: ~~[illegible]~~ 1996 years ~~[illegible]~~

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 6 Sections, Tranquell TVSS installed

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-3C / MECHANICAL BLDG. GEN. RM.

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: GE 7700 LINE

Age of equipment: 1982 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 5 sections. Located in generator room. Reasonable wear for age of equipt. Needs cleaning.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 4A / CONTROL HOUSE 3 SLUDGE PUMP STATION DIG #5

Electrical Rating: 600A, 480V 3Ø

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years 93'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 5 sections located in Pump Room.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-1B / DIGESTERS 3 & 4 CONTROL HOUSE NO. 2

Electrical Rating: 300A, 480V, 3Φ

Manufacturer / Model: GE 7700 W1/AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 6 sections. Some surface rust. Transquell TV35 installed. Gas compressor starters mounted adjacent to line up

K

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-BG / DIGESTERS 1 & 2 (CONTROL HOUSE #1)

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: GE 7700 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 8 sections. Tranquell TVSS installed. Located in room with sludge heaters DXH-2, 11. Corrosion on breaker control handles.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 1 / FLOTATION THKNR BLDG

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: GE 7700 L SHAPE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 8 sections. Tranquell TVSS installed on top. Some exterior rust. Located in separate room but, not sealed off from process area.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP X Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-3A / PUMP STATION NO. 2

Electrical Rating: 300A, 480V, 3ϕ

Manufacturer / Model: GE 8000 LINE W/I AISLE NEMA 3R

Age of equipment: _____ years 2005

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 4 sections. New eqpt

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 4B / DIGESTER NO. 6 CONTROL HOUSE NO. 4

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 4 sections. ~~Located in Sludge Pump Rm.~~ Some exterior rust. Transguard TVSS installed external at adjacent panel board.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-30 / PUMP STATION NO. 10

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: GE 7700 LINE W/I ABLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 6 sections. Some surface rust. Transguard TVSS installed.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2C / PUMP STATION NO. 9

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: GE 7700 LINE W/I AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 6 sections. Some surface rust. No TVSS

25

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 1C / PUMP STATION NO. 1

Electrical Rating: 600A

Manufacturer / Model: GE 8000 LINE W/I AISLE NEMA 3R

Age of equipment: _____ years 2004

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: 4 sections. Looks new. TVSS installed. No exhaust fan.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC BF / PUMP STATION No. 7

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: GE 7700 LINE

Age of equipment: _____ years 79'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 4 sections. Surface rust. No TVSS
Feed from Δ Y. Serves ABB VFD.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

28

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 3B / PUMP STATION NO. 8

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: GE 7700 LINE W/I AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 6 sections. No TVSS. Some surface rust. Needs cleaning.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
29 CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC AB / PUMP STATION NO. 14

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: GE 8000 LINE W/1 AISLE NEMA 3R

Age of equipment: _____ years 94'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 5 sections. Space for 1 future. Tranquell TVSS installed. Appears fairly new.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
#30 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC-BC / BIO RECIRC BLDG PUMP STATION NO.4

Electrical Rating: 600A, 480V 3φ

Manufacturer / Model: GE 7700 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 5 sections. Locate in ~~Blower~~ Engine Room. Tranquell TVSS installed. Some surface rust. Needs cleaning. Also labeled MCC-B4 on drwgs.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

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EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP X Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: BRP-4BR / BIO RECIRC BLDG

Electrical Rating: 800A, 480V 3ϕ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years 96'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 2 sections. Fed from secondary of Power Center B. Feeds RVSS for 350 HP Bio Recirc Pump. Spare breaker of same size Key interlocked with RVSS feeder breaker. Some surface rust. Needs cleaning.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
33 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2 / BLOWER BLDG

Electrical Rating: 600A, 480V 3ϕ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years 96'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 7 sections. Transguell TVSS installed. Fairly new. Light cleaning needed. Located in Blower Room.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

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EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: BLOWER CONTROL PANELS / BLWR BLDG

Electrical Rating: LCP-1, 2, 3

Manufacturer / Model: TURBLEX

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: CRT display. NO N.P. on pushbuttons.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

35

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2A / HEADWORKS

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years 2000

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 6 sections, Like new, located in A/C Atkinson Bldg. TVSS provided.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

35

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2B / CHLORINE FACILITY

Electrical Rating: 600A, 480V 3Ø

Manufacturer / Model: GE 7700 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	(3)	2	1

Additional Comments: NEMA 1 construction outdoors covered. 4 sections. Badly corroded. One section rebuilt w/ new breakers.
Facility no longer operational.
Appears able to be fed from portable generator.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

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PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP □ Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2BE / CHLORINE FACILITY

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: NEMA 1 construction outdoors covered. 4 sections. Fairly new. Corrosion has started. Fed via ATS. Facility no longer operational.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
38 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC C/ PROCESS WTR P.S.

Electrical Rating: 600A, 480V 3Ø

Manufacturer / Model: GE 7700 LINE W/1 AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: 6 sections. Some rust. No TVSS. Door filters missing.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
39 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC CA / EFF P.S.

Electrical Rating: 600A, 480V, 3Ø

Manufacturer / Model: GE 7700 LINE W/1 AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Scheduled for replacement. Has old 75HP VFD's for 3 Effluent Pumps 2 out of service. Surface rust, poor condition. Breaker handles and control devices corroded.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
40 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC CBE / DE CHLORINATION FACILITY

Electrical Rating: 600A, 480V, 3ϕ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Fairly new. 3 section. Transquell TVSS installed external. Fed via ATS.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
41 CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC CB / DE CHLORINATION FACILITY

Electrical Rating: 600A, 480V 3φ

Manufacturer / Model: GE 8000 LINE

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	(1)

Additional Comments: Fairly new. 2 actions, no TVSS.

PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM
CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS
42 HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: MCC 2D / PUMP STATION NO. 12

Electrical Rating: 600A, 480V, 3φ

Manufacturer / Model: GE 8000 LINE W/I AISLE NEMA 3R

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: 6 sections, No TVSS. No enclosure exhaust. Some surface rust.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP X Ina Road WPCF □

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: ~~MCC-3C~~ GDC#1 / MECHANICAL BLDG GEN. RM.

Electrical Rating: 2000A, 480V 3φ

Manufacturer / Model: GE POWERBREAK SWBD

Age of equipment: ≈ 26 years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Serves MCC-AA, BC, BF, 1, 1B, 1C, 2, 2C, 3C, 3D. Located in Generator Room. Same vintage as MCC-3C, Tied to generator breakers w/ overhead bus. Needs cleaning. Overhead bus thermal problem

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: GENERATOR MAIN BREAKERS LINE UP/GEN RM.

Electrical Rating: SEE COMMENTS

Manufacturer / Model: WESTINGHOUSE, GE (ASCO)

Age of equipment: UNK years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	(2)	1

Additional Comments: Main Breakers for EG-1 & 2 800A, SPB 100, EG-3 800A GE Power Break II STD. Line up is newer than GDC. Located in Generator Room. Need cleaning.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: NEWER GDCG / GENERATOR ROOM #2 & #3

Electrical Rating: _____

Manufacturer / Model: GE POWER BREAK SWITCHBOARD

Age of equipment: _____ years 96'

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Power Break II breakers. Located in Generator Room. Serves MCC C-1B, 2A-1B, 2B-1B, CB-1B, 4A-1B, 4B-1B, CA-1B, 3A-1B, 2D-1B, MCC BG, 3B-1B, AB-1B, SEPTAGE RCVG DIST PNL 3E MCC 3E-1B. Needs cleaning.

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PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT

PIMA COUNTY METROPOLITAN WASTEWATER TREATMENT SYSTEM CAPACITY MANAGEMENT, NUTRIENT REMOVAL, SOLIDS HANDLING/TREATMENT AND CIP DEVELOPMENT STUDY

EQUIPMENT CONDITION ASSESSMENT

Facility: Roger Road WWTP ☒ Ina Road WPCF ☐

Name of Greeley and Hansen Interviewer: Ron W. Zanko

Date of Assessment: 5/23 thru 5/26 Name of PCWMD Assessor: _____

Phone Number of PCWMD Assessor: _____

Name of Equipment / Location: GEN PARALLELING CONTROLS

Electrical Rating: NA

Manufacturer / Model: ASCO

Age of equipment: _____ years

Average Weekly Run Time _____ hours

Condition - Rate each category below by circling the number on a scale of 1 - 4, 1 being excellent, 2 being good, 3 Being Acceptable and 4 being poor.

	Poor	Acceptable	Good	Excellent
Mechanical	4	3	2	1
Electrical	4	3	2	1

Additional Comments: Set up for 4 generators. 3 presently installed. Controls the breakers between GDC's. Paralleling issues with load sharing.

APPENDIX C

ADEQ Letters

Appendix C

ADEQ Letters

Roger Road Wastewater Reclamation Facility

RECEIVED
JAN 31 2007
GREELEY & HANSEN
Phoenix Office

PIMA COUNTY
WASTEWATER MANAGEMENT DEPARTMENT
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

MICHAEL GRITZUK, P.E.
DIRECTOR

PH: (520) 740-6500
FAX: (520) 620-0135

January 26, 2007

Joan Card
Water Quality Division Director
Arizona Department of Environmental Quality
1110 W. Washington
Phoenix, AZ 85007

RE: Roger Road Wastewater Treatment Facility (WWTF) AZPDES Permit No. AZ0020923

Dear Ms. Card:

This letter s written in response to the requirement contained in Part VI *Special Conditions*, B(1) *Ammonia Toxicity Variance Terms and Conditions* of the Pima County Roger Road Wastewater Treatment Facility AZPDES permit AZ0020923 issued on March 2, 2006 which requires modifying the Roger Road facility to remove nitrogen ammonia to below toxic levels.

The Pima County Wastewater Management Department (PCWMD) retained the services of Greeley and Hansen Engineers to perform a comprehensive evaluation of the long range planning goals for our Department that we have termed the Regional Optimization Master Plan or ROMP. The purpose of the ROMP study was to perform a holistic evaluation of current treatment plant conditions and continued viability in relation to current and anticipated community needs and regulatory requirements. A key topic addressed in ROMP was the development of a plan to comply with the AZPDES permit requirement and also included odor control, pathogen reduction and improvements in the quality of Biosolids production.

As the results of the ROMP study have the potential to impact numerous stakeholders within Pima County, not just PCWMD, a comprehensive stakeholder panel was solicited for participation. Participants included a scientific peer review panel consisting of Tucson Water, Town of Marana, Town of Oro Valley, Metropolitan Water District, the Pima County Board of Supervisors appointed Wastewater Advisory Committee, Pima Association of Governments, Raftelis Financial Consultants, Brown and Caldwell Engineering, Malcolm Pirnie Engineering, Black and Veatch Engineering, and Pima County Natural Resources Parks and Recreation Department. Evaluation criteria consisted of the following:

- Evaluate and recommend facility operations needed to meet current and anticipated future regulatory requirements
- Evaluate and recommend facility operations needed to meet the anticipated capacity demand through 2030
- Evaluate and recommend facility changes to assure reliable and effective future operability
- Evaluate and recommend facility operations to meet the needs of the Tucson Water reclaimed water system
- Evaluate and recommend facility operations to minimize financial impacts on Department ratepayers
- Evaluate and recommend facility operations to meet community needs

This evaluation of the facility configuration concluded with the following recommendations:

- **Roger Road WWTF** - Construct a new 32 MGD water reclamation treatment plant with a 5-stage Bardenpho treatment process adjacent to the existing Roger Road WWTP and decommission the existing facility
- All Biosolids generated in the new water reclamation facility will be conveyed to and processed at a Regional Biosolids Facility to be located at the Ina Road WPCF.
- **Plant Interconnect** – Construct a new plant interconnect pipeline between the new water reclamation treatment facility and the existing Ina Road WPCF.
- Expand the existing 37.5 MGD Ina Road WWTP to a capacity of 50 MGD.
- All facilities will be designed to meet the capacity needs to 2030.

When implemented, these recommendations are intended to achieve the AZPDES permit required reduction of ammonia to below toxic levels at the effluent discharge point of the new facility by the year 2015 as indicated in the permit.

The above ROMP plan was presented to the Pima County Board of Supervisors (BOS) on January 16, 2007 at which time the Board approved the plan and authorized the submission of this letter to you.

Additionally, it should be noted that while the preliminary cost estimate for these improvements (Ina and Roger Road upgrades) is approximately $501,000,000 based upon 2006 unit cost estimates, this figure is expected to increase as cost estimates are further refined during the completion of the ROMP and due to cost escalations during the years of implementation of the ROMP. These projected costs far exceed the Department's funding ability through current system revenues. Several bond packages are necessary to fund these desired improvements. For these reasons, Pima County Board of Supervisors must also authorize an increase in revenues sufficient to pay for this effort.

We will keep you updated on the progress of this project as more information becomes available and welcome your comments to this plan. Please feel free to contact me at (520) 740-6500 if you have any questions.

Sincerely,

Michael Gritzuk, P.E.
Director

MG:mo

c: The Honorable Chair and Members of the Pima County Board of Supervisors
C.H. Huckelberry, County Administrator
John M. Bernal, P.E., Deputy County Administrator – Public Works
Susan Keith, Director- ADEQ Southern Regional Office
Paul M. Bennett, P.E., Deputy Director – Planning & Engineering
Mike Bunch, Deputy Director – Conveyance & Development Services
Jackson Jenkins, Deputy Director – Treatment
Jeff Nichols, C.P.A., Controller
Andrew Richardson, Principal, Greeley & Hanson
Jerry Bish, P.E., Greeley & Hanson

Appendix C

ADEQ Letters

Ina Road Wastewater Reclamation Facility

PIMA COUNTY
WASTEWATER MANAGEMENT DEPARTMENT
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

MICHAEL GRITZUK, P.E.
DIRECTOR

PH: (520) 740-6500
FAX: (520) 620-0135

January 26, 2007

Joan Card
Water Quality Division Director
Arizona Department of Environmental Quality
1110 W. Washington
Phoenix, AZ 85007

RE: Ina Road Water Pollution Control Facility (WPCF) AZPDES Permit No. AZ0020001

Dear Ms. Card:

This letter is written in response to the requirement contained in Part VI *Special Conditions*, B (1) *Ammonia Toxicity Variance Terms and Conditions* of the Pima County Ina Road Wastewater Treatment facility AZPDES permit AZ0020001 issued on January 2, 2006 to modify the Ina Road facility to remove nitrogen ammonia below toxic levels.

The Pima County Wastewater Management Department (PCWMD) retained the services of Greeley and Hansen Engineers to perform a comprehensive evaluation of the long range planning goals for our Department that we have termed the Regional Optimization Master Plan or ROMP. The purpose of the ROMP study was to perform a holistic evaluation of current treatment plant conditions and continued viability in relation to current and anticipated community needs and regulatory requirements. A key topic addressed in the ROMP was the development of a plan to comply with the AZPDES permit requirement and also included odor control, pathogen reduction and improvements in the quality of biosolids production.

As the results of the ROMP study have the potential to impact numerous stakeholders within Pima County, not just PCWMD, a comprehensive stakeholder panel was solicited for participation. Participants included a peer review panel consisting of Tucson Water, Town of Marana, Town of Oro Valley, Metro Water, the Pima County Board of Supervisors appointed Wastewater Advisory Committee, Pima Association of Governments, Raftelis Financial Consultants, Brown and Caldwell Engineering, Malcolm Pirnie Engineering, Black and Veatch Engineering, and Pima County Natural Resources Parks and Recreation Department. Evaluation criteria consisted of the following:

- Evaluate and recommend facility operations needed to meet current and anticipated future regulatory requirements
- Evaluate and recommend facility operations needed to meet the anticipated capacity demand through 2030
- Evaluate and recommend facility changes to assure reliable and effective future operability
- Evaluate and recommend facility operations to meet the needs of the Tucson Water reclaimed water system
- Evaluate and recommend facility operations to minimize financial impacts on Department ratepayers
- Evaluate and recommend facility operations to meet community needs

This evaluation of the facility configuration has been and consists of the following recommendations:

- **Ina Road WPCF** - Conversion of the existing High Purity Oxygen treatment train to a five stage Bardenpho treatment process capable of reducing nutrient concentration to levels required by the AZPDES permit at a treatment capacity of 50 MGD.
- Improvements will also include the development of a Regional Biosolids Treatment Facility at the Ina Road facility. Roger Road biosolids will also be treated and processed at the Regional Biosolids Facility located at the Ina Road WPCF.

When implemented, these recommendations are intended to achieve the AZPDES permit required reduction of ammonia to below toxic levels at the Ina Road effluent discharge point by year 2014, as indicated in the permit.

The above ROMP plan was presented to the Pima County Board of Supervisors (BOS) on January 16, 2007, at which time the Board approved the plan and authorized the submission of this letter to you.

Additionally, it should be noted that while the preliminary cost estimate for these improvements (Ina and Roger Road upgrades) is approximately $501,000,000 based upon 2006 unit cost estimates, this figure is expected to increase as cost estimates are further refined during the completion of the study and due to cost escalations during the years of implementation of the ROMP. These projected costs far exceed the Department's funding ability through current system revenues. Several bond packages are necessary to fund these desired improvements. For these reasons, Pima County will need to request and receive voter approval as design efforts are initiated. Similarly, the Pima County BOS must also authorize an increase in revenues sufficient to fund this effort.

We will keep you updated on the progress of this project as more information becomes available and welcome your comments on this plan. Please feel free to contact me at (520) 740-6500 if you have any questions.

Sincerely,

Michael Gritzuk, P.E.
Director

MG:mo

c: The Honorable Chair and Members of the Pima County Board of Supervisors
C.H. Huckelberry, County Administrator
John M. Bernal, P.E., Deputy County Administrator – Public Works
Susan Keith, Director- ADEQ Southern Regional Office
Paul M. Bennett, P.E., Deputy Director – Planning & Engineering
Mike Bunch, Deputy Director – Conveyance & Development Services
Jackson Jenkins, Deputy Director – Treatment
Jeff Nichols, C.P.A., Controller
Andrew Richardson, Principal, Greeley & Hanson
Jerry Bish, P.E., Greeley & Hanson

APPENDIX D

Regulatory Requirements

Regulatory objectives for effluent quality are currently established by each facility's AZPDES and APP permits. Limits in the AZPDES permits are driven by State Surface Water Quality Standards. Limits in the APP permits are driven by numeric State Aquifer Water Quality Standards and BADCT requirements.

Tabke D-1 and **Tabke D-2** presented here summarize the regulatory requirements for Roger Road WRF and Ina Road WRF respectively. There are no significant permitting issues at Randolph Park WRF. Regulatory requirements for each of outlying facilities are outlined in **Table D-3**

Table D-1
Roger Road WRF Regulatory Requirements

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
Aquifer Protection	5/26/05 - Until plant is expanded or modified	Compliance point: relocating monitoring well 12 (away from influence of landfill). Compliance schedule for locating replacement monitoring well. Compliance with 1000' setback limits. Permit re-openers for future expansions may trigger new compliance point at WWTP effluent. BADCT concurrence with ADEQ. Need to filter vs. Soil Aquifer Treatment (SAT). Use of Central Arizona Project (CAP) water by Tucson may change background characteristic of wastewater.	Compliance Schedule: Within 3 months of May 26, 2005 – supply map to Water Permits Section showing facility and location of replacement Point of Compliance (POC) well for W-12. Commence monthly monitoring at new well and continue for 8 months. No later than July 31, 2006 and within 30 days of collecting last sample: Submit an amendment application with monitoring data, a proposed acceptable quality level (AQL) for nitrates, and one round of sampling results from an upgradient well. Modify APP when upgrading plant to meet AZPDES schedule.	Current POCs are monitoring wells, using SAT. Plant expansion will be required to meet the 8 mg/L nitrate (Alert Level) at the WWTP effluent. (Level of safety factor to be determined). Interim Nitrate as Nitrogen (Nitrate-N) for well 12 set to “not established” until new POC approved and sampled. Current AQL for monitoring well SC-01 at 18.6 mg/L for Nitrate-N due to natural nitrates in the aquifer. Alert level “not established”. <u>Near to mid-term contaminant considerations:</u> ■ Non-detect microbial levels (fecal or Escherichia coli (E. coli)). ■ Total Organic Carbon (TOC) ■ Trihalomethanes (THMs) ■ Haloacetic acids (HAAs) ■ Bromate <u>Future contaminant considerations:</u> ■ Salinity ■ Endocrine Disruptors ■ Pharmaceuticals ■ N-nitrosodiumdimethylamine (NDMA)

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
AZPDES	3/2/06 - 3/2/11	Current ammonia levels are 20-30 mg/L. Ammonia toxicity. Copper variance. Chlorine monitoring method. Metal translator study. Minimum flow from Ina Road. Regulations do not require a minimum amount of water in the river or the removal of water from the river, but must be consistent with PAG's 208 Amendments, and satisfy public concerns over habitat.	Copper compliance by 1/30/11. Ammonia: Eng. Design Review by 1/30/07. Construction contract award by 1/30/11. Compliance by 1/30/15. Chlorine method investigation results by 9/30/06. Metal translators for future permit. (Water-effect ratio study on zinc and copper toxicity)	Interim copper level 25 micrograms per liter (µg/L). 2 mg/L ammonia standard expected. (Level of safety factor to be determined <u>Current:</u> <u>Std.</u> <u>Range</u> Chromium-Valence ;6 (Cr VI) 11 ppb* 6 - 10 ppb Copper (Cu) 12.7 ppb 6 - 15 ppb Sulfide 100 ppb <0.2 ppb Cyanide 9.7 ppb <1 ppb Oil&Gr Treat. Tech. <2 mg/L Bis-(2 ethylhexyl) phthalate 360 ppb <2 - 67 ppb *ppb = parts per billion <u>Future:</u> Phosphorus (costs for removal?) Endocrine disruptors, pharmaceuticals. Toxicity Tests: Results and follow-up actions
Reclaimed Water	4/29/04 - 4/20/09	Need to upgrade to higher class? Use Tucson Water facility to meet higher class.	Notice of Intent (NOI) by 1/20/09 to renew	Class B <u>Future:</u> Enhanced water quality standards not expected. Microbial fouling in distribution system Ultraviolet (UV) system efficiency Salinity (specific absorption rate (SAR)) CAP water importation

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
Air Quality	5-year permit expires 2010	Synthetic minor source permit for nitrogen oxide (NO_X) and carbon monoxide (CO) Minor source for other criteria pollutants Permitted Equipment: WWTP processes nine – internal combustion (IC) engines, 357 to 935 horsepower (hp) (digester and natural gas)		POTENTIAL TO EMIT (tons/year) NO_X 59 CO 84 Volatile organic carbons (VOCs) 32 Sulfur oxides (SO_X) Particulate matter less than nanometers (PM10) Hazardous (halogenated) air pollution (HAP) 7 Impacts of expanding/replacing plant: could potentially trigger major source - examine cost/benefits.

Table D-2
Ina Road WRF Regulatory Requirements

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
Aquifer Protection	2/26/02 – Until plant is expanded or modified	Archeological implications when breaking ground. Permit re-openers for future expansions may trigger new compliance point at WWTP effluent. BADCT concurrence with ADEQ.	Compliance Schedule: Monitoring for pesticides and polychlorinated biphenyls (PCBs): Four consecutive quarters of monitoring for pesticides and PCBs If non detects (NDs), monitoring to cease; otherwise, 4 more quarters of monitoring for any pesticide or PCB exceeding Practical Quantitation Level (PQL) and below AWQS. Modify APP when upgrading plant to meet AZPDES schedule.	Current POCs are monitoring wells, using SAT. Plant expansion will be required to meet the 8 mg/L nitrate (Alert Level) at the WWTP effluent. <u>Near to Mid-term contaminant considerations:</u> ■ Non-detect microbial levels (fecal or E. coli). ■ TOC ■ THMs ■ HAAs ■ Bromate <u>Future contaminant considerations:</u> ■ Salinity ■ Endocrine Disruptors ■ Pharmaceuticals ■ NDMA

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
AZPDES	1/2/06 - 1/2/10	Current ammonia levels are 20-30 mg/L. Fecal coli form violations. Total Residual Chlorine. Copper violations.	Compliance schedules for ammonia and copper toxicity and chlorine variances. Chlorine monitoring investigation–Results by 9/30/06 Ammonia Toxicity: Initial eng. study – 2/7/07 First phase upgrade (BNRAS) – 12/31/06 Second phase contract award by 12/31/10 Ammonia variance until 1/30/14. Copper variance until 12/31/10.	Current: Std. / Range Cu: 11 ppb / 15 - 20 ppb Chlorine (Cl_2): 5 ppb / <0.05 mg/L Cyanide: 9.7 ppb / <1 ppb Lead (Pb): 3.3 ppb Silver (Ag): 5.3 ppb Bis-(2 ethylhexyl) phthalate: 360 ppb / <2 - 5 ppb 2 mg/L ammonia standard expected. Toxicity Tests: ■ Results and follow-up actions Future: ■ Nutrients ■ Endocrine disruptors, pharmaceuticals

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
Reclaimed Water	1/6/04 - 1/6/09	Need to upgrade to higher class? Microbial fouling in distribution system. Future reuse customer base.	NOI by 10/26/08 to renew	Two treatment trains: (1) 25 mgd - Class B (2) 12.5 mgd - Class B+ Enhanced future standards not expected (e.g., point of use monitoring). Arizona Class A, A+ among the highest standards in the nation. Potential benefits of upgrading to Class A or A+: Expanded customer base and end uses to include irrigation of food crops, school ground and residential landscape irrigation, vehicle washing, comm. closed loop A/C systems, etc. Future: ■ Salinity Issues

Permit	Effective Dates	Key Issues	Schedule Considerations	Key Standards/Limits
Air Quality	5 year permit expires 2010	Major source permit for NO_X and CO Minor source for other criteria pollutants. Permitted Equipment: WWTP processes seven - 1000 hp IC engines (digester and natural gas) <u>Issues common to Ina Rd., Roger Rd., and Green Valley Plants:</u> Opacity testing and limits acceptable. Sulfur content acceptable. Hydrogen sulfide (H_2S) testing and limits acceptable.	Evaluate HAP emissions after future expansions Determine if additional controls are required to stay below 25 tons/year. <u>Common to Ina Rd., Roger Rd., and Green Valley Plants:</u> Permit may be reopened if new CAA requirements apply to this type of major source. Modifications: upgrades to facility may trigger permit modification. Additional emission controls and lean burn technologies likely required for new engines to comply within limits and Best Available Control Technology (BACT)/ Maximum Achievable Control Technology (MACT). More extensive emissions modeling required for WWTP processes in future -- consider during design phase?? Permit modification required if additional HAP standards promulgated by EPA.	POTENTIAL TO EMIT (tons/year) NO_X 581 CO 2405 VOCs 35 SO_X 112 PM10 3 HAPs 12 <u>Common to Ina Rd., Roger Rd., and Green Valley Plants:</u> Odor scrubbers H_2S limit 0.03 mg/L for >30 minutes at fence line [separate project initiated to address compliance] Costs and benefits of upgrading to meet new emission standards versus value of power (e.g., from Tucson Electric Power).

Table D-3
Non-Metro Facility Regulatory Requirements

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
AVRA VALLEY WWTF				
Aquifer Protection	Feb 2007 - Until plant is expanded or modified	Future disinfection considerations.	Report use of emergency overflow basin within 5 days.	Near to Mid-term contaminant considerations: ■ Non-detect microbial levels (fecal or E. coli) ■ TOC ■ THMs ■ HAAs ■ Bromate Future contaminant considerations: ■ Salinity ■ Endocrine Disruptors ■ Pharmaceuticals ■ NDMA
AZPDES	8/22/04 - 8/22/08	Future disinfection considerations. Emergency discharge to Black Wash.	After 10 quarters of trace substances monitoring - can request reduction or elimination of requirements (with no exceedance of alert levels (ALs))	Current: Std. Range Cl_2 5 ppb Cu 12.7 ppb Future: 2 mg/L ammonia standard expected Nutrients Toxicity Tests: Results and follow-up actions

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
Reclaimed Water	7/30/04 - 7/30/09	On-site only, minimal uses. 6.2-mgd planned expansion with UV and filtration - application submitted.	NOI by 3/30/09 to renew	Class A+ Reclaimed Water when expansion completed (upgrade from B+). <u>Future:</u> Enhanced water quality standards not expected. Microbial fouling in distribution system UV system efficiency Salinity (SAR)
ARIVACA JUNCTION WWTF				
Aquifer Protection	2/28/2003	Scheduled to close after completion of a gravity/pressure sewer line to Green Valley WWTF. 66,000 gallons per day (gpd) aerated lagoon	Sewer line to Green Valley	
Reclaimed Water	5-year permit expires June 17, 2008	Effluent used to irrigate nearby pastureland		Class C

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
CORONA DE TUCSON WWTF				
Aquifer Protection	6/1/05 - Until plant is expanded or modified	1st stage expansion: increase from 117,000 gpd (no discharge) to 300,000 gpd with addition of mechanical aeration and SAT disposal (current APP is amendment to these upgrades). SAT capability to meet nitrogen and coliforms is major issue. 2nd stage expansion: 500,000 gpd package plant oxidation ditch (Spring 2007)	Must meet the ALs for total nitrogen and coliforms (next column) starting seventh month following 1st stage (Dec 2005?)	SAT intended to treat bacteria, nutrients, total suspended solids (TSS) and biochemical oxygen demand (BOD). BADCT requires meeting levels of: - 10 mg/L total nitrogen - non-detect of coliforms at 31 ft deep Central Treatment Plant-03 (CTP-03) piezometer station or construct a dentrification plant to replace the existing 0.3-mgd facility. <u>Near to Mid-term contaminant considerations:</u> ■ Non-detect microbial levels (fecal or E. coli). ■ TOC ■ THMs ■ HAAs ■ Bromate <u>Future contaminant considerations:</u> ■ Salinity ■ NDMA

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
GREEN VALLEY WWTF				
Aquifer Protection	7/1/03 - Until plant is expanded or modified	Modifications to original WWTP may trigger permit reopeners for future expansions and may trigger new compliance point at WWTP effluent. BADCT concurrence with ADEQ -- future modifications. 2.1 mgd (old plant) 2.0 mgd (new Biological Nutrient Removal Oxidation Ditch (BNROD)) Operated as two separate facilities - likely to continue? SAT used for nitrate (NO_3) compliance.	No compliance schedule issues.	8 mg/L nitrate (Alert Level) at the POC. Change in POC anticipated? BNROD Class A+: Turbidity limits 5 nephelometric turbidity unit (NTU) (single), 2 (24 hr); Non-detect enteric virus; fecal coliform 23 colony forming units (CFU) (single) and non-detect (4 of last 7 samples) at discharge. <u>Near to Mid-term contaminant considerations:</u> ■ Non-detect microbial levels (fecal or E. coli). ■ TOC ■ THMs ■ HAAs ■ Bromate <u>Future contaminant considerations:</u> ■ Salinity ■ Endocrine Disruptors ■ Pharmaceuticals ■ NDMA

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
AZPDES	8/22/04 - 8/22/08	Future disinfection considerations. Emergency backup storage.	After 10 quarters of trace substances monitoring - can request reduction or elimination of requirements (with no exceedance of ALs)	Current: Std. Range Cl_2 5 ppb Cu 12.7 ppb Ag 5.3 ppb Cr VI 11 ppb Future: 2 mg/L ammonia standard expected Nutrients Toxicity Tests: Results and follow-up actions
Reclaimed Water	12/28/04 - 12/28/09		NOI by 9/28/09 to renew	WWTF (2.1 mgd): Class B BNROD (2.0 mgd): Class A+ (with filters) Class B+ (without filters) Future: Enhanced future standards not expected. Microbial fouling in distribution system. UV system efficiency. Salinity (SAR)

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
Air Quality	5-year permit originally expired 2005 and has been administratively continued.	Synthetic minor source permit for NO_X and CO Minor source for other criteria pollutants Permitted Equipment: WWTP processes on - IC engines, 378 hp emergency portable generator (500 hours/year restriction)		POTENTIAL TO EMIT (tons/year) NO_X 51 CO 11 VOCs 4 SO_X 3 PM10 4 HAPs NEGLIGIBLE
MARANA WWTF				
Aquifer Protection	11/22/06 - Until plant is expanded or modified	3 X 50,000 gpd packaged BNR extended aeration plants. 4th 50,000 gpd unit planned for 2005. Lagoons used for emergency storage. Groundwater monitoring not required unless discharges to emergency storage basin exceed limit. 0.5-mgd Biolac system constructed Spring 2007.	Modify APP when upgrading plant to meet AZPDES schedule Discharge to emergency storage basin limited to 90 days per year, otherwise monitoring well will be required.	Near to Mid-term contaminant considerations: Non-detect microbial levels (fecal or E. coli). TOC Future contaminant considerations: Salinity NDMA

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
AZPDES	5/25/06 – 5/25/11	New permit needed.		Future: 2 mg/L ammonia standard expected Nutrients (phosphorus). Toxicity Tests: Results and follow-up actions
Reclaimed Water	7/18/2005 - 7/14/2010		NOI by 4/14/10 to renew	Class B+ Future: Enhanced future standards not expected. Microbial fouling in distribution system. UV system efficiency. Salinity (SAR)

Permit	Effective Dates	Key Issues	Schedule	Key Standards/Limits
RILLITO VISTA WWTF; FAIRGROUNDS; MT. LEMMON WWTF				
Aquifer Protection	General Permits: Rillito Vista 9/16/1994 – LIFE Fairgrounds 4/4/1996 – LIFE Mt Lemmon 1/25/1999 – LIFE	Rillito Vista: no major issues. Fairgrounds: 3,000 gpd evaporation pond; no major issues. Mt. Lemmon: 12,500 gpd package plant oxidation ditch; experiences freezing temperatures in winter.		
AZPDES	2/10/06 - 12/31/10 (Mt. Lemmon only)	Variances for copper, zinc. Assessment monitoring for trace substances and WET. ALs for trace metals. Cultural resources survey may be needed if breaking ground.	Copper and zinc variances until 12/31/10.	Interim levels for copper (50 µg/L) and zinc (270 µg/L). Future: 2 mg/L ammonia standard expected Nutrients Toxicity Tests: Results and follow-up actions

APPENDIX E

Stakeholders' Interview Summaries

As part of the Pima County Wastewater Treatment System Capacity Management, Nutrient Removal, Solids Handling/Treatment and CIP Development Study, individual interviews were conducted with various stakeholders at the beginning of the Study to gather their views and input for evaluation during the study. Each interview varied from one-half hour to over one hour depending on the individual. Key questions asked in every interview were:

- What will success look like?
- What are the goals and needs?
- What needs to happen for success?
- What are the three most difficult/important issues that have to be worked through?
- What issues can be addressed with confidence; with no confidence?
- What has worked well; what hasn't?
- What additional topics need to be addressed in each of the workshops?

Results of these interviews are compiled and used as part of the evaluation of study alternatives.

List of names interviewed is provided below.

List of Stakeholders to be Interviewed

PCWMD

Administration/Engineering

1. Michael Gritzuk, Director
2. Paul Bennett, Assistant Director - Engineering
3. Michael Bunch, Assistant Director - Conveyance
4. Jackson Jenkins, Assistant Director - Treatment Plant O&M
5. Jeff Nichols, Assistant Director - Controller
6. Eric Wiederwilt, Chief Engineer
7. John Munden, PM/Engineering
8. Ron Riska, PM Regional Optimization Study
9. Frank Luiz, Engineering Design

Roger Road WWTP

10. Helen Rhudy, Manager - Roger Road WWTP
11. John Sherlock, Operations Supervisor - Roger Road WWTP
12. Jack Van Riper, Maintenance Supervisor - Roger Road WWTP

Ina Road WPCF

13. Jim Doyle, Manager - Ina Road WPCF
14. David Garrett, Operations Supervisor - Ina Road WPCF
15. Paul Jordan, Maintenance Supervisor - Ina Road WPCF

Outlying Treatment

16. Frank Gall

Planning
17. Ed Curley
18. Bill Richardson

Others
19. Stewart Spaulding, Power
20. John Warner, Richey Road Operations (Conveyance)
21. Byron McMillan, Permits
22. Laura Fairbanks, Public Relations
23. Harlan Agnew, Legal

Tucson Water
24. Dave Modeer
25. Melodee Loyer
26. Mitch Basefsky

Oro Valley Water
27. David Ruiz

Metro Water
28. Mark Stratton

Pima County
29. Chuck Hucklelberry, County Administrator
30. John Bernal, Deputy County Administrator Public Works
31. Kathy Chavez, Flood Control District

After the list of stakeholders was confirmed for an interview, the interview process began by contacting each individual and arranging a time for a face-to-face or telephone interview. After each interview the comments during the interview were summarized. The summarized interviews were evaluated for major trends, reoccurring themes or issues, and other important items that would be of value to the study.

Summary of Interview Comments

A general summary of the interviews is divided into four categories -- planning, stakeholder buy-in, decision making and technical challenges. Items in bold are regarded to be of higher importance than the other items listed in the summary.

- Planning
  - **Need long-term plan that integrates all wastewater aspects for the benefit of the whole community**
  - **Need a short-term plan that addresses critical issues and decisions so "on-hold" improvements can proceed**
  - Lack of consistency in how planning is done by member and regulatory agencies

- Stakeholder Buy-In
  - **Satisfying all interests related to the Roger Road plant operation and associated wetland and riparian habitat impacts will be challenging**
  - **Need to build trust between the Pima County Board and PCWMD. Recent PCWMD management change seen as positive for culture**
  - **Need to address odor issues quickly to gain community trust**
  - **Need buy-in at all levels, staff, the Board, local agencies, and regulatory agencies**
  - The stakeholder workshop approach is good
  - Public doesn't understand the difference and impacts of managed recharge vs. constructed recharge on water rights

- Decision Making
  - **Final recommendations need to allow maximum flexibility in balancing funding with regulatory requirements and needs**
  - **Wastewater/Reuse/Water planning decisions need to be coordinated and made holistically**
  - **There is confidence that the best technical solution can be identified but that the regulatory deadlines will be missed due to procurement decisions/procedures**
  - Have procedures to prevent backsliding of decisions after workshops
  - There are differing perspectives at all levels as to the drivers for decisions

- Technical Challenges
  - **Sizing of the Interconnect pipeline between Ina and Roger Road plants**
  - **Alternative methods for biosolids disposal due to shrinking land availability**
  - Site and setback issues at Ina Road plant
  - Increase in influent wastewater concentrations due to conservation and gray water use

Specific Major Trends

Specific comments repeated in a number of the interviews are represented as a major trend for consideration. The comments often repeated and deemed important to the plan are noted below.

- The study needs to provide a long term plan that integrates aspects of wastewater conveyance, treatment, reuse, and biosolids for the good of the community as a whole.

- To be successful, the study must obtain the buy-in of the Board of Supervisors, Tucson Water, Oro Valley, Marana, the Sonora Desert Conservation plan, the Bureau of Reclamation and ADEQ. Consistency of planning among these entities is an issue.

- The study must address the key reuse issues of who owns and operates reclamation treatment facilities, where the reclaimed water will be delivered, whose water is it, what quality of reclaimed water is produced and direct recharge vs. other forms of reclamation/reuse. Water/wastewater/reuse need to be considered together, not separately.

- Alternatives that would adversely affect the wetlands and riparian habitat downstream of Roger Road are likely to encounter public, environmentalist and political resistance. Multiple use type projects are more acceptable to the community.
- Community objections to Roger Road plant are odor-related and would go away if odors controlled.
- Differing perspectives of study drivers for plant location, capacities and conveyance system – long term growth patterns vs. shorter term cost effective facilities.
- There is a lack of public understanding of the effects of constructed recharge vs. managed recharge as it relates to the wetlands and riparian habitat and the ability to obtain CAP water during a drought.
- There is a history of distrust of the wastewater department by the Board of Supervisors. A proactive program to build Board buy-in throughout the study will be needed to overcome this history.
- Presenting a single package with a huge price tag is not likely to be effective with the Board. Phased projects with choices to be made by the Board will be more effective.
- Address odor problems as quickly as possible to gain public confidence.
- There is confidence that the study can identify the best technical solution. There is no confidence that the County system of procurement and project implementation can complete the planning, design and construction of the facilities in time to meet the regulatory deadlines.
- A short term plan is needed as quickly as possible to address the immediate facility and staffing needs at Ina Road and Roger Road plants and what is to be done with the interconnecting pipeline so that so that the plants remain in compliance with treatment requirements during the 8-9 years before any significant new facilities can be placed in service. Funding is in place for rehab projects so just need direction.
- Sizing of the interconnecting pipeline to cope with the large diurnal flow variations at Roger Road and pipeline routing issues will be challenges associated with transferring Roger Road flow to Ina Road.
- The fact that water conservation and gray water use will increase influent wastewater concentrations needs to be considered in treatment process evaluations.
- The development of alternative methods of biosolids disposal needs to be accelerated. There are concerns about loss of current land application sites to development.
- Site and setback issues are significant when considering expansion at Ina Road.

- Funding of the needed projects and the related rate structure is a major concern.
- There is a history of backsliding on decisions – documentation of workshop decisions with appropriate signoffs will be needed.
- The approach of workshops involving all levels of County staff and involving other affected entities is a good one.
- There is a sense that the County culture is slowly changing for the better to allow more participation of all levels affected by decisions. Recent changes in wastewater department management are viewed favorably and there is a cautious air of optimism about the future.

The interview information will be applied in areas where appropriate to strengthen the outcome of the plan.

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- What will success look like?
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- Stakeholder Buy-In
  - **Satisfying all interests related to the Roger Road plant operation and associated wetland and riparian habitat impacts will be challenging**
  - **Need to build trust between the Pima County Board and PCWMD. Recent PCWMD management change seen as positive for culture**
  - **Need to address odor issues quickly to gain community trust**
  - **Need buy-in at all levels, staff, the Board, local agencies, and regulatory agencies**
  - The stakeholder workshop approach is good
  - Public doesn't understand the difference and impacts of managed recharge vs. constructed recharge on water rights

- Decision Making
  - **Final recommendations need to allow maximum flexibility in balancing funding with regulatory requirements and needs**
  - **Wastewater/Reuse/Water planning decisions need to be coordinated and made holistically**
  - **There is confidence that the best technical solution can be identified but that the regulatory deadlines will be missed due to procurement decisions/procedures**
  - Have procedures to prevent backsliding of decisions after workshops
  - There are differing perspectives at all levels as to the drivers for decisions

- Technical Challenges
  - **Sizing of the Interconnect pipeline between Ina and Roger Road plants**
  - **Alternative methods for biosolids disposal due to shrinking land availability**
  - Site and setback issues at Ina Road plant
  - Increase in influent wastewater concentrations due to conservation and gray water use

Specific Major Trends

Specific comments repeated in a number of the interviews are represented as a major trend for consideration. The comments often repeated and deemed important to the plan are noted below.

- The study needs to provide a long term plan that integrates aspects of wastewater conveyance, treatment, reuse, and biosolids for the good of the community as a whole.

- To be successful, the study must obtain the buy-in of the Board of Supervisors, Tucson Water, Oro Valley, Marana, the Sonora Desert Conservation plan, the Bureau of Reclamation and ADEQ. Consistency of planning among these entities is an issue.

- The study must address the key reuse issues of who owns and operates reclamation treatment facilities, where the reclaimed water will be delivered, whose water is it, what quality of reclaimed water is produced and direct recharge vs. other forms of reclamation/reuse. Water/wastewater/reuse need to be considered together, not separately.

- Alternatives that would adversely affect the wetlands and riparian habitat downstream of Roger Road are likely to encounter public, environmentalist and political resistance. Multiple use type projects are more acceptable to the community.
- Community objections to Roger Road plant are odor-related and would go away if odors controlled.
- Differing perspectives of study drivers for plant location, capacities and conveyance system – long term growth patterns vs. shorter term cost effective facilities.
- There is a lack of public understanding of the effects of constructed recharge vs. managed recharge as it relates to the wetlands and riparian habitat and the ability to obtain CAP water during a drought.
- There is a history of distrust of the wastewater department by the Board of Supervisors. A proactive program to build Board buy-in throughout the study will be needed to overcome this history.
- Presenting a single package with a huge price tag is not likely to be effective with the Board. Phased projects with choices to be made by the Board will be more effective.
- Address odor problems as quickly as possible to gain public confidence.
- There is confidence that the study can identify the best technical solution. There is no confidence that the County system of procurement and project implementation can complete the planning, design and construction of the facilities in time to meet the regulatory deadlines.
- A short term plan is needed as quickly as possible to address the immediate facility and staffing needs at Ina Road and Roger Road plants and what is to be done with the interconnecting pipeline so that so that the plants remain in compliance with treatment requirements during the 8-9 years before any significant new facilities can be placed in service. Funding is in place for rehab projects so just need direction.
- Sizing of the interconnecting pipeline to cope with the large diurnal flow variations at Roger Road and pipeline routing issues will be challenges associated with transferring Roger Road flow to Ina Road.
- The fact that water conservation and gray water use will increase influent wastewater concentrations needs to be considered in treatment process evaluations.
- The development of alternative methods of biosolids disposal needs to be accelerated. There are concerns about loss of current land application sites to development.
- Site and setback issues are significant when considering expansion at Ina Road.

- Funding of the needed projects and the related rate structure is a major concern.
- There is a history of backsliding on decisions – documentation of workshop decisions with appropriate signoffs will be needed.
- The approach of workshops involving all levels of County staff and involving other affected entities is a good one.
- There is a sense that the County culture is slowly changing for the better to allow more participation of all levels affected by decisions. Recent changes in wastewater department management are viewed favorably and there is a cautious air of optimism about the future.

The interview information will be applied in areas where appropriate to strengthen the outcome of the plan.

APPENDIX F

Reclaimed Water System Alternatives

Appendix F

Reclaimed Water System Alternatives

Meeting Notes – August 2, 2006

Meeting Notes – August 2, 2006
Reclaimed Water System Alternatives

As part of the Pima County Regional Optimization Master Plan program, a subcommittee of Tucson Water and PCWMD staff was formed to consider the integration of reclaimed water into the alternative analysis of the regional system configurations. The subcommittee met on August 2, 2006 to discuss a range of reclaimed water issues and address the 13 reclaimed water alternatives developed in Workshop #2 – Reuse/Flow Transfer. Attendees of the meeting were:

Tucson Water	PCWMD	Greeley and Hansen
Melodee Loyer	Steve Munsell	Jerry Bish
Sandy Elder	Ron Riska	
Tim Thomure		
Dean Trammel		

A summary of the meeting discussions and comments are provided below.

1. As a result of the meeting, there were three universally agreed upon position statements by the subcommittee:

   - Tucson Water will continue to operate the Sweetwater recharge/recovery facilities and wetlands indefinitely. The recharge/recovery facilities are required to meet peak reclaimed water demands now and in the future.
   - The 20-mgd capacity at Roger Road WWTP is one scenario being evaluated by Pima County Wastewater Management Department. Tucson Water has plans to work with the County on whatever option the County adopts regarding flow split between the two facilities.
   - Tucson Water plans to make use of its ten acres at the Ina Road WPCF for reclaimed water facilities, as provided for in the 1979 IGA.

2. For future (2030) reclaimed water needs in Pima County, Tucson Water would ideally like to have its allocated average daily flow share of the effluent (at Class A+ quality) split between two locations with 30mgd, plus or minus, at Roger Road WWTP and 20 mgd, plus or minus, at Ina Road WPCF. In addition, up to 3 mgd of reclaimed water would be available from Randolph Park WRF.

   The above effluent allocation does not include possible additional flows for Metro Water, Oro Valley Water, Pima County, SAWRSA or any other entity who may be interested in wheeling water through the reclaimed system.

   30 mgd at Roger Road WWTP will serve the Sweetwater recharge/recovery facilities with a future capacity of up to 20,000 AF/yr, Sweetwater wetlands, booster pump station that feeds the reclaimed

water distribution system, and groundwater augmentation at some future date. At times, under certain operational conditions, some of the 30 mgd could be released to the Santa Cruz River.

20 mgd at Ina Road WPCF (at Class A+ quality) would serve a booster pump station that feeds the reclaimed water distribution system. At times and under certain conditions, some or all of that 20 mgd could be released to the Santa Cruz River.

3. Recharge and recovery facilities at Sweetwater are currently rated at 6,500 AF/yr and are being expanded to 10,000 AF/yr. The ultimate build out of the recharge and recovery facilities at Sweetwater would increase the capacity to 20,000 AF/yr. The build out would occur in steps or stages as demands require.

4. Tucson Water plans to construct a reclaimed water pump station and reservoir at the Ina Road WPCF site. The earliest date for startup after construction would be five years. The facility would likely be about 20 mgd, depended on customer demands.

   If the facilities are constructed prior to the construction of the wastewater upgrades to NdeN facilities at Ina Road WPCF (as stated above), then at a minimum filtration will be required until the new NdeN facilities are constructed (approximately four years). If possible, Tucson Water would like to use the discharge from the BNRAS facility at Ina Road WPCF because of the better water quality. This may not be possible because of the plant discharge permit requirements (blended effluent).

5. Sweetwater wetlands will remain at Roger Road. When the effluent from Roger Road WWTP is upgraded to Class A+, the filtration plant at the Roger Road Reclaimed Water Facility will be decommissioned and the filter backwash will be discontinued. To sustain the wetlands, Class A+ effluent from Roger Road WWTP or perhaps backwash from the filters at the Roger Road WWTP would be utilized. This will require additional review after the system configuration and unit processes are determined for Roger Road WWTP.

6. At some future date, effluent may be treated to drinking water standards for purposes of groundwater augmentation. The facilities to treat the effluent will likely be located at the Roger Road facility on City or County property. Planning will need to include space for the potential of this future facility.

7. Tucson Water has evaluated the reclaimed water system needs for the 2030 condition under each of the regional system configuration options (using Class A+ quality only) – **existing plan, transfer some and transfer all**. In addition, they evaluated a transfer none option. These scenarios would be altered significantly if effluent is not Class A+ quality.

   Current features of the reclaimed water system configuration are shown on the attached Present Conditions schematic. Salient features required for each system configuration option are described below. A schematic of each system configuration option is attached.

- ***Existing Plan (Roger Road WWTP (RR) 32 mgd; Ina Road WPCF (IR) 50 mgd):***
  System configuration option requires additional effluent pumping at Roger Road WWTP and construction of effluent pumping (20 + mgd capacity), disinfection, storage reservoir and booster pumping at Ina Road WPCF. Flow to the Santa Cruz River at Roger Road WWTP will need to be addressed in order to determine facility size at Ina Road, as well as adequacy of 24-inch line to transfer needed flows. (See attached schematic: X-fer Some RR = 32-mgd.)
- ***Transfer Some (RR 20 mgd; IR 62 mgd):***
  System configuration option requires construction of effluent pumping (30 + mgd capacity), disinfection, storage reservoir and booster pumping station at Ina Road WPCF and a reclaimed water transfer main between Roger Road and Ina Road (up to 10 mgd could flow through an existing reclaimed water distribution main but an additional flow of up to 7 mgd or more may have to be transferred for discharge to the Santa Cruz River). (See attached schematic: X-fer More RR = 20 mgd.)
- ***Transfer All (RR 0 mgd; IR 82 mgd):***
  System configuration option requires construction of effluent pumping, disinfection, storage reservoir and booster pumping station at Ina Road WPCF and a reclaimed water transfer main between Roger Road and Ina Road. Pumping capacity will be at least 50 + mgd and transfer main capacity at 30 mgd (plus additional flow to be discharged at Roger Road WWTP into the Santa Cruz River). (See attached schematic: X-fer All.)
- ***Transfer None (RR 60 mgd; IR 22 mgd):***
  System configuration option requires additional effluent pumping at Roger Road WWTP and construction of effluent pumping (20 + mgd capacity), disinfection, storage reservoir and booster pumping at Ina Road WPCF. Discharge from Roger Road WWTP will be available to the Santa Cruz River. (See attached schematic: X-fer None.)

8. Subcommittee comments on the 13 reclaimed water alternatives developed in Workshop # 2 – Reuse/ Flow Transfer are provided in items 8.1 through 8.13 below. The description of the alternative is provided with the subcommittee comments following in italicized type.

   8.1. Base case – Roger Road WWTP remains in operation at 32 mgd with the Sweetwater Recharge/Recovery Facilities.

   a. Reclaimed water system centered at Roger Road WWTP with recharge basins (underground storage) in service.
   This alternative meets the future requirements for reclaimed water flow at Roger Road as long as there is no minimum discharge required to the Santa Cruz, but does not meet the 20-mgd requirement at Ina Road. This is not a suitable alternative.

   b. Reclaimed water system centered at Roger Road WWTP with recharge basins (underground storage) in service and additional new supply provided from Ina Road WPCF
   Meets the Tucson Water's reclaimed water requirements for pumping capacity and storage. Minimal infrastructure required to implement.

   c. Reclaimed water system centered at Roger Road WWTP, reclaimed basins decommissioned and additional new supply provided from Ina Road WPCF.

Without underground storage, Tucson Water will be unable to meet peak summer demands. This is not a suitable alternative.

8.2. Roger Road WWTP size is reduced to optimize utilization of the existing infrastructure for future needs (20 mgd). (Scalping facility or with some discharge to the Santa Cruz River?)

a. Reclaimed water system centered at Roger Road WWTP with recharge basins (underground storage) in service. Some flow released to Santa Cruz River.
Insufficient quantities at Roger Road WWTP to meet future reclaimed water system demands of Tucson Water. This is not a suitable alternative.

b. Reclaimed water system centered at Roger Road WWTP with recharge basins (underground storage) in service and additional new supply provided by Ina Road WPCF. Some flow released to the Santa Cruz River.
Meets Tucson Water's reclaimed water requirements, but requires pumpback of at least 10 mgd from Ina Road WPCF to Roger Road WWTP to meet reuse water demands plus additional flow for the Santa Cruz River.

c. Scalping plant scheme -- reclaimed water system centered at Roger Road WWTP, recharge basins (underground storage) in service. No flow released to the Santa Cruz River from Roger Road WWTP.
Same as 8.2.a above. Insufficient quantities at Roger Road WWTP to meet future reclaimed water system demands of Tucson Water plus Zero discharge to the Santa Cruz River may not be acceptable. This is not a suitable alternative.

8.3. All reclaimed water is produced at Ina Road WPCF. Roger Road WWTP is eliminated and Sweetwater Facilities are eliminated. Tucson Water or the County builds Sweetwater like facilities at or near Ina Road WPCF.

a. Reclaimed water from plant. No underground storage.
Underground storage facilities are required to meet seasonal demands. This is not a suitable alternative.

b. Reclaimed water from plant with underground storage.
Constructing new underground storage for reclaimed water may be possible, but Tucson Water is committed to the proven underground storage facilities at Roger Road WWTP. Building new underground storage facilities for reclaimed water service would be extremely costly and is not feasible in many areas.

8.4. Ina Road WPCF produces reclaimed water and the Sweetwater Recharge and Recovery Facilities remain in operation next to Roger Road WWTP.
Meets Tucson Water's reclaimed water needs, but requires pumpback of at least 30 mgd from Ina Road WPCF to Roger Road WWTP to meet reuse water demands.

8.5. Randolph Park WRF remains at existing 3-mgd capacity.

Tucson Water is supportive of keeping the Randolph Park WRF. This facility provides low flow demands in the reclaimed water system in the winter and is an additional source or reclaimed water, although small.

8.6. Randolph Park WRF expands to a greater capacity than 3 mgd. (This does not appear viable because of the limited service area connected with the plant.)
Expansion of the Randolph WRF is limited by the maximum collection system capacity associated with the plant and the limited site for expansion of the plant. This is a very unlikely alternative.

8.7. Abandon Randolph Park WRF.
This is possible but unlikely for three reasons. 1) The County has a significant new investment in the facilities, 2) the volume provided to Tucson Water would have to be made up somewhere else, and 3) the County risks losing favorable wheeling rate charges associated with their share of the reclaimed water discharged from the facility.

8.8. Satellite wastewater treatment (scalping?) plants in the outlying areas are upgraded to reclaimed water quality and are used by Tucson Water to augment the reclaimed water system.
At this time there is not an overarching plan by Tucson Water for reclaimed water in the outlying areas. Reclaimed water opportunities will be evaluated on a case-by-case basis considering the effluent water rights, economics, environmental impacts and other factors.

8.9. Santa Cruz River recovery is increased by constructed versus managed recharge systems.
This alternative relates to keeping the effluent discharge water in the County. Provided Tucson Water can received its 2030 effluent allocations at Roger Road and Ina Road as stated in item 2 above, this is not a consideration of this study.

8.10. Connect all outlying facilities to either Roger Road WWTP or Ina Road WPCF.
There are advantages and disadvantages to Tucson Water's overall objectives for reclaimed water by connecting outlying facilities to the two metro plants. There does not seem to be a compelling issue from the reclaimed water perspective to connect the outlying facilities. This option may, however, resolve lingering effluent ownership questions.

8.11. Provide an independent Southlands treatment facility with reclaimed water provisions.
The response to this alternative is similar to item 8.8 above. Reclaimed water opportunities will be evaluated on a case-by-case basis considering the effluent water rights, economics, environmental impacts and other factors. It was suggested that the current HAMP model appears to be working in addressing issues regarding reclaimed water and other water/wastewater issues.

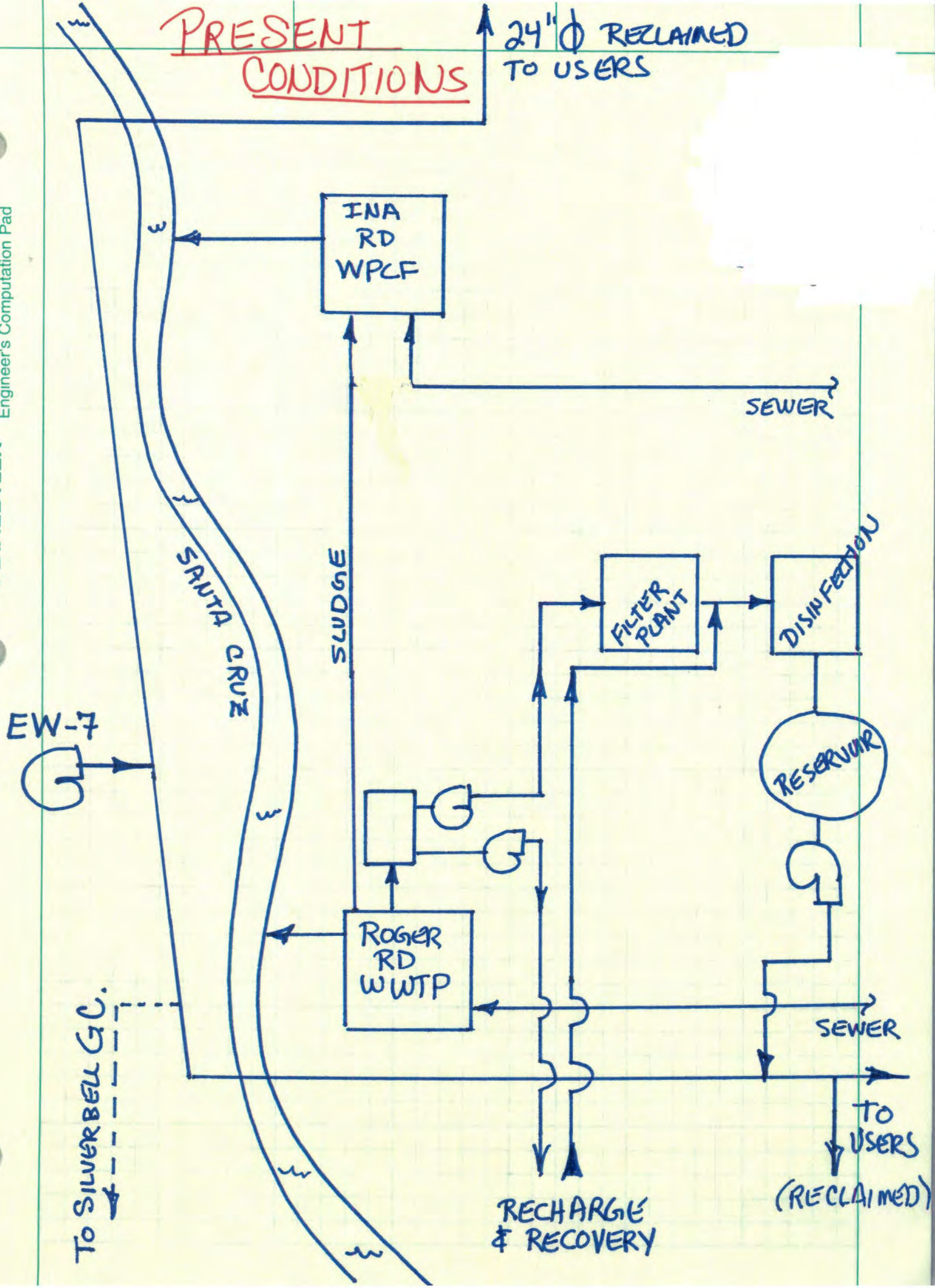
8.12. Expand Roger Road WWTP to provide effluent for Tucson Water use at a higher elevation.
Future use may include transport and treatment to near potable water quality and percolation at Avra Valley recharge facilities. Tucson Water is supportive of this alternative. This capitalizes on

the reclaimed water assessments that Tucson Water has constructed and plans to utilize in the future. This option will also eliminate the need to pump reclaimed water back to Roger Road.

8.13. Provide potable quality reclaimed water for groundwater augmentation.
This is discussed in item 6 above. Space for future facilities will likely need to be provided at Roger Road.

The subcommittee review of the reclaimed water alternatives is summarized below.

- Tucson Water can work with Pima County to make the system configuration options work for their future needs.
- Some alternatives, like the existing plan and expand the capacity of Roger Road WWTP, fit the future of the reclaimed water system better than others (transfer some and transfer all). Features to comply with the various alternatives at Class A+ water quality are provided in Item 7 above.
- In all cases the underground storage and recovery of reclaimed water is required and that facility will be located at Roger Road.
- The existing Randolph Park WRF at 3 mgd should continue operation into the future.
- Reclaimed water operations/utilization basis for the outlying facilities will be decided on a case-by-case basis. The current HAMP cooperative approach appears to be an appropriate model.



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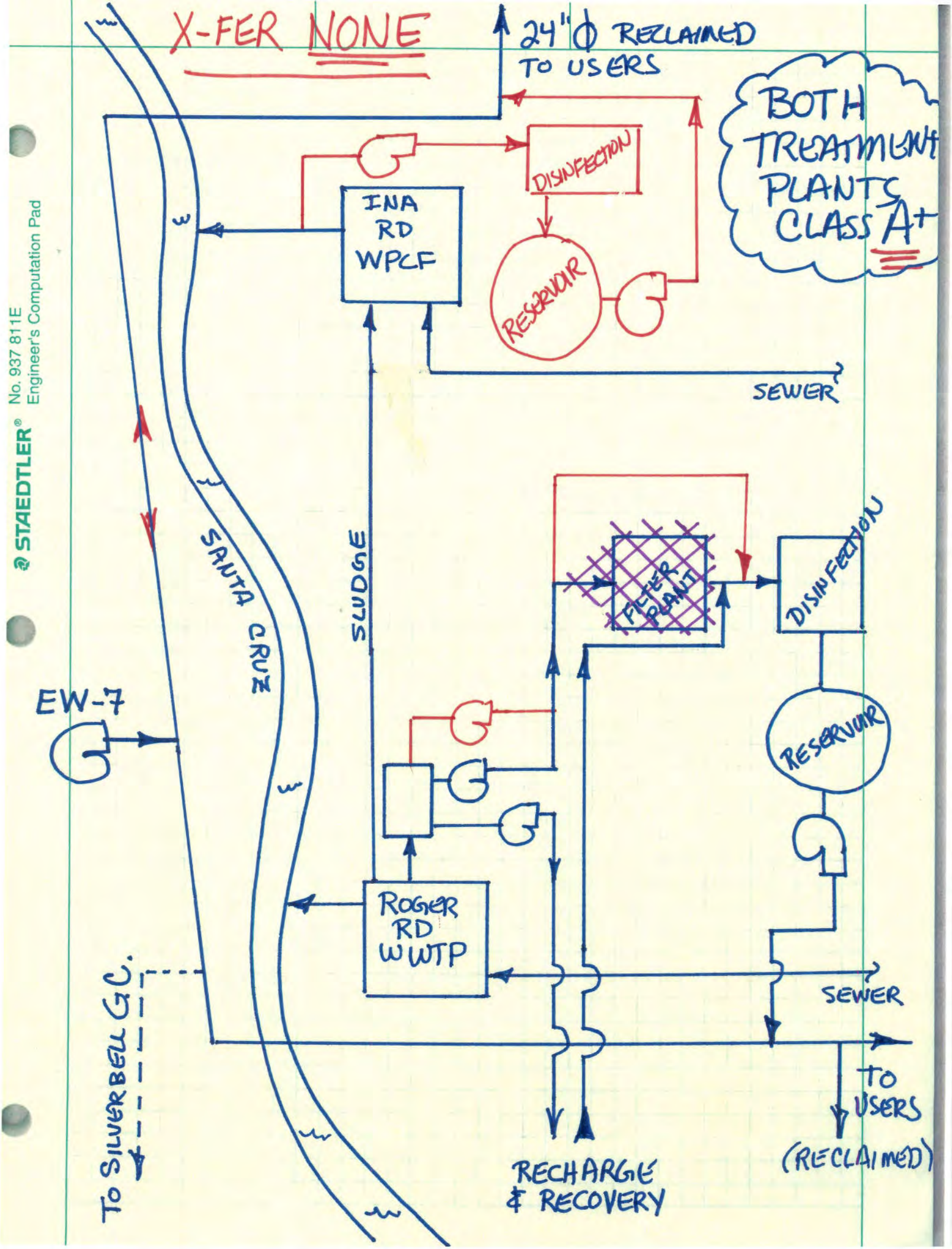

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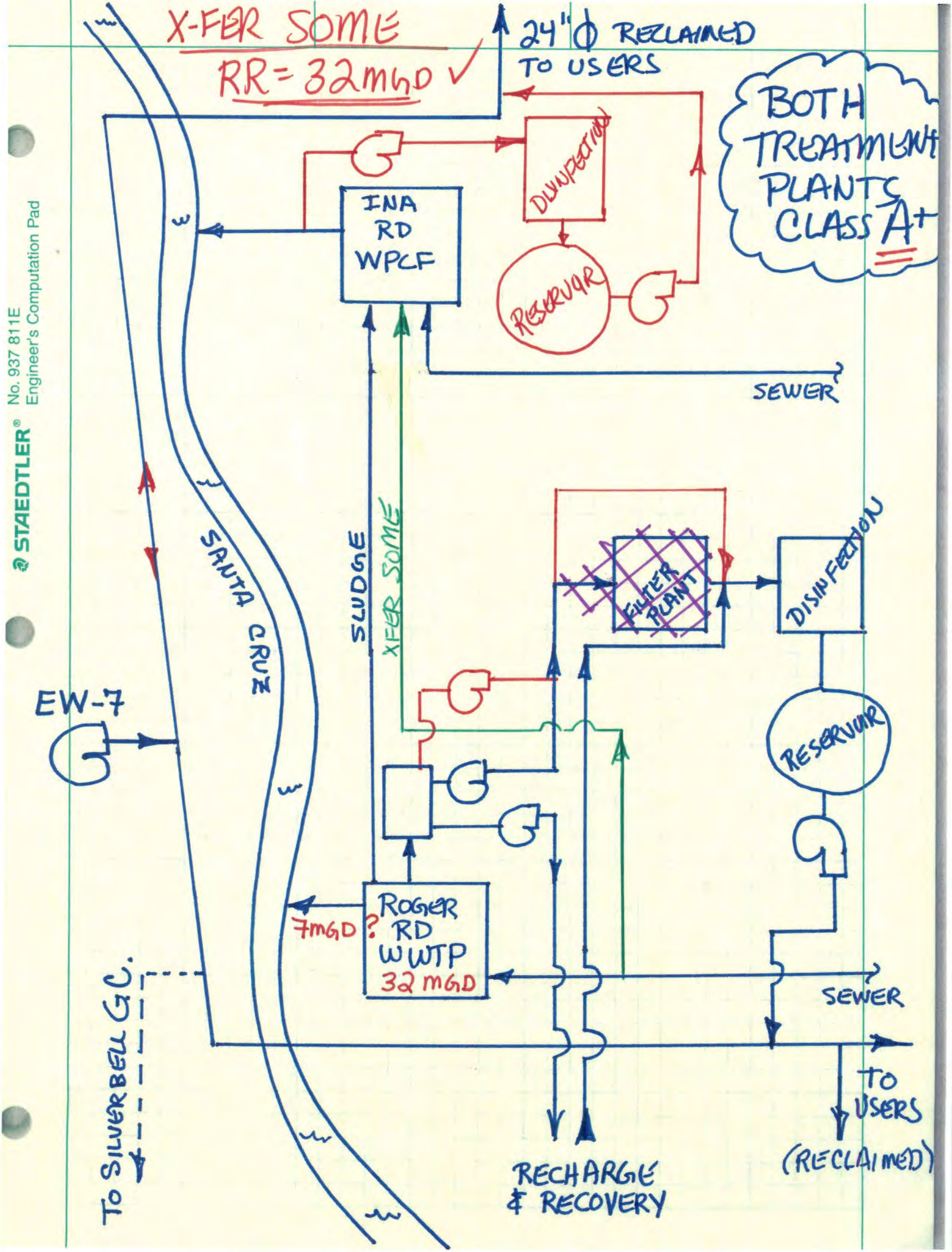

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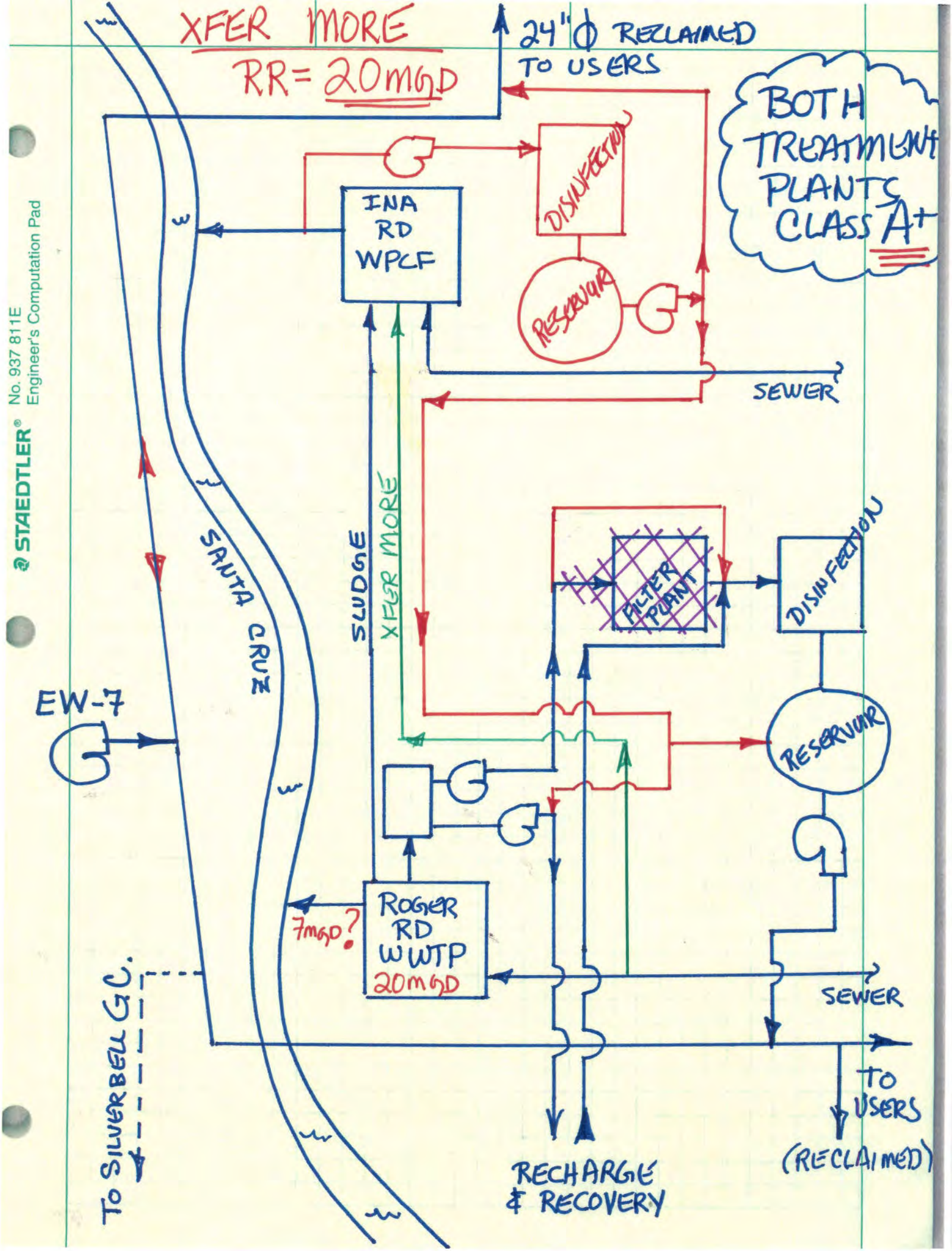

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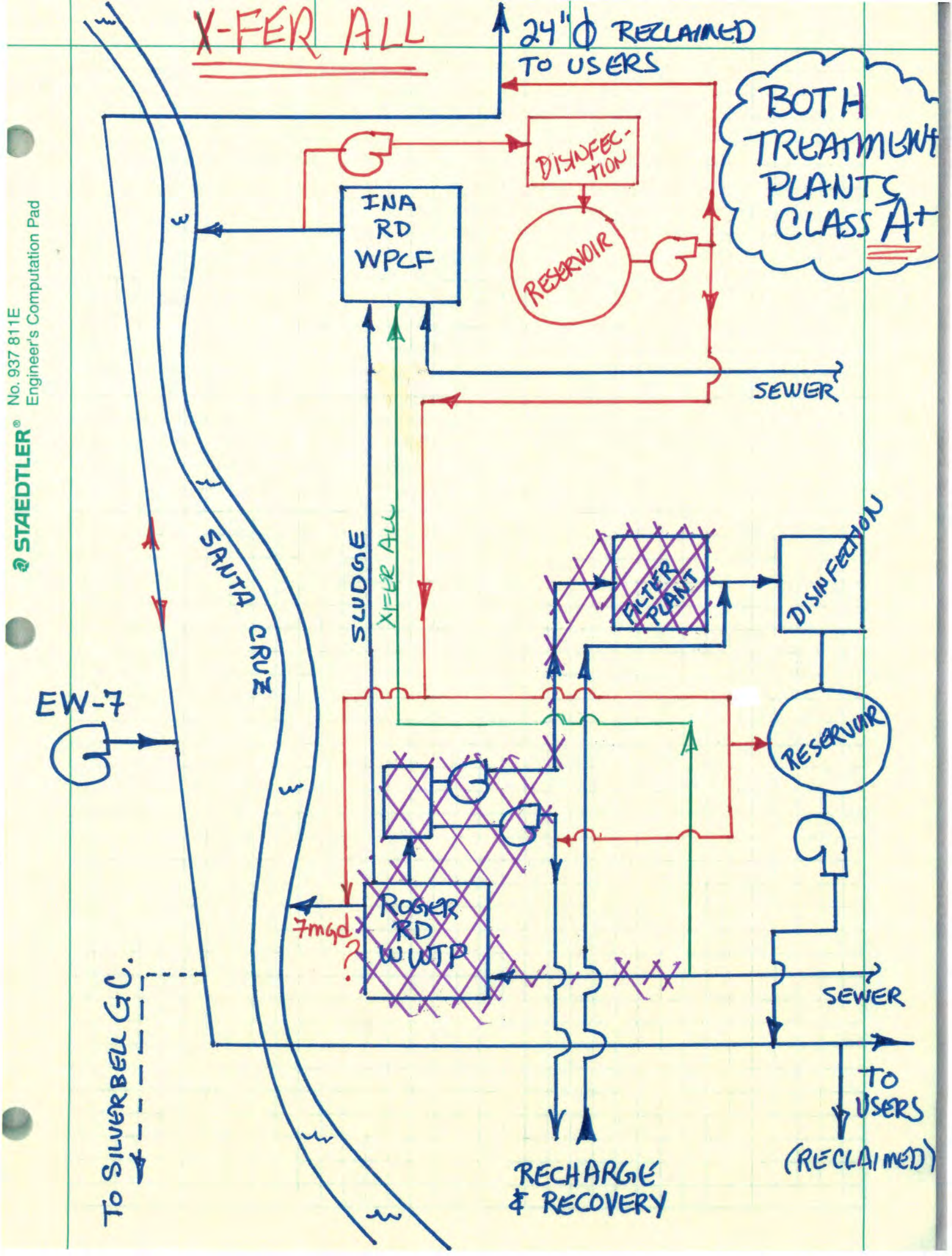

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APPENDIX G

Enhanced Chlorination / De-Chlorination Evaluation

Appendix G

Enhanced Chlorination / De-Chlorination

Workshop #1 – March 15, 2007

Enhanced Chlorination/De-Chlorination Evaluation
Scoping Session Workshop
Meeting Notes

1. The Enhanced Chlorination/De-Chlorination Evaluation Scoping Session Workshop with regard to the disinfection of the effluent wastewater for Pima County Regional Optimization Master Plan was held on March 15, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Paul Bennett
Mike Bunch
Jackson Jenkins
PCWMD Staff
Gary Blomstrom
Jim Doyle
Laura Fairbanks
Dave Garrett
Byron McMillan
Jeff Prevatt
Ron Riska, Project Manager
Mandley Rust
John Sherlock
Legal
Harlan Agnew
Barbara McMurray
Chuck Wesselhoff

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Dennis Rule
Tim Thomure

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Andy Richardson
Art Umble

ADDITIONAL ATTENDEES
Larry Leong, Kennedy/Jenks
Sam Jeyanayagam, MPI
David Murray, Brown and Caldwell
Jennifer McPhillips, MPI

2. Major topics of the workshop were:

- Current disinfection conditions/performance
- BADCT standards
- Other effluent requirements
- Investigation / study success factors
- Investigation / study objectives
- Investigation / study tasks

A set of handouts were provided to each attendee at the workshop. Throughout the workshop a set of notes were recorded on "flip-charts." Those notes summarize questions, comments and notes to be

utilized by the project team while conducting the study. The flip chart notes are included at the end of the meeting notes.

3. Mike Gritzuk welcomed the attendees to the workshop and articulated the focus of the meeting. He stated that the study needed to focus on three objectives:

   - Meet a Class A+ effluent quality discharge
   - Meet the BADCT standards
   - Minimize the need or necessity of spending nearly $70 million (which would be the case if the ultimate process selected for disinfection is filtration coupled with UV)

4. After introductions of the process experts: Larry Leong, Dave Murray, Sam Jeyanayagam and Art Umble, a brief discussion of various disinfection issues ensued. Jackson Jenkins mentioned that perhaps filtration would be required along with chlorination instead of ultraviolet (UV) disinfection to meet the future standards. Mike Gritzuk indicated that if filtration is necessary perhaps it is a different type at a lower cost to the County. Harlan Agnew cautioned that all effluent parameters will need to be met. Key issues from the regulatory perspective include the Aquifer Protection Permit (which has implications for disinfection by-products); BADCT standards for effluent quality (which define the bacteria limits in the discharge in terms of 4 of 7 samples taken within a week period must register as "non-detect", with no single (fecal) sample exceeding 23 MPN; the disinfection standards as defined by the AZPDES permit limit chlorine residual in the effluent to less than 11 μg/L for a daily maximum and less than 8 μg/L on a monthly average. Also, the Whole Effluent Toxicity (WET) requirements will need to be addressed.

   Dennis Rule asked if A+ effluent was a driver for the study. This was articulated as a goal to meet the requirements for reclaimed water in the spirit of cooperation with Tucson Water and the overall needs of the community for water. Harlan Agnew indicated that ADEQ, as a policy, wants the whole effluent to be treated to an optimal quality. For example, the state would not want a facility to provide Class A+ to Tucson Water and Class B+ to the river.

5. Andy Richardson outlined the meeting topics and objectives. He further elaborated on his role as facilitator and encouraged all to participate. The workshop objectives were to develop the scope for the enhanced chlorination/de-chlorination investigation and study, and to identify issues and concerns regarding the investigation/study.

   Overview, agenda, meeting objectives, and ground rules were covered on pages 1 through 5 of the handout.

6. Jerry Bish provided overview of the cost differential between UV (with filtration) and enhanced chlorination/de-chlorination (without filtration) disinfection systems and a summary of the disinfection systems in service at Ina Road WPCF and Roger Road WWTP.

The potential capital costs savings for the County is over $70 million for a reliable, effective chlorine based disinfection system. The disinfection process utilized at the Ina and Roger plants is conventional sodium hypochlorite disinfection technology followed by sodium bi-sulfite de-chlorination. A 12.5 % solution of sodium hypochlorite and a 40 % solution of sodium bi-sulfite are delivered on site for use. There are three sets of contact tanks at the two plants, which are designed to provide a detention time of 30 minutes at average design flows. One set of contact tanks at the Ina Road WPCF serves the new biological nutrient removal activated sludge process (BNRAS) facility and another set serves the high purity oxygen activated sludge process (HPO).

Performance data at the two treatment plants for the past six months was plotted and presented. The data trend is a steady improvement in lowering chlorine dosages and in reducing fecal and E. coli counts in the effluent grab samples. This is in response to initiatives undertaken by Operations to improve the disinfection system performance. Sam Jeyanayagam pointed out that there is a different maximum allowable standard under BADCT for fecal (23 cfu) and E. coli (15 cfu). Also, it was suggested that Pima County meet with ADEQ. Mike Gritzuk stated that Pima County had indicated that they would meet ADEQ on this topic and a meeting was to be scheduled soon.

Lastly, the wastewater treatment system process to be in place when the BADCT rules take effect was summarized. A Bardenpho system operating with an effluent TKN less than 6.5 mg/l will be constructed and in operation at the time that Pima County is required to meet the BADCT requirements.

Project cost drivers, current operating features and status of the disinfection process at Roger Road WWTP and Ina Road WPCF were covered on pages 5 through 17 of the handout.

7. Art Umble presented the scope of the enhanced chlorination investigation and study. The success factors and workplan flowsheet were presented to demonstrate how the project elements are integrated to achieve project results within a limited timeframe. The investigation and study is a three-pronged approach that can proceed in parallel paths – 1) literature research, 2) insitu study, and 3) laboratory bench scale study. Chlorination disinfection has been well studied and researched over the last 100 years. The key for this project is to extract pertinent scientific data from the available literature to support the efficacy of enhanced chlorination. The insitu study will be used in conjunction with the bench scale study to determine the capabilities of the existing chlorine disinfection system configuration to determine the gap, if any, in meeting BADCT requirements with the conventional disinfection approach and what system improvements can be made for enhanced performance. Another key of the investigation is to demonstrate that chlorination technology is working elsewhere in meeting strict pathogen removal standards.

   There was a discussion about which disinfection system would be used for insitu evaluation. While the BNRAS most closely represents the future process for removal of total nitrogen from the wastewater, it is being operated abnormally at steady-state mode until some hydraulic control elements are made functional at the plant. This may limit its use for insitu field evaluations in the early study phases. Larry Leong asked if the standard was for fecal or E. coli or both. The response was that the regulations permit either. In this case, it was suggested that the County adopt an E. coli

standard for reporting to the regulators. It was further explained that the standard was for a calendar seven days (week basis) and not a running 7-day average.

Byron McMillan asked if UV will meet the disinfection standards. It was suggested that in California and Florida, where strict pathogen removal standards are in place, that facilities with UV are struggling for compliance. Mike Gritzuk stated that ADEQ BADCT requirements specifically lists UV, chlorination, ozone and soil aquifer treatment (SAT) as disinfection technologies. Jennifer McPhillips offered that ADEQ prefers filters to be included on effluent discharges. Filters could reduce chlorine and de-chlorination chemical consumption.

Ron Riska indicted that the disinfection study needs to identify the best present worth approach. Art Umble indicated that that could be a mixed oxidant process and this will be explored in the study. Melodee Loyer cautioned that the use of mixed oxidants could create other issues and consequences that will need to be recognized and addressed.

Jeff Prevatt indicated that there is a strong possibility of fecal re-growth in the outfall conduit before sampling. The County is working with the regulators on relocating the point of compliance for the fecal sampling upstream in the system, while keeping the chlorine residual monitoring located downstream. Larry Leong suggested that the laboratory may want to consider a modification of the test procedures to include multiple dilutions to increase sensitivity.

For insitu testing on the contact tanks, a basic tracer test is proposed with dye or fluoride based tracers. Jeff Prevatt has access to fluorometer test instrumentation as required for the testing.

Byron McMillan reemphasized that the County needs to meet the chlorine residuals requirements, WET limits, as well as, BADCT requirements.

Larry Leong has a large database of disinfection information from a WERF study. This can be used to some extent to screen potential plant sites for further investigations relative to the Pima County disinfection issues.

The elements and schedule for the enhanced chlorination investigation and study were covered on pages 17 through 24 of the handout.

8. Ron Riska asked the process experts what other items need to be included in the study outline.

   Dave Murray stated that the proposed scope outline seemed appropriate, but asked how will the in-plant studies, which will be mostly dry weather, reflect all weather conditions? It will be difficult to demonstrate system performance under severe conditions, such as a severe wet weather event, when the testing is designed primarily around dry weather conditions. In addition, it was offered that testing of the system performance should be conducted on both filtered and non-filtered samples. This is to reflect the impact of solids in the effluent on disinfection testing.

Larry Leong offered that obtaining data from comparable plant operations may prove difficult simply due to the fact that some operators/managers will be reluctant to share information. They may view this study as subjecting their data unnecessarily to public or regulatory scrutiny. Further, it was suggested that the proposed 90-day schedule is too tight. It will not be possible in this period of time to conduct the full literature search and to conduct a search of available data from comparable facilities. In addition, the proposed schedule is too tight to allow for adequate statistical analysis to be done on testing the plant at full scale. The bench scale studies should be extended as well. The concern is that in order to gain enough data to conduct appropriate and defendable statistical analysis, at least one to one and one-half years of data is required. At least 30 tests are needed for each operation mode in order to establish a credible data set. At this point it was stated that at 90 days a "go/no-go" decision would be made to continue the enhanced chlorination or discontinue the study based on the evidence developed at that time.

Across the US, approximately 17% of the municipal wastewater treatment plants are using UV for disinfection. Nearly 75% are using some form of chlorine-based disinfection. The remaining plants are using some other means of oxidation method for disinfection. This raised the question provided earlier as to whether this study should include evaluating the applicability of UV for the Ina Road and Roger Road facilities. The general indication was that the study should include enough information on UV disinfection for comparative purposes.

Sam Jeyanayagam offered that in compiling data from comparable plants, it will be important to establish "lessons learned" from those that have had problems with similar systems. Too often that data is unavailable. Data is often used from plants that have been successful, and data from those that have not been successful is either not available, or is overlooked. It will be important in this study to identify where problem areas have occurred and to understand the reasons behind those problems and how they were resolved.

Further there needs to be caution with regard to "predicting" the performance of these systems in the long term. No one knows what the future will hold in terms of community growth (effecting the characteristics of the influent wastewater), the long term plant performance, the regulatory environment, and so forth. Caution must therefore be taken so as to not "over-predict" the guarantees of the system's performance.

John Sherlock offered that both Ina Road and Roger Road plants need to be examined because each facility has significantly different influent characteristics. In the past, the facilities have experienced "nitrite lock", primarily during periods in the summer months. This issue is important and needs to be considered when the study is conducted.

The investigation team should consider the possibility of reducing the bacteria in an upstream process to reduce the demand on the chlorination/de-chlorination system. For example, would adding chemicals upstream in an aeration basin or a final clarifier to further reduce solids (and the associated bacteria) help reduce the chlorine demand?

A review should be done of the control loop systems for the de-chlorination process. One plant uses a concentration-based control, while the other uses the ORP control. Data indicates that historically, the concentration-based control methodology has performed better.

For the WET testing, ammonia has been the chemical of concern, but the use of excess bi-sulfite may also be of concern. This issue needs to be considered in the project.

Melodee Loyer offered that when looking at the option of mixed oxidants, there must be consideration given to "unintended consequences" that may result. This specifically relates to any safety and public health issues associated with the presence of these oxidants. As much as is possible, these potential concerns must be identified and addressed at the outset. The concern is that there is not enough time proposed in the study schedule to allow for this research. Also, if the Roger Road facility is used for the field testing, Tucson Water would be willing to participate, specifically for issues related to filtered versus unfiltered samples since Tucson Water filters the effluent at their Sweetwater facility adjacent to that plant.

Paul Bennett stated that there may not be much benefit garnered from doing testing at the Roger Road facility simply because as part of the facility master plan, the existing facility will be demolished and a new facility built in its place. Thus, testing the existing facilities may not generate useful data. Furthermore, recommendations need to be "operator friendly." This means that specific communications protocol need to be set up and followed throughout the study that incorporates input from operations staff.

Jeff Prevatt (Laboratory Director) offered that the analytical laboratory staff would cooperate fully with the needs of the study in terms of laboratory facility, equipment availability and staff participation as time and schedules permit.

Ron Riska commented that the County originally suggested that the scope time table should be in the 60 to 90-day frame. This may not be enough time to complete the necessary and critical elements of the study. Therefore, it seems reasonable that the study be lengthened by at least two additional months. The challenge here is that this study represents the "last piece of critical information" needed to complete the Regional Optimization Master Plan (ROMP). Delaying the results of this study too long could jeopardize the implementation schedules for the ROMP.

Agenda
Enhanced Chlorination/De-Chlorination Evaluation Scoping Session
March 15, 2007

Time	Topic	Presenter
8:45 am	*Outlying Facilities Offices –4527 W. Walker Road (near intersection of Ina Road and I-10)*	
9:00 am	Opening Session	
	• Welcoming Remarks / History and Objective	Mike Gritzuk
	• Review Agenda	Andy Richardson
9:15 am	Overview of Pima County Facilities	Jerry Bish
	• Existing Conditions: Chlorination Disinfection System	
	• Existing Conditions: Chlorination Disinfection System Performance	
	• Overview of Current BADCT Standards	
	• Overview Description of Wastewater Process when BADCT Takes Effect	
9:45 am	Develop Set of Critical Success Factors	Art Umble
9:55 am	Define Literature Review Objectives	Art Umble
10:05 am	Chlorine-Based Disinfection Alternative Evaluation	Art Umble
11:15 am	Alternative Chlorine-Based Disinfection Evaluations	Art Umble
11:35 am	Future Investigation/Study Objectives	Art Umble
11:45 am	Summary Wrap-Up	Andy Richardson
	• Comments by Group	
	• Closing Remarks	Mike Gritzuk
12:00 pm	Adjourn	

Flip Chart Notes – March 15, 2007

OBJECTIVES

- Save $70 million
- Meet permit requirements
- CL_2 residual water quality standard
- Whole effluent toxicity standards
- THM's in APP
- "Parking Lot" crypto and giardia - MCL
- Per ADEQ have to treat "total" flow to same quality.
- "Bullet Proof vs. some risk
- Cost benefit vs. risk

DATA NEEDED

- Get volumes in each CL_2 tank
- CL_2 @ 8PPM to 11PPM avg.
- Need to meet BADCT coliform or e-coli limit
- Need to look at steady-state vs. diurnal flow

SCOPE

- Benchmarking – who else is doing enhanced CL_2 /De- CL_2
- Need to make sure that the insitu condition is a good representation of future facilities.
- May need to bring in a "pilot plant"
- Need to make sure we use quality of effluent that is representation of what future effluent will be.
- Use e-coli as standard in permit
- What is the standard? Is it 7 days for a calendar week or 7 day moving median
- Scope and work effluent will be discussed with ADEQ at start of investigation
- System specification is a final deliverable of this investigation
- Permit - change sample location for cfu analysis
- Need to have team determined method for analysis
- Consider system with water champ for pilot scale?
- How are we going to make sure effluent quality matches future effluent?
- How to address wet weather conditions?
- Present or absence of solids relate to use of filters
- What happens if we have to filter?
- Review operating data at other locations
- Concern: will information be shared when a plant is in trouble?
- Concern on amount of data accessibility in short period
- How to use existing facilities to match future conditions
- 30 trials for a given condition for testing insitu
- May want to have study go longer
- Look at extending time to make certain
- How far can we go at first
- Find out "lessons Learned" – may not be able to get information

- Future process is an issue – need to pay attention to this
- May not have facility that will match future
- More time at Ina Rd. and less time at Roger. Look at influent characteristics to make sure using right data
- Look at work that has been on reported on fecal loadings upstream of CL_2 addition
- Control systems now vs. future
- Maybe a phased implementation - get results and then do some additional work
- Whatever we come up with – make sure we are aware of impact
- 3 to 4 month period for "go-no/go"
- Add some information on "UV" as a comparison in the benefit/cost analysis – use literature review data
- Need to be aware of how plants operates when interconnected
- Why testing at Roger may not be necessary
- On De-CL_2 what process mimics residual CL_2
- Visit w/Jeff Prevatt before doing insitu work
- Only look CA, FL, AZ for last 5 years

Pima County Wastewater Regional Optimization Plan Study

Enhanced Chlorination / Dechlorination Evaluation Scoping Session

March 15, 2007

Workshop Presenters

- Mike Gritzuk — Welcome / Closing
- Andy Richardson — Facilitator
- Jerry Bish — Overview of Facilities
- Art Umble — Project Scope

2

Welcoming Remarks

Mike Gritzuk

Overview

Andy Richardson

Agenda

- History and objectives
- Current conditions / performances
- Current BADCT standards
- When BADCT takes effect
- Critical success factors
- Literature review objectives
- Chlorine-based disinfection
- Alternative chlorine-based disinfection
- Investigation / study objectives

5

Groundrules

- Success is the responsibility of all
- Everyone shares the responsibility for success
- Everyone must participate fully to the extend of their expertise
- We agree to speak up honestly and with candor

6

Groundrules *(continued)*

- Disagreements are with opinions or issues, and have basis in fact, not with personalities
- Listen attentively and respectfully to others
- Participate conscientiously
- Understanding is our objective, but consensus is not required
- Adhere to these groundrules and hold each other accountable

7

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned, place items in “parking lot”

8

Role of Facilitator

- Remind all of groundrules
- Negotiate changes in agenda, schedule, or procedure
- Manage discussion, sequence speakers, and exercise leadership

9

Pima County Wastewater Management Department

GREELEY AND HANSEN

Overview of Pima County Facilities

Jerry Bish

UV Disinfection vs. Enhanced Chlorination – Systems

- UV Requirements
  - Lift pump station
  - Filtration
  - High Intensity UV
- Enhanced Chlorination
  - Contact Tank (longer retention)
  - Higher sodium hypochlorite dosages
  - Higher sodium bisulfite dosages

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UV Disinfection vs. Enhanced Chlorination – Cost Impacts

- UV Costs $91.0 million
  - Construction/Contingency/ Engineering
- Enhanced Chlorination $17.6 million
  - Construction/Contingency/ Engineering

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Existing Treatment Processes

- Ina Road WPCF
  - High purity oxygen
    - Effluent 30/30
  - BNRAS
    - Effluent TKN < 15 mg/L
- Roger Road WWTP
  - BT/AS
    - Effluent 30/30

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Existing Chlorine Systems

- Sodium hypochlorite (12.5% solution)
- Contact tanks (3 sets)
  (30 minutes at average Q)
- Sodium bisulfite (dechlorination)
- Chemicals flow paced

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Ina Road WPCF Site

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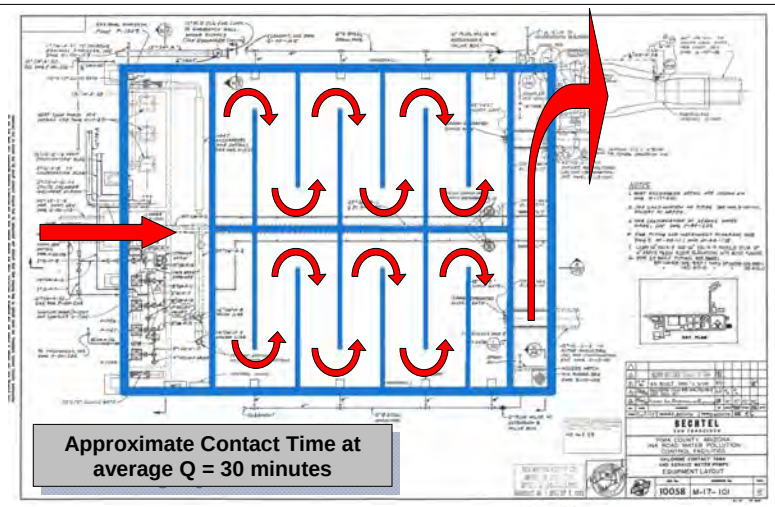
Ina Road Chlorination Facilities – HPO



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Ina Road HPO Chlorination Photo

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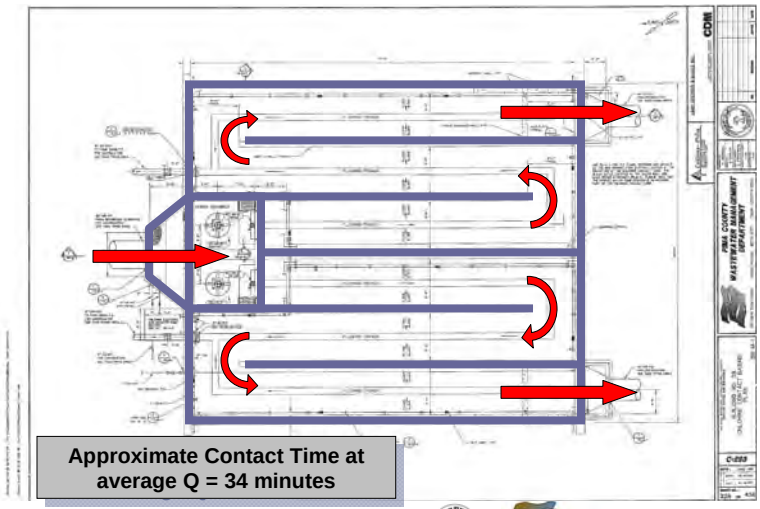
Ina Road Chlorination Facilities – BNRAS Plan



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Ina Road BNRAS Chlorination Contact Tank

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Roger Road WWTP Site

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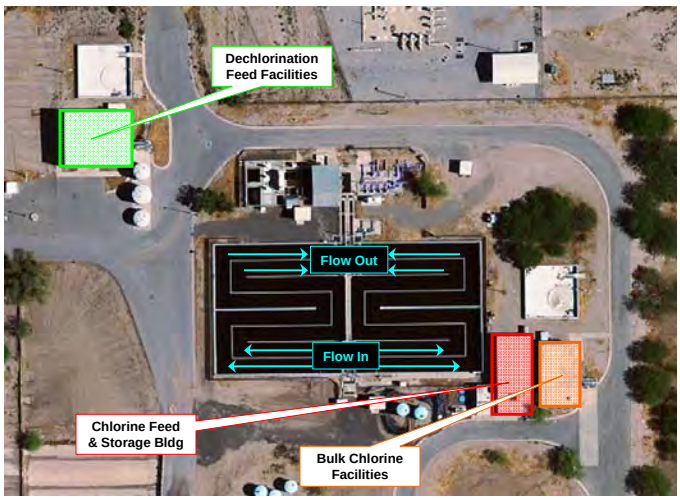
Roger Road Chlorination Facilities – Plan



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Roger Road – Chlorination Equipment

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Roger Road – Chlorination Contact Tank

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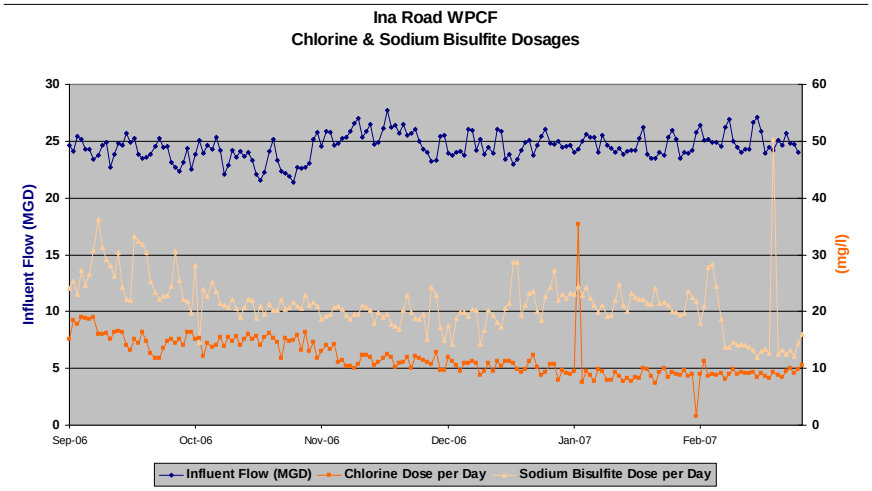
Ina Road Performance



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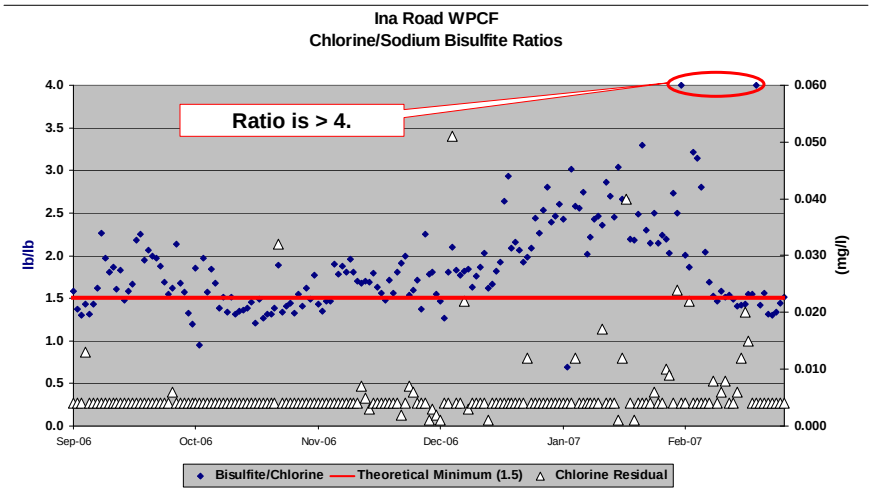
Ina Road Performance



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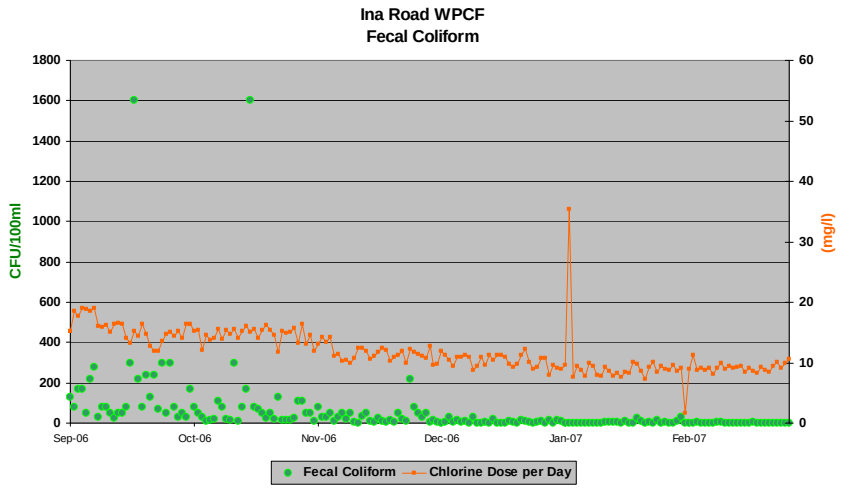
Ina Road Performance



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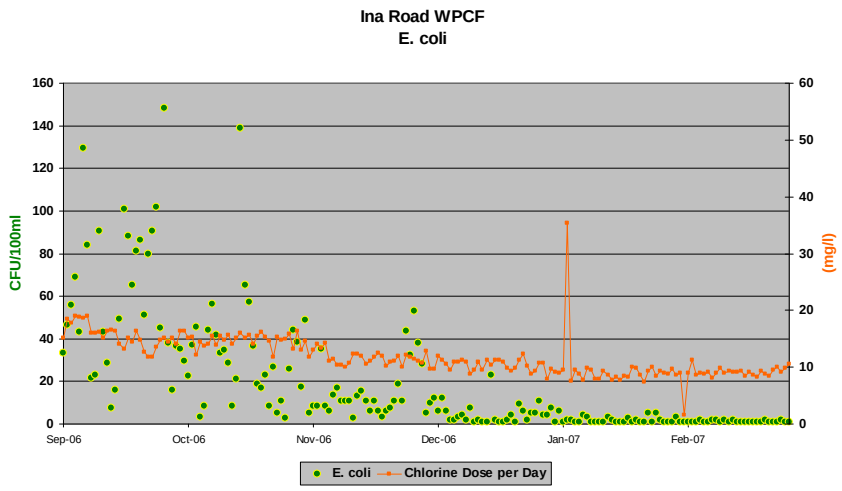
Ina Road Performance



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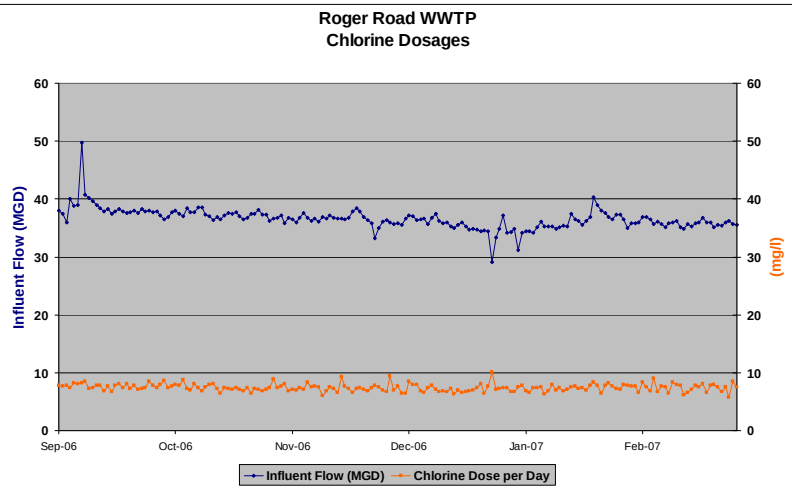
Roger Road Performance



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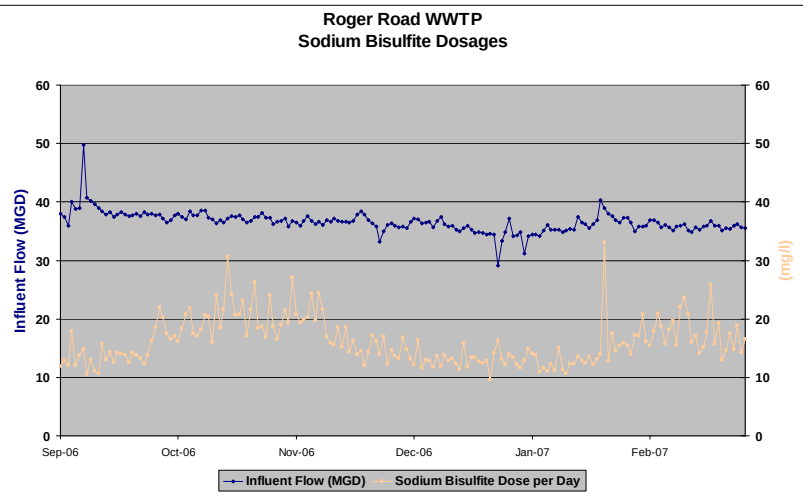
Roger Road Performance



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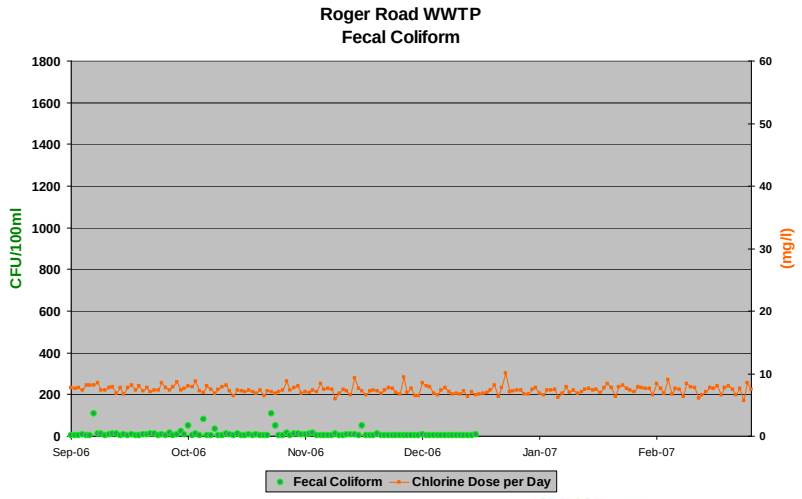
Roger Road Performance



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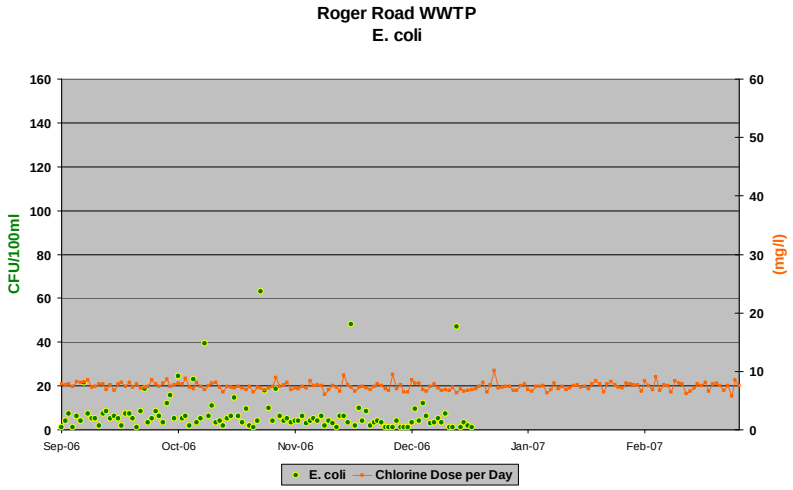
Roger Road Performance



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BADCT Requirements

- Disinfection
  - No detect (E. coli) in 4 out of 7 samples per week
  - None to exceed 23/100 mL

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Process When BADCT Takes Effect

- Treatment process – Bardenpho
- Effluent TKN ≥ 6.5 mg/L
- Future:
  - Effluent P > 1.0 mg/L

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Pima County Wastewater Management Department

GREELEY AND HANSEN

Enhanced Chlorination Project Scope

Art Umble

Critical Success Factors

- Meets BADCT requirements
- Performs without filtration
- Demonstrates performance elsewhere
- Demonstrates performance at Roger Road and Ina Road

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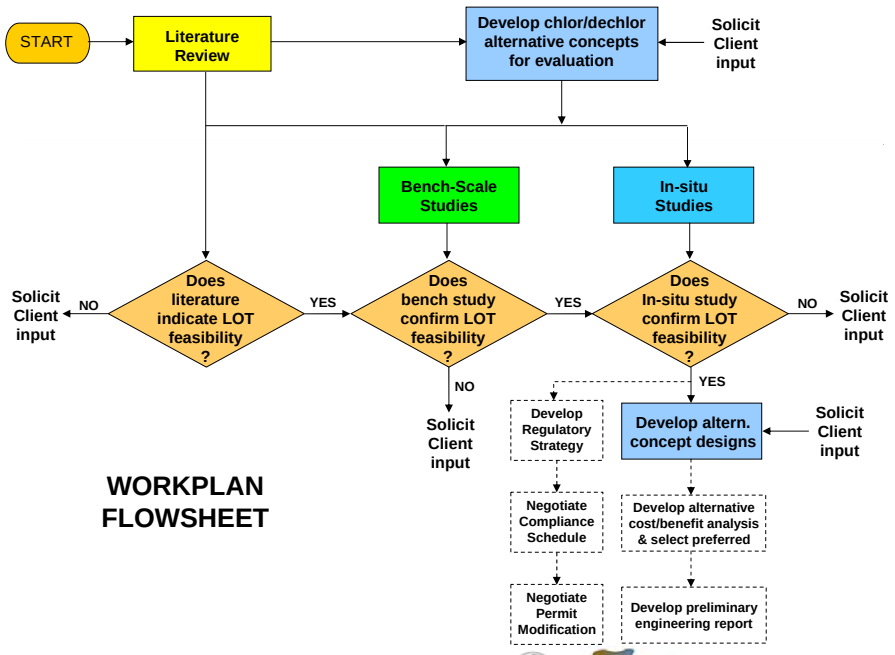

WORKPLAN FLOWSHEET

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Basic / Fundamental Research Actions

- Laboratory study
  - Chlor/dechlor fundamental reaction chemistry and reaction kinetics research has been completed
- Literature search
  - Technical justification for applying existing technology for environmental protection and public health
  - Review the realm of feasible alternatives to conventional chlor/dechlor practices
  - Review the LOT for inactivation and environmental protection
  - Review the relationship between LOT and current BADCT and permit limits
  - Review the LOT performance equivalency with other BADCT technologies
  - Review the statistical limitations of the technology

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Literature Review and Research Results

- Focus of Review: Disinfection for Water Reuse Applications*
- Identify chlor/dechlor disinfection facility enhancement research studies
- Identify facility enhancements with respect to regulatory compliance
- Applicability of models (Collins, Collins-Selleck, etc.) to existing disinfection efficacy
- Identify comparable facilities that utilize enhanced chlor/dechlor disinfection systems
- Establish accepted capital and O&M cost targets for enhanced systems

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Bench / Pilot-Scale Research Actions

- Verification study
  - Chlor/dechlor reaction kinetic models research has been completed
- Site-specific validation study
  - Determine limits of technology effectiveness using site-specific conditions
  - Determine operating ranges for inactivation as function of dose and contact for meeting existing BADCT standards for alternatives
  - Determine operating ranges for inactivation of specific target organisms for alternatives
  - Determine operating ranges for inactivation efficiencies as function of WET requirements
  - Determine limits of technology enhancement, such as applying mixed oxidants
  - Establish confidence interval statistics for comparison with research literature

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Bench / Pilot-Scale Research Results

- Establish N fractionation: monochloramine/dichloramine formation
- Establish disinfection efficacy using varying levels of nitrified effluent
- Verify impact of bacterial re-growth potential
- Determine dechlorination efficacy in eliminating toxicity
- Confirm the most effective Cl:N weight ratio for germicidal response
- Define Methods of Analysis

40

Full-Scale Confirmation Actions

- Validation Study
  - Chlor/dechlor reaction kinetic model calibrations/validations and operational configurations using pilots have been completed
- Site-specific Confirmation Study
  - Review and analysis of historical performance data from existing systems
  - Determine performance limits of existing systems as a function of operational limits of existing equipment
  - Develop and run tests for enhancements to existing system to meet BADCT
  - Develop statistical confidence intervals for enhanced conditions to equal or exceed current BADCT
  - Conduct in-situ hydraulic studies to confirm limits of flow dynamics in achieving contact times and mixing requirements
  - Prepare recommendations for system improvements based on in-situ confirmations of literature reviews and bench studies

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Full-Scale Confirmation Results

- Establish qualitative/quantitative mixing energy and mixing regimes in contact chamber
- Establish the dispersion index, the t_i and the modal time, t_p for existing conditions
- Derive the preferred L:W and H:W ratios for existing geometry
- Determine wind impacts on surface currents that impact short-circuiting
- Determine limitations of existing chlor/dechlor systems for disinfection performance
- Stress tests of existing delivery systems to simulate enhancements for disinfection efficacy
- Document disinfection efficacy simulations for enhanced chlor/dechlor

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Alternative Chlorine-Based Disinfection

- With chlorine addition:
  - Use of mixed oxidants
    - Hydrogen peroxide
  - Other

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Study Objectives

- Prove BADCT compliance with enhanced chlorination/dechlorination
- Develop report for ADEQ review and acceptance

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Report Summaries / Deliverables

- Documentation of literature review for existing and enhanced processes for compliance
- Documentation of bench testing and methods
- Documentation of full-scale testing and analyses and statistical variations
- Documentation of recommendations for full-scale system enhancements

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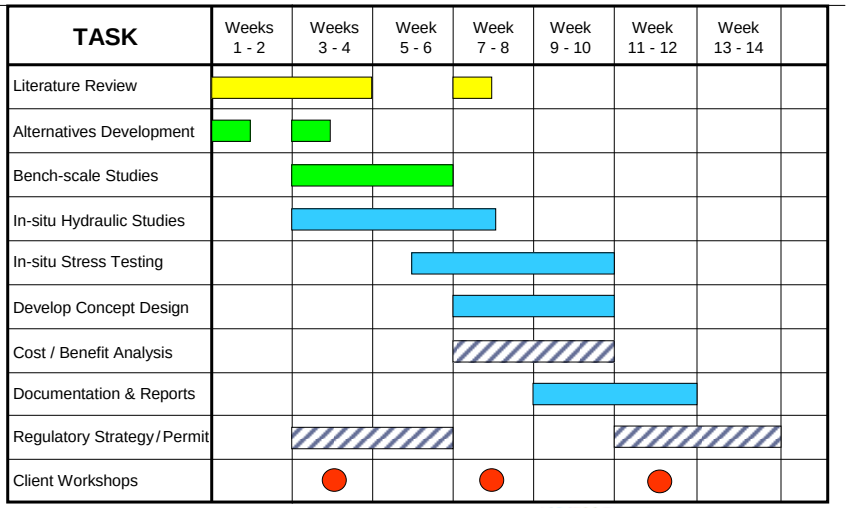
Future Investigations Schedule



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Next Steps

- Assignments – who and what
- Schedule
- Next meeting

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Summary

Andy Richardson

Appendix G

Enhanced Chlorination / De-Chlorination

Workshop #2 – May 23, 2007

Enhanced Chlorination/De-Chlorination Evaluation
Literature Review and Findings
Meeting Notes

1. Enhanced Chlorination/De-Chlorination Evaluation Workshop No. 2 regarding the future disinfection of the wastewater effluent was held on May 23, 2007. The agenda is attached. The following were in attendance:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Jackson Jenkins
PCWMD Staff
Jim Doyle
Frank Gall
Byron McMillan
Jeff Prevatt
Prakash Rao
Helen Rhudy
Ron Riska, Project Manager
Mandley Rust
John Sherlock
Legal
Harlan Agnew
Chuck Wesselhoff

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Wally Wilson

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Art Umble
Larry Leong, Kennedy/Jenks
David Murray, Brown and Caldwell
Jennifer Phillips, MPI

2. Major topics of the workshop were:
   - Literature review of current disinfection performance/practices with regard to Pima County future operations
   - Current disinfection facilities assessment/performance

   A set of handouts were provided to each attendee of the workshop.

3. Attendees were welcomed to the workshop by Jerry Bish who introduced the workshop topics and presenters. The workshop topics included:
   - Literature Review and Analysis
   - Disinfection Facility Assessments
   - Laboratory Facility Assessments
   - Discussions / Clarifications / Debate
   - Next Steps

4. Art Umble presented the decision-making process that would lead either to, or away from the use if enhanced chlorination to meet future ADEQ BADCT disinfection requirements. The intent of the

process is for the group to come to a degree of consensus as a result of the information provided during the workshop.

5. Larry Leong summarized the issues related to regulatory framework for the Pima County facilities. He used information from Florida and California that have standards most similar to those in Arizona to illustrate how the permitting issues in these other states have progressed and how these are, or may become issues for Pima County.

   Issues of concern are:
   - Single sample maximums for fecal and E.coli with or without filtration and with chlorine and UV technologies
   - WET testing that relate to the presence or absence of chlorine residual, ammonia, sulfite and/or non-neutralized organochloramines
   - Increased chlorine dosages developing disinfection by-products such as THMs and HAA5s
   - Cyanide formation potential

   Issues of consideration in the future are:
   - Enteric virus removal for effluent discharge quality greater than Class A which is to be recharged into potable aquifers
   - Florida and California foresee possible standards for *Cryptosporidium* and *Giardia* and enterovirus for water recycling, lower DBP standards (including NDMA) than currently applied to drinking water, and endocrine disruptors.

6. A survey of disinfection practices of major POTWs in the United States was correlated with those plants that use the Bardenpho process of comparable size to the future Pima County facilities. The key to this information was relating the disinfection practice associated and treatment process to the number of permit violations that have been reported. For plants that practice chlorination followed by filtration, the majority of violations correlated with failure to meet a single sample maximum criterion, or a WET test failure.

7. An overview of the data provided by Pima County from January 2004 through April 2007 was presented by Larry Leong. By using a frequency distribution statistical technique, observations from the analysis of the data revealed:
   - Fecal coliform and E.coli follow a log-normal distribution
   - 1.5 logs additional removal is necessary to achieve the 4-day non-detect criterion
   - 2.0 logs additional removal is necessary to achieve the single sample maximum for fecal coliform of <23 cfu/100 mL
   - 2.2 logs additional removal is necessary to achieve the single sample maximum for E.coli of <15 cfu/100 mL
   - 2.5 logs are needed for current Ina Road influent

   It was noted that driving much of the "upper removal" requirements is the presence of several "high" values for fecal and E.coli present in the data set provided. If these few points are removed from the data analysis, the higher log removal needs may actually turn out to be less. If the four maximum points were removed from the data analysis, it is likely that the amount of log-removal needed would be more in the range of that necessary to achieve the 4-day non-detect.

8. To set the stage for a potentially successful enhanced chlorination process design, two studies will need to be conducted. The first relates to determining the disinfection kinetics for the Ina Road BNRAS treated effluent. This study is performed in the laboratory using samples from the mixing chamber immediately following chlorine injection and held for various periods of time to simulate periods of chlorine contact, i.e., required CT. This will establish the CT required for compliance with future BADCT disinfection requirements. This study establishes the relative rate of inactivation and is a direct function of mixing regime. If the resulting kinetic analysis indicates that inactivation follows a first order relationship, then perhaps filtration is not needed at Ina Road WPCF. But if the declining rate of inactivation demonstrates more of a "knee" response, then filtration may be necessary. It is important that this set of data take into account the effect of suspended solids. This test could likely be accomplished within 3 months.

   The second study will attempt to establish the "actual" log-removal being achieved at the Ina Road facility by characterizing the influent/effluent fecal and E.coli concentrations. This will determine the total logs of removal necessary to meet the 4 days of non-detect out of 7 days. If more than 6 logs are found to be needed, then it may be concluded that enhanced chlorination is not likely the appropriate disinfection process for Pima County's facilities. However, if less than 4 logs are necessary, then enhanced chlorination will likely be appropriate without filtration. If it turns out to be somewhere between 4 and 6 logs, filtration may be needed if chlorination is applied. This study is especially critical with respect to the apparent seasonal variability that is seen in the existing data from 2004 to 2007. This second study would best be conducted over a 6-month period in order to gain the insights into the seasonal variations.

9. David Murray presented summaries of the observations of the existing chlorination facilities at both Ina Road WPCF and Roger Road WWTP, with focus on the former. These included hypochlorite feed systems, initial mixing systems, instrumentation and control systems, contact basin geometries, de-chlorination feed systems, and system hydraulics. He provided data on chlorine contact basin contact times and CT versus flow rate based on theoretical relationships. For the BNRAS (east) plant at Ina Road, there is a theoretical total CT of 230 mg-min/L and 160 mg-min/L for flow rates of 7 and 10 MGD, respectively, and 120 mg-min/L for a flow rate of 12.5 MGD. These values included the additional contact time achieved in the outfall pipeline from the contact basin prior to de-chlorination. Because the BNRAS plant operates in a full nitrification mode, the chlorine residual is predominantly free chlorine, thus indicating that the system operates at or above breakpoint.

   For the HPO (west) plant, the approximate CT for flow rates of 9 and 34 MGD are 180 and 30 mg-min/L, respectively. Total chlorine residual is made up mostly of combined chlorine, implying presence of ammonia in the final effluent.

   To establish a basis for design criteria for an enhanced chlorination system, specific field studies were proposed for the BNRAS (east) chlorine contact basin. The first of these would be a tracer study to establish the actual modal contact time in the chlorine contact basin. The tracer analysis provides evidence of hydraulic inefficiencies within the chlorine contact basin reflective of geometric configurations. The modal contact time would be what would be applied to the CT calculations for design modifications to improve and maximize contact basin performance.

To develop a more representative data set for establishing the parameters for a basis of design, operating the BNRAS plant outside of its currently operated "flat-lined" condition (currently operating around a constant 10 MGD flow) is encouraged during the aforementioned study.

10. Jennifer Phillips presented a review of the observations made of the existing laboratory facilities. Of primary concern is the limited incubator space available for the studies described above. The laboratory staff recommends that COD rather than BOD, and E.coli rather than fecal coliform tests be run to minimize incubator space requirements. It will be necessary to ensure that a chlorine analyzer capable of reading low levels (below 100 ppb) be available for residual analyses.

11. Mike Gritzuk observed from the workshop discussions that there is an optimism amongst the PCWMD staff that meeting the BADCT disinfection requirements using a chlorination process is feasible. He raised the question: Is it necessary to fully "bullet-proof" the system (such as with using a UV with filtration), or, is the PCWMD willing to accept infrequent microbial maximums and address consequences thereof if encountered?

    Jeff Prevatt stated his confidence in meeting the microbial standards. Recent test results at the chlorine contact basin for the BNRAS (east) plant indicate greater than $1x10^6$ concentrations entering the chlorine contact tanks and less than $5x10^0$ concentrations exiting, resulting in a 5.5-log removal. From this data he believes the issue for Pima County will be meeting the chlorine residual standard in the permit. His evidence is the initial results for the log removal levels on the influent versus effluent of the BNRAS chlorine contact basins.

    Jim Doyle challenged the team's interpretation of the TSS and corresponding microbial data that illustrates an inverse relationship. He stated that the data was not representative of the specific time of day that samples are taken and the respective chlorine dosages applied at those times. He believes that if this were taken into account, results would not show this type of correlation. The team responded in that the data provided to them for analysis was that which the laboratory collects and analyzes daily, and this analysis was reflective of the data in the reports.

12. The group reached consensus that the enhanced chlorination process is appropriate for the PCWMD facilities, but that additional studies be conducted to generate the additional information needed to confirm the log removal requirements, and to establish a set of parameters to support a basis of design for the preliminary design of system upgrades, improvements and modifications to the existing system at the Ina Road BNRAS plant, and for new systems PCWMD plans to construct to replace the HPO (west) plant and the existing Roger Road plant. Implications are that the design criteria established and operations and control strategies developed would then apply to both treatment plants.

    It was agreed that the team would establish a scope of services for PCWMD to consider for these additional studies. It was agreed that these additional studies would be conducted over a three month period beginning as soon as practical. In the meantime, the Ina Road operations staff would begin looking at what is needed to operate the BNRAS system in a more normal diurnal mode (assuming that the equipment and controls necessary will be able to be placed in service without delay). The team was also asked to provide specific information to the PCWMD laboratory staff on the type and

number of analytical tests that will be necessary to complete the study. Further , the team was asked to investigate the possibility of an outside laboratory to provide all microbial testing services necessary to complete the laboratory portion of the studies.

Agenda
Enhanced Chlorination/Dechlorination Disinfection Process Review
May 23, 2007

Time	Topic	Presenter
1:00 pm	*Outlying Facilities Offices –4527 W. Walker Road (near intersection of Ina Road and I-10)*	
1:00 pm	Opening Session	Art Umble/Jerry Bish
	• Welcoming Remarks	
	• Review Agenda	
	• Program Goals	
1:45 pm	Literature Review	Larry Leong
	• BADCT: Other states and Arizona	
	• Comparable Facility Requirements and Performance	
	• System Performance With and Without Filtration	
	• Standards and Design Criteria: Can they be met?	
	• Implications of WET	
2:45 pm	*Break*	
3:00 pm	Operations Data Overview	Dave Murray
	• Review of Physical Systems	
	• Can Existing System Limitations Be Defined?	
	• Existing System Performance (data analysis)	
	• Existing System Deficiencies for Meeting Standards	
4:15 pm	Questions/Discussion	ALL
4:40 pm	Next Steps	Art Umble
	• Actions	
	• Schedule	
4:50 pm	Summary/Wrap-up	Art Umble
5:00 pm	Adjourn	

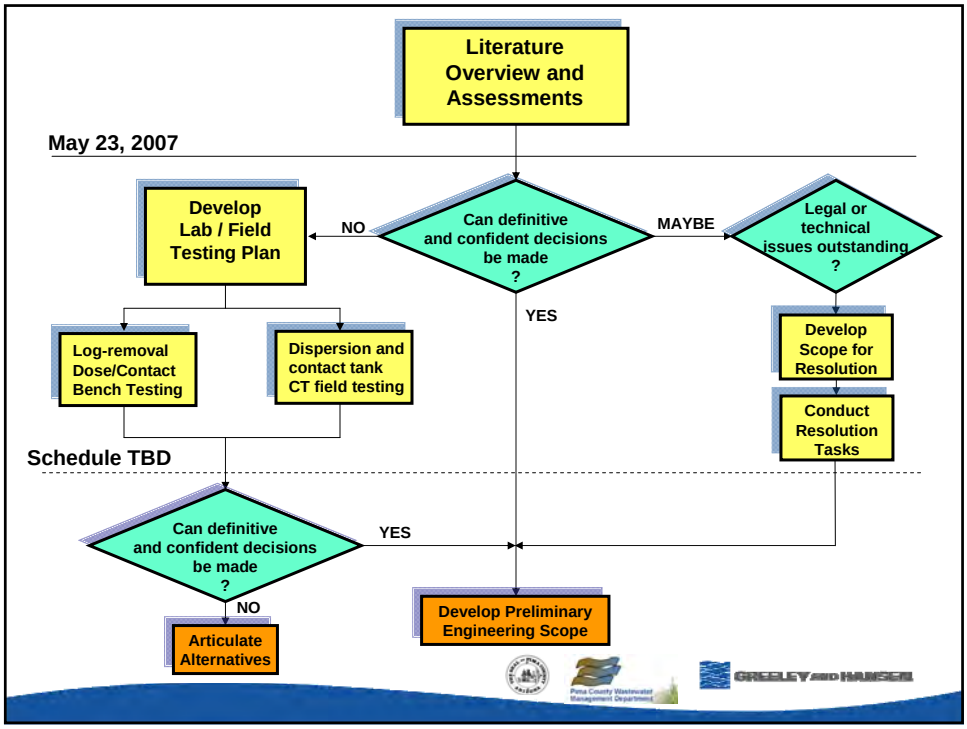
WORKSHOP:
Disinfection Process Review

Pima County Wastewater Management Department

May 23, 2007

Pima County WMD Program Goals

- Meet the BADCT Standards
- Meet a Class A+ Effluent Quality Discharge
- Minimize necessity of a $70M Expenditure if Filtration/UV is Req'd



WORKSHOP AGENDA

May 23, 2007

- Part 1: Literature Review
- Part 2: Disinfection Facility Assessments
- Part 3: Laboratory Facility Assessments
- Discussions / Clarifications / Debate
- Next Steps

Part 1: Literature Review

Larry Leong
Kennedy/Jenks Consultants

Organization of Literature Review Discussion

- BADCT, FL and CA regulations
- Enhanced chlorination issues
- Survey of practice
  - Disinfection
  - Bardenpho
- Estimated additional removal
- Proposed studies

Regulatory Review

AZ Title 18 - BADCT, APP, NPDES, Reclamation Rules w/B+ Treatment

- FC/*E. coli* limits
  - ND in 4 out of 7 samples per week
  - Single sample < 23 FC/100 ml or < 15 *E. coli*/100 ml
- TN <10 mg/l
- Disinfection byproducts
  - 0.1 mg/l Total THMs with 0.08 mg/l as Alert Level
  - Cyanide ?
- WET
- Chlorine

Florida Regulatory Framework Chapter 62

- Surface water disposal
  - Secondary treatment – 20/20 BOD/TSS
  - High-level disinfection
  - No degradation of background water quality
- Reclamation, discharge to potable water supplies
  - High-level disinfection
  - <10 mg/l TN
  - MCLs<specified for community water systems

Florida's High-Level of Disinfection

Chlorine contact tank Influent (FC/100 ml)	Required CT (mg/l•minutes)	Logs Removal (%)
≤1000	At least 25	3 (99.9)
>1000-10,000	At least 40	4 (99.99)
>10,000	At least 120	>4 (>99.99)

- Max TSS < 5 mg/l, 30 day period, chlorine contact tank influent
- 75 percent, ND in 30 day period
- Max sample in 30 day period, <25 FC/100 ml

California Regulatory Framework Title 22 – Purple Book

- CA regulates total coliform and enteric viruses
- Defines different TC treated water
- Constrains water use and imposes conditions

Applicable CA Treatment Goals

- Disinfected secondary-2.2 recycled water
- Disinfected tertiary recycled water

Secondary - 2.2 Recycled Water

- 7 day median <2.2 Total Coliform (TC)/100 ml
- 1 sample can exceed 23 TC/100 ml in 30 day period with max <240 TC/100 ml

Secondary-2.2 Recycled Water

- Surface irrigation of food crops where edible portion is produced above ground and not contacted by recycled water

Tertiary Recycled Water

- Filtered effluent
- CT of 450 mg/l•minutes with modal contact time of >90 minutes on peak dry weather design flow
- Demonstrated disinfection technology that removes 5 logs of Ms2 or polio virus
- 7 day median <2.2 TC/100 ml
- 1 sample can exceed 23 TC/100 ml in 30 day period with max <240 TC/100 ml

Tertiary Recycled Water

- Edible root crops where the recycled water contacts edible portions
- Parks and playgrounds
- School yards
- Residential landscaping
- Unrestricted access golf courses
- Other irrigation not prohibited by CCR
- Groundwater Recharge Reuse Projects

Groundwater Recharge Reuse Projects

- Project requirements
  - Surface water spreading
  - Retained 6 months as groundwater
  - < 20 percent recycled water
- Water quality constraints on tertiary effluent
  - TOC < 16 mg/l (weekly 24 hr composite average)
  - <MCLs, SMCLs, notification levels for drinking water
  - TN < 5 mg/l with single sample maximum of 10 mg/l (blended water, weekly 24 hr composite average)

Permit Specified Microbes

- AZ – virus monitoring and limits for Class A and A+
- FL – *Giardia* and *Cryptosporium* for reuse/discharge to drinking water
- CA – virus monitoring, historically; *None* if using 5 logs removal technology defined by DHS

Enhanced Chlorination Issues

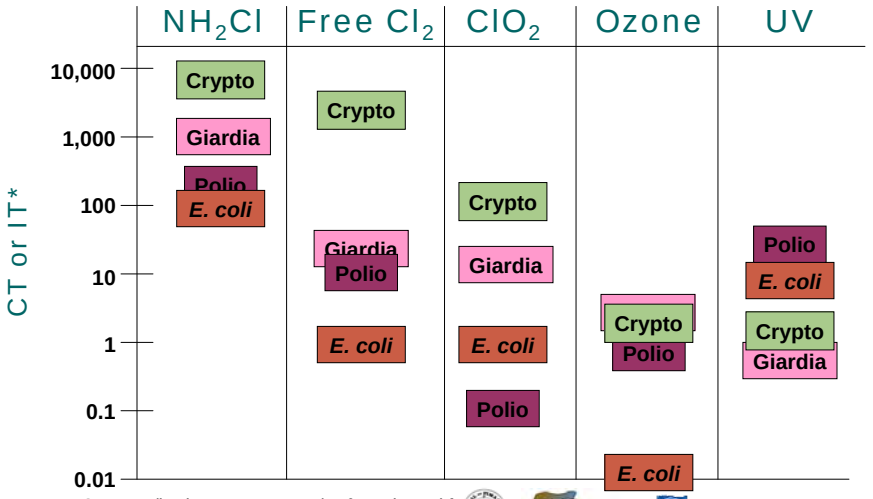
Current Issues

- > Max FC or *E. coli* with or without filters and with Chlorine and UV technologies
- WET testing – + for Chlorine and UV
  - Chlorine residual
  - Ammonia
  - Sulfite – oxygen?
  - Non-neutralized organochloramines (Blatchley, et al WERF 2005)
- Increased chlorine
  - Chlorinated DBPs (THMs & HAA5)
  - CN potential due to low limits, ~4 ug/l

Potential Future Issues

- Arizona
  - Enteric virus for >Class A recharged into potable aquifers
- Florida
  - *Giardia*, *Cryptosporium* and enterovirus for recycling
  - lower THMs/HAA5 than for drinking water
- California - Groundwater Recharge Recycling
  - NDMA,
  - very low THMs/HAA5
- Others – endocrine disruptors, etc.

Comparative Dose for 99% Inactivation in Drinking Water



*CT = mg/l*minutes IT = mJ/cm² Adapted from MWH, 2005

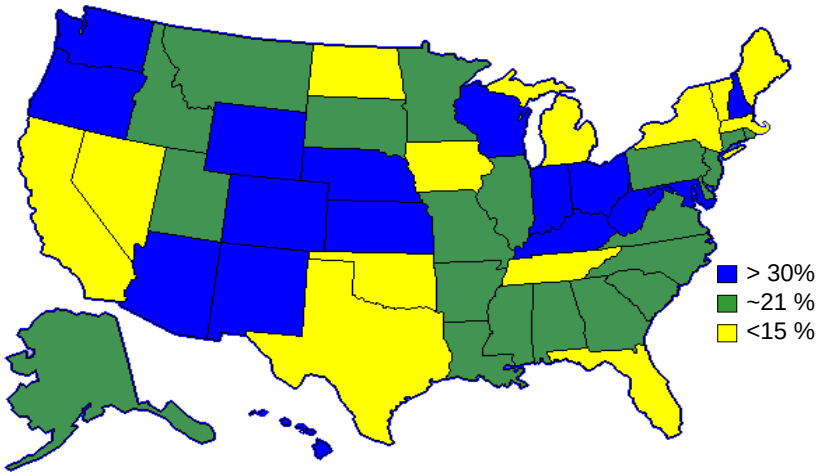
Survey of Practice

'06 US Profile of Major POTWs

(Total Major POTWs = 4,450)

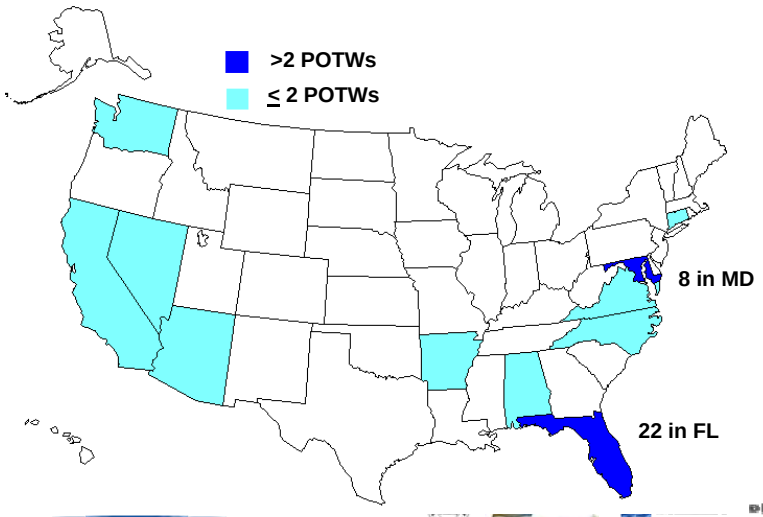
Disinfectant	Number	Percent
Chlorine	3,351	75.3
UV	930	20.8
Ozone	7	0.2
None	173	3.9

UV Disinfection at Major POTWs



45 Major POTWs Using Bardenpho

1-24 MGD, 27 % use UV



Profile of Similar Size for UV Disinfection and Bardenpho

Treatment Plant	Flow Range (MGD)	No. POTW	No. UV (%)	Bardenpho
Roger Road	22-42	149	25 (17%)	2 (22 & 24 mgd)
Ina Road	40-60	67	10 (15%)	0
Combined	72-92	18	1 (6%)	0

17 Major Bardenpho POTWs and Microbial Performance

Config-uration	Size (mgd)	No.	No. POTWs w/ Microbial Violations	
			Max	Average
UV	**17**	**1**	**1 (6)**	**0**
UV + Filters	**12,15**	**2**	**1 (2)**	**0**
Chlorine	**4-22**	**3**	**1 (1)**	**0**
Chlorine + Filters	**6-24**	**11**	**8 (25)**	**1 (1)**

( ) = total number of violations for category

17 Major Bardenpho POTWs and WET Performance

Config-uration	Size (mgd)	No.	No. POTW w/WET Violations	
			Flea	Minnow
UV	**17**	**1**	**1**	**0**
UV + Filters	**12,15**	**2**	**1**	**0**
Chlorine	**4-22**	**3**	**1 (6)**	**1 (4)**
Chlorine + Filters	**6-24**	**11**	**10 (23)**	**5 (25)**

( ) = total number of violations for category

THMs Violations at 7 POTWs

- Chlorine + Filters Config
- 37 total violations
  - 2 TTHM
  - 35 Single with 28 dichlorobromomethane
- Highly correlated with Max and WET violations (6 out of 7)

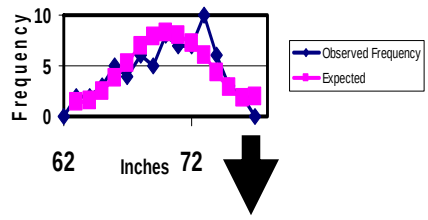
Phone Survey Highlights of 6

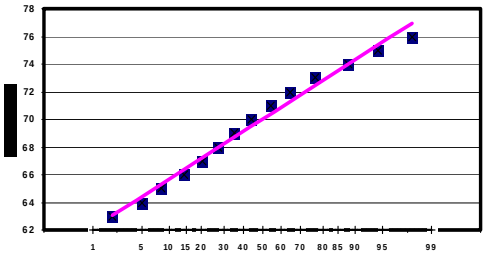
- No recollection of problems/violations after startup
- ~ 0.5-1 year to get plant under control
- Flotables/scum are issues
- High energy use, expanding using different treatment
- Filtration recommended for ≥ 4 ND

Estimated Additional Removal

Frequency Histogram to Linear Model

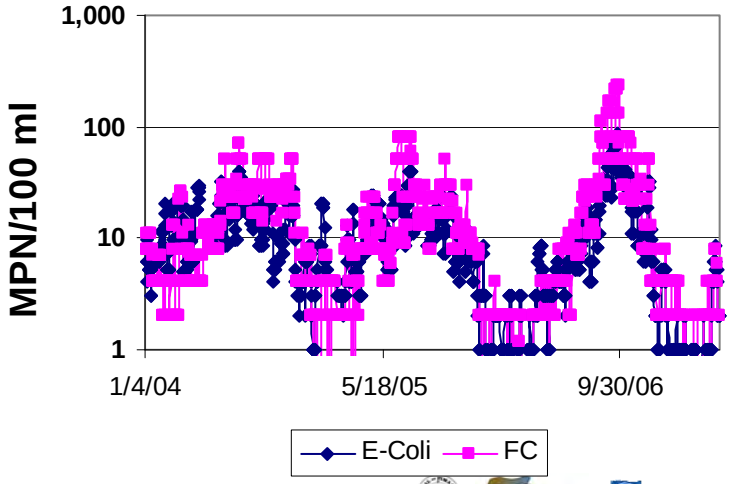
Height (in.)	Observed Freq	Expected Freq
63	2	1.51
64	2	1.53
65	3	2.5
66	5	3.79
67	4	5.28
68	6	6.96
69	5	7.85
70	8	8.34
71	7	8.09
72	7	7.18
73	10	6.01
74	6	4.28
75	3	2.9
76	2	1.79
77	0	1.97





Ina Road FC & *E. coli* Historical

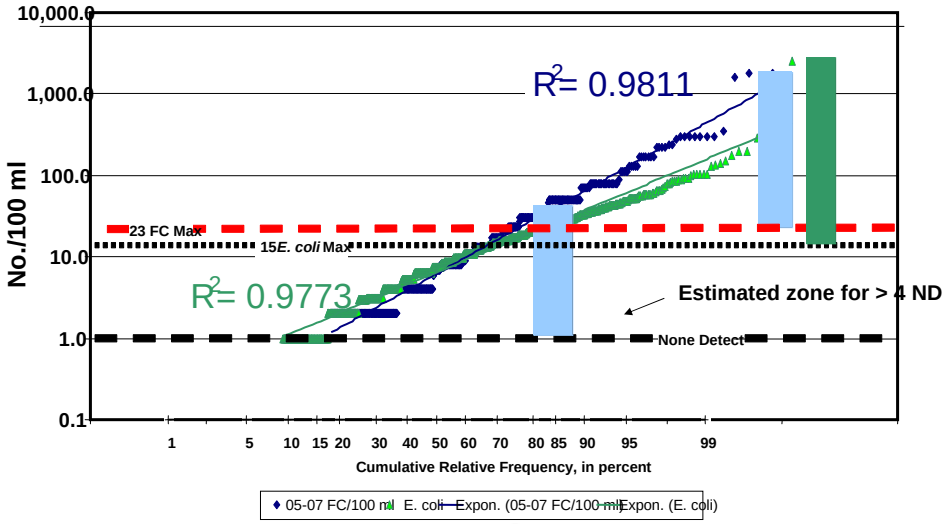
1 Jan 04 to 20 Apr 07



Convert to Frequency Distribution

- 1 Jan 04 to 20 Apr 07 FC and *E. coli*
- Determine frequency percent
- Plot and determine best linear fit

Estimated Removals to Meet BADCT



Results of Analysis

- FC and E. coli are log-normal
- ~ 1.5 logs needed for > 4 days ND
- ~ 2 logs needed for Max FC < 23
- ~ 2.2 logs needed for Max E. coli <15
- ~2.5 logs needed for current Ina Road influent, but Bardenpho influent likely to be lower than current

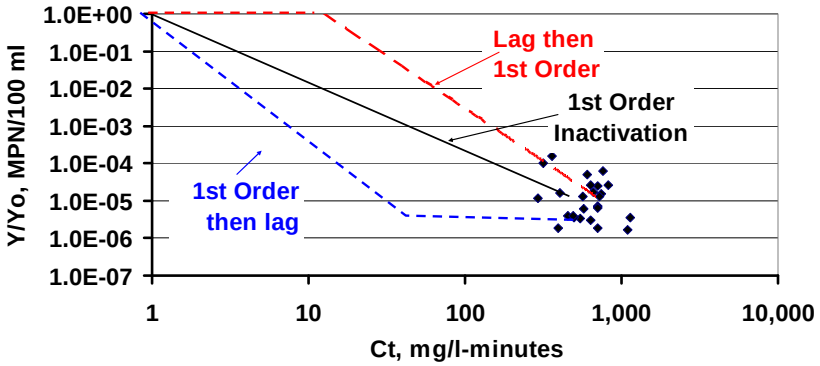
FC Removals for Different Secondary Effluent

Secondary Effluent	FC/100 ml	Estimated Removal to 4 ND (logs)
Activated Sludge	29,300	4.17 + 0.5 = 4.7
Nitrified AS	37,000	4.27 + 0.5 = 4.8
Biological Nutrient Removal	3,600	3.26 + 0.5 = 3.8

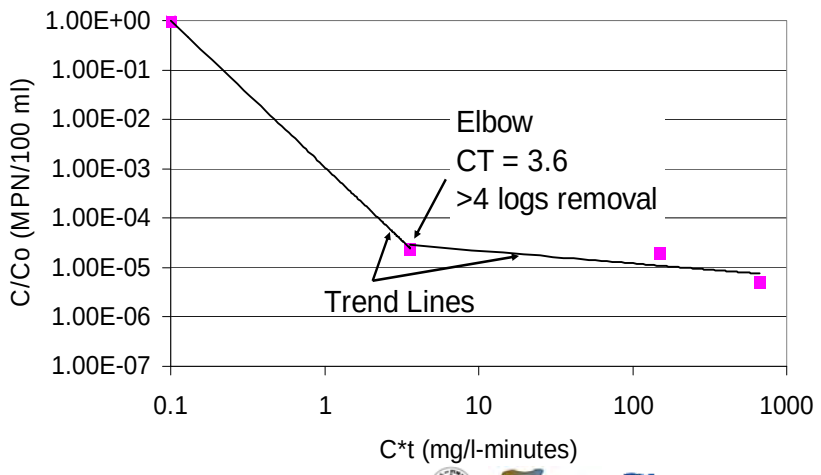
Rose, J., et al, WERF 2004

Proposed Studies

Potential Disinfection Kinetics

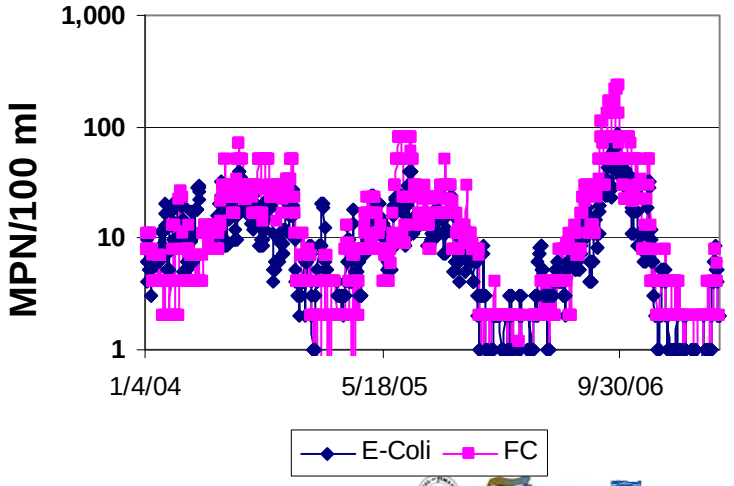


Full Scale California Study
First Order then Lag



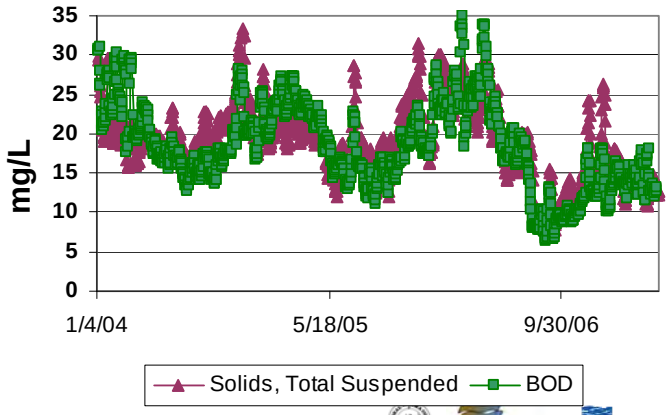
Ina Road Microbial

1 Jan 04 to 20 Apr 07



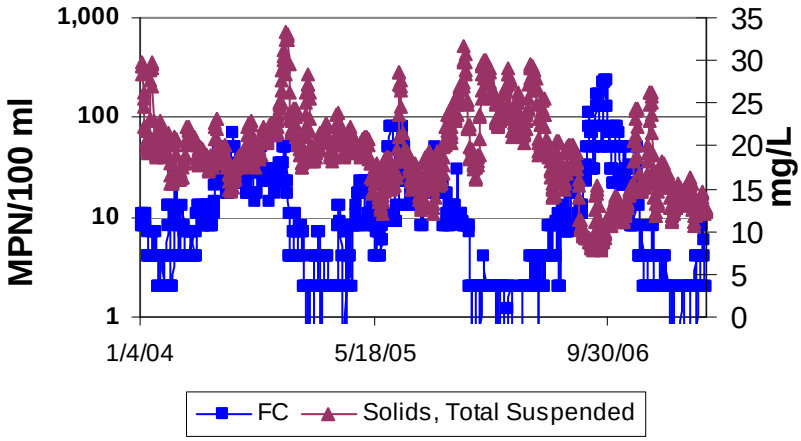
Ina Road BOD & TSS

1 Jan 04 to 20 Apr 07



Ina Road FC vs TSS

1 Jan 04 to 20 Apr 07



FC Historical Data

- Exhibits seasonality – winter & summer
  - FC peaks in summer
  - TSS peaks in winter
- TSS seems to have reverse correlation with FC, i.e., with high solids, lower chlorinated effluent FC

Proposed Bench & Field Studies

- Full-scale mixing with bench holding time to simulate chlorine contact tank (Study 1)
- Chlorine contact tank influent FC and or *E. coli* characterization (Study 2)

Study 1 Objectives

- Define BNRAS and therefore Bardenpho disinfection kinetics
  - If first order, perhaps filters not needed
  - If declining rate (elbow), perhaps filters may be needed
- Bench defines CT needed to meet BADCT

Study 1: Determine log-removals: Is there an elbow?

- BNRAS Effluent
- Full scale Water Champ mixing
- 0, 5 minutes, 30 minutes, 60 minutes holding times
- Analyze with 5 tube - 5 L, 100 ml, 10 ml for <0.02 FC MPN/100 ml reporting limit

Study 1 (cont.): Determine log-removals

- 5-7 trials per TSS conditions
- Normal and high TSS based on TU
  - Wait for high TU
  - Spike holding samples to simulate high TU
- Estimated time: 1-3 months depending on approach

Study 2 Objectives

- Determine seasonal variability of FC and *E. coli* concentrations
- Determine total logs removal to meet 4 ND
  - If > 6 logs needed, enhanced chlorine may not work
  - If <4 logs, perhaps without filtration may work
  - Something in between, filtration may need to be evaluated

Study 2: Characterize FC/*E. coli*

- 10-30 data points per scenario
- Potential scenarios
  - Seasonal – winter/summer
  - Plant performance – Low/high TSS
  - Others?
- Schedule – six months max

Pima County Wastewater Management Department

GREELEY AND HANSEN

Part 2: Facility Assessment

David Murray
Brown and Caldwell

Existing Disinfection Facilities

- Roger Road Facility
  - Sodium hypochlorite feed system
  - Contact basins
  - Initial mixing
  - Instrumentation and control
  - Dechlorination

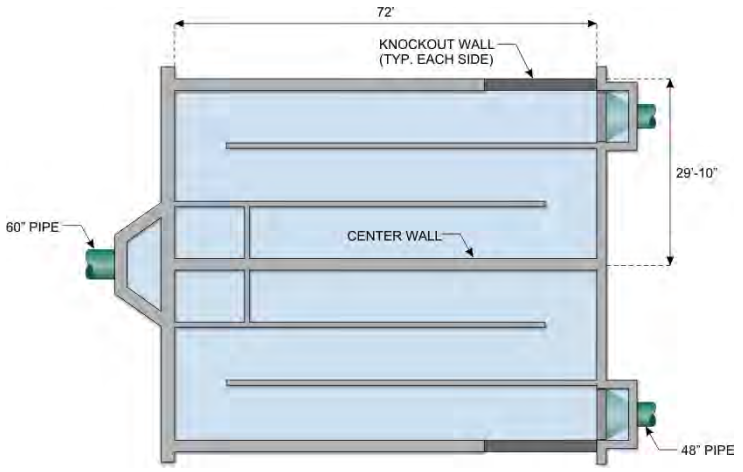
Existing Disinfection Facilities

- HPO (West) Plant
  - Hypochlorite feed
  - Initial mixing
  - Contact basins
  - Instrumentation and control

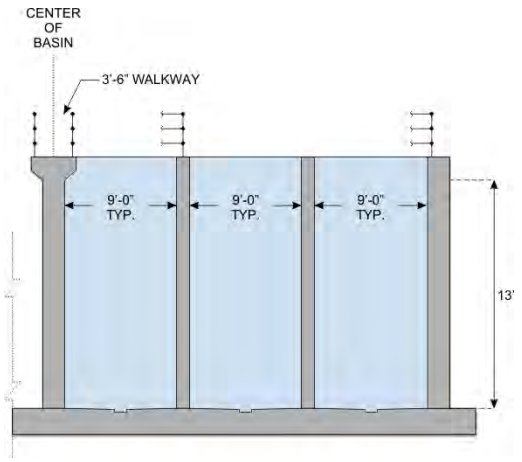
Existing Disinfection Facilities

- Ina Road BNRAS Facility
  - Hypochlorite feed
  - Initial mixing
  - Contact basins
  - Instrumentation and control

Ina Road East Chlorine Contact Basin – Plan

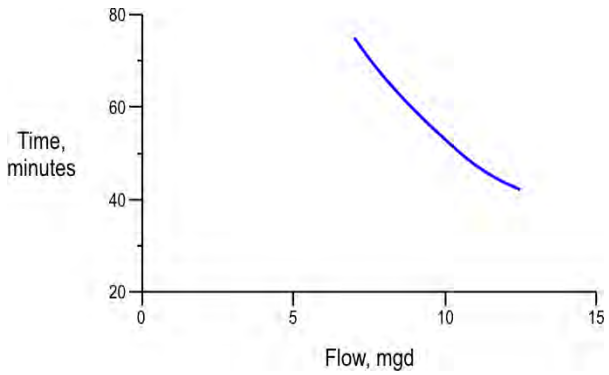


Ina Road East Chlorine Contact Basin – Cross Section

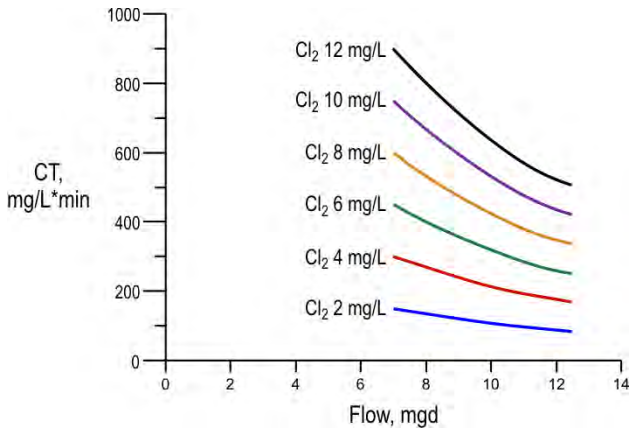


Existing Disinfection Operation and Contact Time

Ina Rd East (BNRAS) Plant CCB Contact Time vs. Flow Rate



Ina Rd East (BNRAS) Plant CCB CT vs. Flow Rate



Ina Rd East (BNRAS) Plant contact times

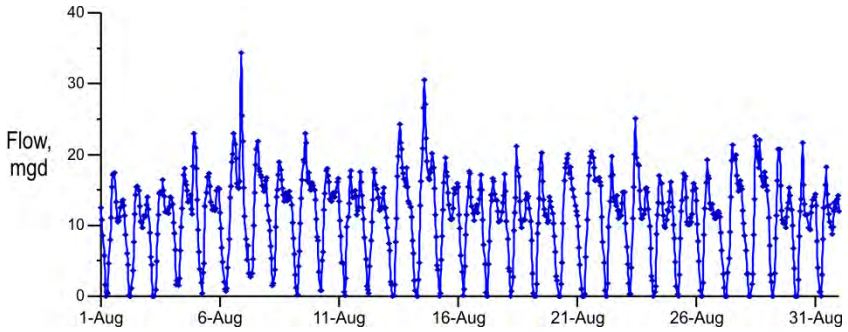
Flow (MGD)	7	10	12.5
Approx. chlorine residual (mg/L)[1]	2	2	2
Contactor residence time (min)	75	55	40
Pipe contact time (min)	40	25	20
CT in Contactor (mg/L*min)	150	110	80
CT in Pipe (mg/L*min)	80	50	40
Total CT (mg/L*min)	230	160	120

[1]Applied chlorine dose target is 2.5 mg/L

Summary of Ina Rd East (BNRAS) Plant operations

- Total chlorine residual primarily free chlorine
  - ammonia concentration ND
- Low initial chlorine demand
- Average residence times achieved in contactor
- Additional contact time in pipe flow prior to bisulfite quenching

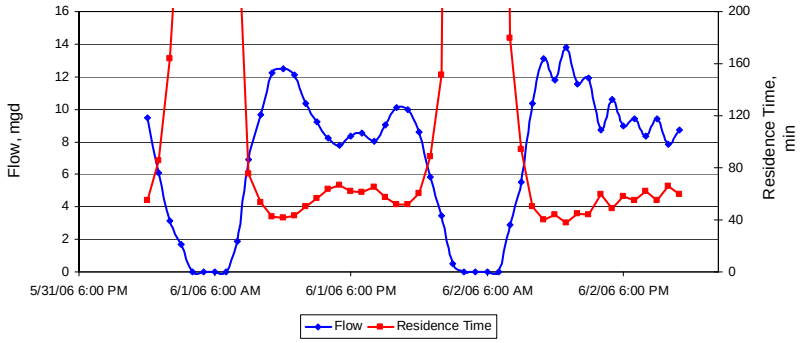
Ina Rd. West Plant theoretical flow



Assumptions;

- Total Flow **–** 12.5 mgd BNRAS **=** Ina Rd. West Plant Flow
- Wet Weather flow data from 2005
- 2005 total typical hourly flow values are representative of current flows

Ina Rd. West Plant CCB theoretical flow and residence time



Summary of Ina Rd. West Plant CCB flow and residence time

- Typical flows 8-12 mgd
  - 40 – 60 min residence time
- Max wet weather flow of 34 mgd
  - 15 min residence time
- 9 hours a day – flow less than 8 mgd
  - > 2 hr residence time
  - Stagnant
  - Great environment for microorganism growth

Ina Rd. West Plant contact times

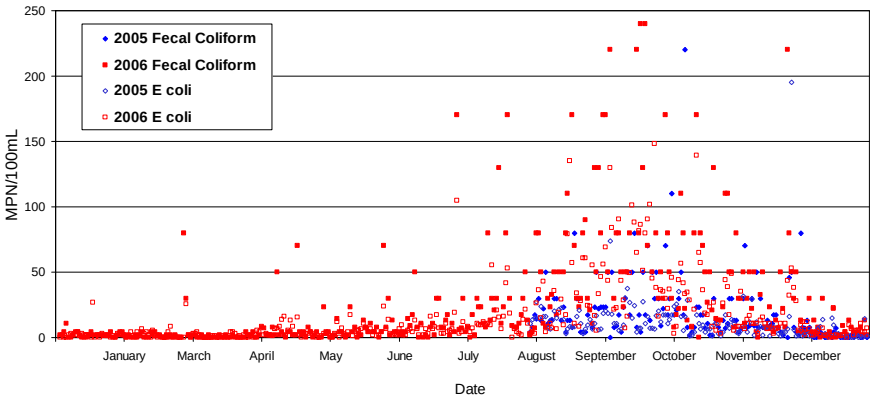
Flow (MGD)	9	34
Approx. chlorine residual (mg/L)[1]	2	2
Contactor residence time (min)	60	15
Approx. CT (mg/L*min)	180	30

[1]Applied dose approximately 6.5 mg/L with end residual of 1.7 mg/L

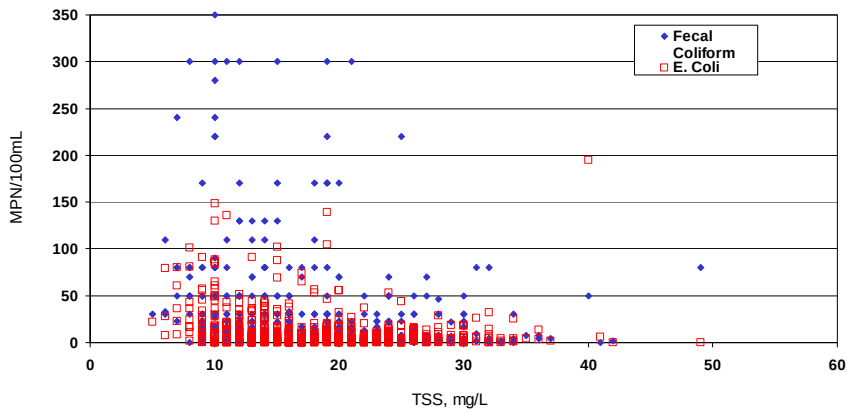
Summary of Ina Rd. West Plant Operations

- Low applied chlorine dose
- Total chlorine residual potentially mostly combined chlorine
  - Less efficient disinfectant
- Potential microorganism growth during lower flows
  - residual decay
  - microorganisms protected by TSS

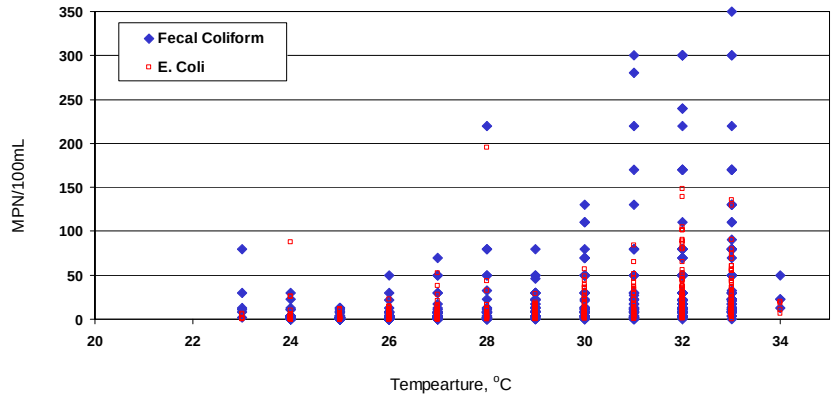
Fecal Coliform and *E. coli* concentrations increased in 2006



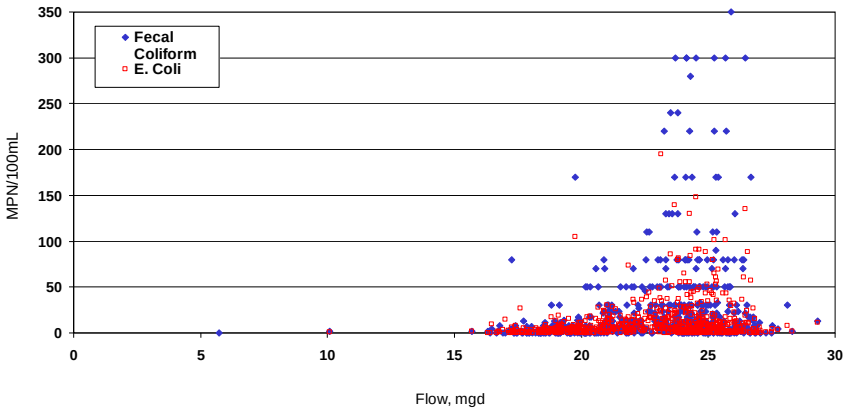
Fecal Coliform and *E. coli* versus TSS



Increase in Fecal Coliform and *E. coli* at higher temperatures



Increase in Fecal Coliform and *E. coli* at higher flows



Roger Rd. Plant contact times

Flow (MGD)	35	38	40
Approx. chlorine residual (mg/L)[1]	4.0	4.0	4.0
Contactor residence (min)	50	48	43
Contact time (mg/L*min)	200	192	172

[1] **Approximately 6.0 mg/L applied chlorine concentration**

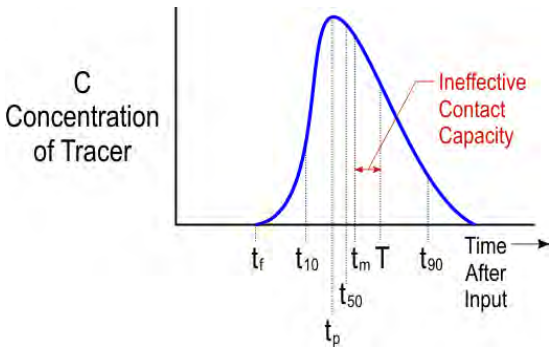
Summary of Roger Rd. operations

- Low applied chlorine dose
  - About 2 mg/L necessary to meet initial demand
- Total chlorine residual potentially mostly combined chlorine
  - Less efficient disinfectant
- Short residence time in contactors

Proposed Additional Studies

- Initial mixing optimization
- Contact basin dispersion
- Control optimization
- Chlorine residual/decay (volatilization) in contactor
  - Chlorine speciation

Contact Time Definitions



t_f = time at which the tracer first appears

t_p = time at which the peak concentration of the tracer is observed

t_{10} = time at which 10 percent of the tracer had passed through the reactor

t_{50} = time at which 50 percent of the tracer had passed through the reactor

T = the theoretical mean time

t_{90} = time at which 90 percent of the tracer had passed through the reactor

t_m = modal contact time

Initial Mixing Optimization

- To provide optimum contact between hypochlorite and influent to CCB
- Initial mixing should be as short and complete as possible
- Mixing can be evaluated with tracers

Contact Basin Dispersion

- Tracer studies to determine CCB efficiency
- Required to assess effectiveness
- Disinfection based on actual rather than theoretical contact time
- Can lead to basin improvements

Control Optimization

- Control by flow, oxidation reduction potential or chlorine residual
- Optimize placement of chlorine probes and sample points
- Can improve disinfection while reducing dose demand

Recommendations

- Identify chlorine concentration necessary to reach breakpoint chlorination (bench scale testing)
  - Each treatment plant
  - Determine combined vs. free chlorine concentrations
- Optimize current disinfection
  - Increase applied chlorine dose to achieve higher free chlorine concentrations
- Balance flow and chlorine concentration to Ina Rd. West Plant
  - Limit stagnant periods

Pima County Wastewater Management Department

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Part 3: Laboratory Assessment

Jennifer Phillips

Malcolm Pirnie, Inc.

Existing Laboratory Facilities

- Located at the Ina Road WPCF
- Comprised of three divisions:
  - Micro Lab
    - COD, BOD, TSS, F. Coliform, E. Coli, etc.
  - Nutrient Lab
    - Nitrate-N, Nitrite-N, TKN, ammonia-N, etc.
  - Organics Lab
    - Metals

Existing Laboratory Facilities

- Analyses typically completed within a week
- Lab reports available within two weeks
- QA/QC performed by a separate group
- QC check of analytical equipment - daily
- Calibration - quarterly

Existing Laboratory Facilities

- Incubator space limited
  - COD rather than BOD
  - E. Coli rather than Fecal Coliform
- Chlorine residual measured with HACH DR 2800
  - Manufacturer - specified Detection Limit = 10 ppb
  - Actual DL = 29 ppb (Method Detection Level study)
- On-line chlorine analyzer DL = 100 ppb
  - Cannot measure down to permit limits

Whole Effluent Toxicity (WET) Tests

- WET tests originally performed on-site
- 1999 waiver reduced WET test requirements
- Outside contract lab used presently
- Permit now requires increased WET testing
- County is considering resuming on-site WET testing

Use of Contract Laboratories

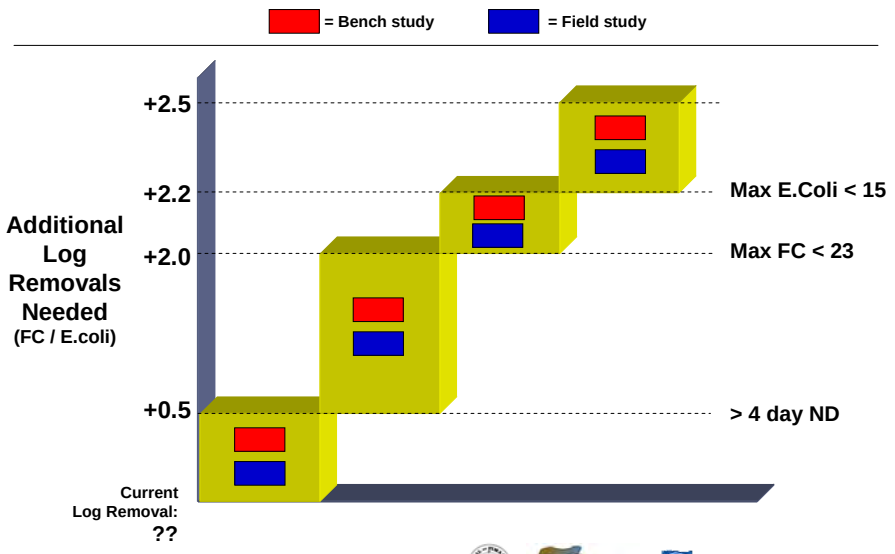
- Certified contract labs used
  - To relieve workload
    - Aquatic Consulting & Testing Inc., Tempe, AZ
  - For Whole Effluent Toxicity (WET) Testing
    - GEI Consultants, Inc., Littleton, CO

"Lab" Building at the Roger Road WWTP

- Located near the CCT
- Currently not in use
- Staff planning to use it as process control lab
- Has utility connections: Power, water, air, and possibly gas
- Could potentially be used for bench scale testing

Wrap Up & Summary

Enhanced Chlorination: with or without Filtration?



General Conclusions and Recommendations

OPINION:

- **Enhanced Chlorination has high probability of meeting the current BADCT**
- **Concern is high with Enhanced Chlorination meeting THM limits if free chlorine is dominant species**
- **Without Filtration:**
  1) **likely will meet 4-day non-detect**
  2) **potentially will not meet the FC and E.coli max**

SUGGESTED STUDIES/EVALUATIONS:

- **Gain confidence in understanding how the maximums can be met**
- **Provide information toward basis of design**

Team Contacts

- Art Umble
  Greeley and Hansen LLC
  aumble@greeley-hansen.com
  317-924-3380
- Larry Leong
  Kennedy/Jenks Consultants, Inc.
  949-261-1577
  LarryLeong@KennedyJenks.com
- David Murray
  Brown & Caldwell, Inc.
  503-977-6603
  dmurray@brwncald.com
- Sam Jeyanayagam
  Malcolm Pirnie, Inc.
  614-430-2611
  sjeyanayagam@pirnie.com
- Jennifer Phillips
  Malcolm Pirnie, Inc.
  602-241-1770
  jphillips@pirnie.com
- Jerry Bish
  Greeley and Hansen LLC
  602-778-8479
  jbish@greeley-hansen.com

Wrap Up

Questions

Discussion

Debates

Next Steps

Appendix G

Enhanced Chlorination / De-Chlorination

Workshop #3 – September 12, 2007

Enhanced Chlorination/De-Chlorination Evaluation
Laboratory and Field Study Results and Conclusions
Meeting Notes

1. Enhanced Chlorination/De-Chlorination Evaluation Workshop No. 3 regarding the future disinfection of the wastewater effluent in Pima County was held on September 12, 2007. The agenda is attached. The following were in attendance:

PCWMD
Deputy Directors
Jackson Jenkins
Mike Bunch
PCWMD Staff
Jim Doyle
Byron McMillan
Jeff Prevatt
Dave Bartos
Ed Jandali
Michael Kostrzewski
Mandley Rust
Ron Riska, Project Manager
Legal
Harlan Agnew

TUCSON WATER
Tucson Water Staff
Melodee Loyer
Wally Wilson

GREELEY AND HANSEN
Project Team
Jerry Bish
Art Umble
Larry Leong, Kennedy/Jenks
David Murray, Brown and Caldwell
Jennifer Phillips, MPI
Sam Jeyanayagam, MPI

2. Major topics of the workshop were:

- Review results from laboratory and field studies performed during July and August 2007
- Review implications of results in terms of BADCT compliance
- Review recommended improvements to existing BNRAS chlorine contact basin to enhance the disinfection efficacy
- Establish disinfection criteria for future facilities upgrades and expansions

A set of handouts of the presentation was provided to each attendee of the workshop. The following is a brief summary of the discussions and results.

3. Kinetics Studies

Results of the two studies conducted to examine the log inactivation of E.coli were presented. The basic conclusion was that the system is likely to meet the BADCT's requirement of 4 days of E. coli (or fecal) non-detects out of 7 days based on the current operational mode for the BNRAS plant, and the current chlorine contact basin design and operation of the chlorination injection system.

The challenge with the current system is consistently meeting the single sample maximum limits for E. coli of 15 colonies per 100 ml. If no improvements were made to the existing system, on average log inactivation achievable is greater than 4 logs. But under the system's "worst case" operating

condition (i.e., E. coli concentrations in the secondary effluent being at their maximum--based on measured data--at the same time the chlorine contact basin exhibits its poorest level of performance), this inactivation drops to 2.3. It is under this scenario that the system is vulnerable to a single sample maximum limits violation.
To reduce the vulnerability of single sample maximum violations, achieving a 5-log inactivation in the average condition is necessary. The kinetics generated by the modeled results indicate that greater than 5-log inactivation for an average is feasible. But since the field study data shows that only slightly higher than 4-logs are being achieved on average, this indicates that there is a strong possibility that the existing facility can be improved. Extrapolation of the kinetics results indicates that to achieve a 5-log inactivation, a CT of approximately 85 mg/L*min is needed. Achieving this means that adjustment to the chlorine (hypochorite) dosage and upgrades to the chlorine contact basin are necessary to boost the CT.

For purposes of conceptual design, a target of 100 mg/L*min will be used for any new chlorine contact basin construction at the metropolitan Pima County wastewater treatment facilities requiring disinfection. Upgrades in design features of the contact basins focus on two improvement areas: 1) mixing of the sodium hypochlorite into the bulk fluid, and 2) improving the plug flow nature of the contact basin. Modifications discussed related only to the existing BNRAS chlorine contact basin, but the basic modification requirements would apply to the high purity oxygen chlorine contact basin which is planned for use in the expansion and upgrades at the Ina Road WPCF. In the new, and expanded and upgraded facilities, provisions should be provided to modify the CT up to 450.

4. Field Studies

Results from two detailed field studies were presented. These were: 1) tracer results reflecting the mixing regime of the WaterChamp mixing in the influent chamber and the turbine mixers in the flash mix chambers, and 2) degree of dispersion of the plug flow as the flow travels through the contact basin. Results indicate that mixing in the influent chamber can be improved by adding a second WaterChamp unit and positioning these to more central points in the chamber. An alternative would be to use just one WaterChamp unit, but place it parallel to the influent flow with its injection discharge positioned upstream in the flow path.

PCWMD staff suggested that the team also consider use of a static mixing regime in the channel upstream of the influent chamber to minimize any need for modifications to the influent chamber or to the chlorine contact tank.

Upgrades to the flash mixing chamber include consideration of removing the mixers from service due to the significant degree of back-mixing that these mixers create, thereby dramatically reducing the plug flow efficiency in the channel.

Upgrades to the chlorine contact tank include placement of corner fillets, a longitudinal baffle in the first pass, and a perforated transverse baffle at the end of the first pass, all of which would improve the plug flow characteristics. Hydraulic head considerations must be examined before any of these options, particularly the perforated transverse baffle, are installed.

5. pH Shift

The concept of shifting the operational pH of the water was presented as an option to consider for improving the effectiveness of the disinfection strength. Though this option was not presented as a formal recommendation, it was suggested that the PCWMD staff may want to include this in their internal deliberations of measures to investigate for further improving the disinfection system performance. This could be a factor if and when disinfection by-products become a regulatory issue for Pima County.

6. Additional Studies Recommended

It was clarified for the attendees that the results of these studies did not address the implications of the enhanced chlorination process on whole effluent toxicity (WET) assays or on the formation of disinfection by-products (DBP). It was suggested that the PCWMD laboratory director consider conducting a series of bench-scale tests to determine what, if any, impact on the WET and DPB elevated levels of chlorine dose might create. It was also suggested that a set of jar tests be run to determine the probable levels of chlorine dose that will be necessary to support the CT = 100 mg/L*min target. It is likely that the dosage will be at least double (4 mg/L to 6 mg/L) what is currently practiced (2 mg/L) at the BNRAS facility.

7. Consensus

The project team, consisting of Larry Leong (Kennedy/Jenks Consultants), David Murray (Brown & Caldwell), Sam Jeyanayagam (Malcolm Pirnie), Jennifer Phillips (Malcolm Pirnie), and Art Umble (Greeley and Hansen) agreed unanimously on the conclusions of the studies and the proposed recommendations. The PCWMD staff present accepted the team's recommendations.

The project team will prepare a final report that summarizes the studies, results, conclusions and recommendations. Upon acceptance by PCWMD, this report will then become an appendix to the Regional Optimization Master Plan and the report recommendations incorporated into disinfection requirements for the new and expanded and upgraded facilities.

Agenda
Enhanced Chlorination/Dechlorination Disinfection Process Review
May 23, 2007

Time	Topic	Presenter
1:00 pm	*Ina Road WWTP Offices*	
1:00 pm	Opening Session • Welcoming Remarks • Review Agenda • Program Goals	Jerry Bish/Art Umble
1:15 pm	Results of Kinetics Studies • Data analysis • Implication of results for BADCT	Larry Leong
2:00 pm	Velocity Profiles & Chlorine Residual Decay • Study results from tests on West HPO Plant CCB • Results of E.coli inactivation study (August 2007)	Jeff Prevatt
2:30 pm	Field Study Results • Mixing analysis • Tracer dispersion analysis • Implications for BNRAS CCB	Dave Murray
3:15 pm	Recommendations for BNRAS CCB Upgrades	Art Umble
3:45 pm	Open Discussion • Consensus • Next Steps	Jerry Bish/Art Umble
4:00 pm	Adjourn	

WORKSHOP:
Enhanced Chlorination:
Field Studies – Protocols, Results, Conclusions

Pima County Wastewater Management Department

September 12, 2007

Overview of Workshop Purpose

- Review of Project Objectives
- How did we get to this point?
- Review of the Field Study Objectives
- What decisions need to be made today?

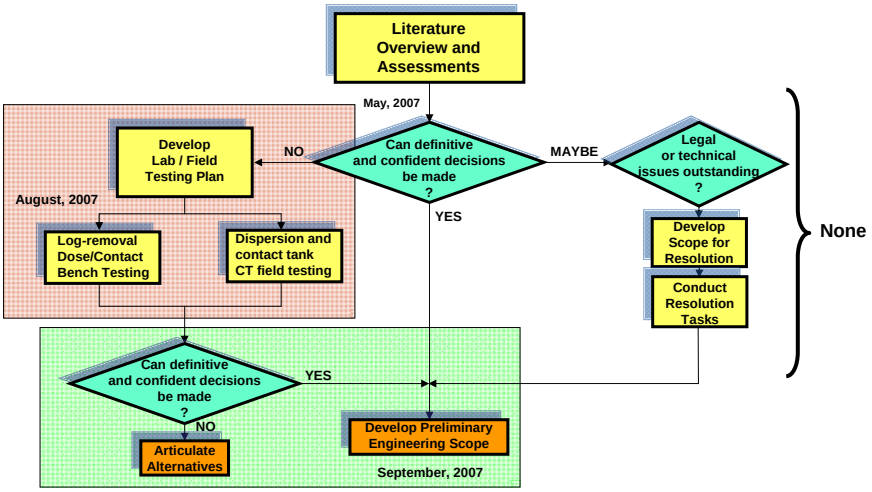
AGENDA

- Review of the Kinetics Analysis
- Review of the Field Study Results
- Overview of Opinion
- Overview of Recommendations
- Next Steps

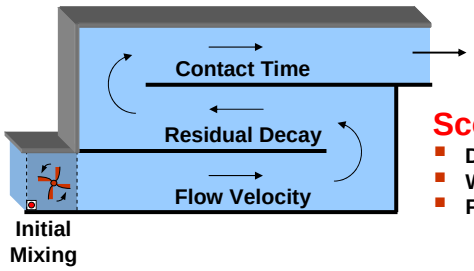
Review of Primary Objectives

- PCMWD intends to meet BADCT
- PCMWD desires to produce a Class A+ effluent quality
- PCMWD desires to eliminate the need for Filtration + UV because of the economic impact on the utility

Review of Decision Process



General Technical Approach



Scope Does NOT Address:

- Dechlorination efficiency
- WET "Reasonable Potential to Exceed"
- Formation of DBP

Scope Addresses Several Essential Questions

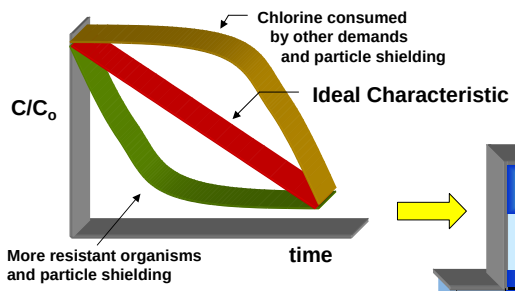
- What removal is required of the system to reach BADCT?
- What is the overall removal "capability" of the system?
- How do CCB physical characteristics relate to the disinfection efficiency?
- Can the physical system be modified to improve efficiency?

General Technical Approach

- Kinetics: What are the rate and characteristics of bacterial inactivation?
- Mixing Efficiency: How effective is the mixing energy at "breaking up" the particulates that shield organisms?
- Flow Efficiency: What is the relationship between the flow regime and the contact time of exposure?

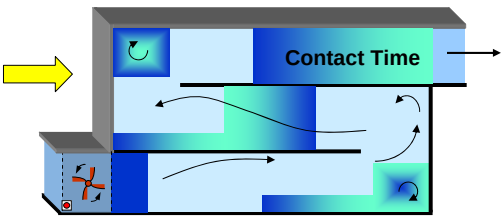
General Technical Approach

Rate and Characteristic of Inactivation



Fundamental Design Parameter

(C) x (T)



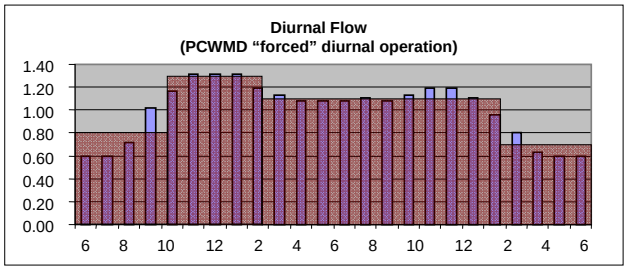
Dosage affects potential for exposure → inactivation

Mixing affects degree of dosage distribution → exposure

Flow regime affects dispersion → contact time

General Technical Approach

- Studies conducted under pseudo diurnal flow pattern through BNRAS



6AM – 10AM ➔ $0.8Q_{ave}$
10AM – 2PM ➔ $1.3Q_{ave}$
2PM – 1AM ➔ $1.1Q_{ave}$
1AM – 6AM ➔ $0.7Q_{ave}$

Pima County Wastewater Management Department

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Part 1: Kinetics Study – Protocol; Results; Conclusions

Jeff Prevatt
Larry Leong

Summarize Results

- Two Studies
  - Kinetic Study – Evaluation of Site Specific Disinfection Behavior
  - 27-Day Study – Determine Disinfection Removal Goals
- Observations, Recommendations

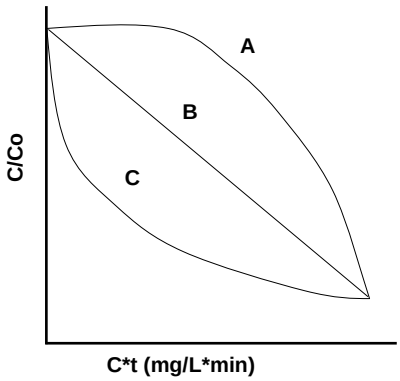
Kinetic Study*

- Sampling locations
  - Secondary Effluent
  - Collected replicate samples, just outside mixing chamber = 2.25 minutes @12.5 MGD
  - Held for 5 to 90 minutes, neutralized, then tested
- Determine Total Coliform and *E. coli* in triplicate
- Nine trials on different days

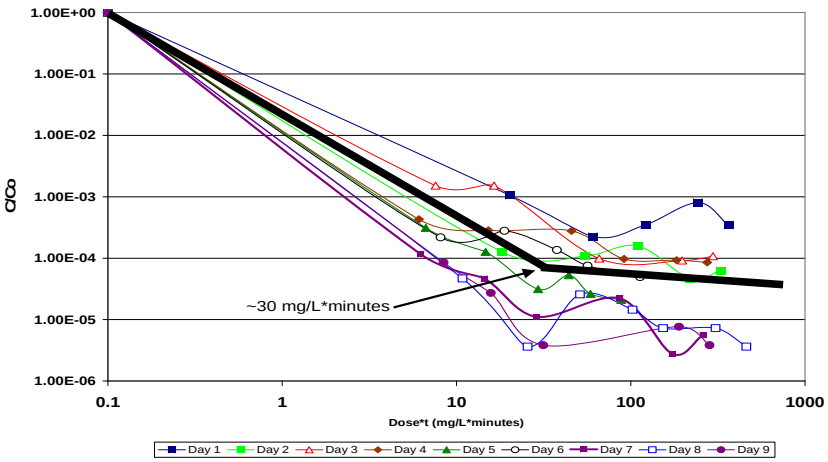
*PCWMD performed study

Typical Disinfection Kinetic Curves

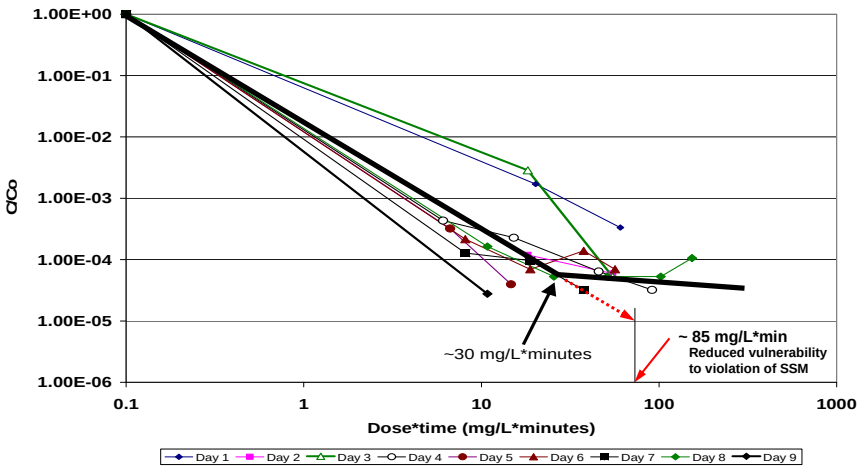
- A. Convex – initial lag
- B. Linear – 1st Order
- C. Concave
  - Multiple resistance
  - Clumps
  - Imbedded in particles or TSS



Total Coliform Kinetics



E. coli Kinetics



27-Day Study*

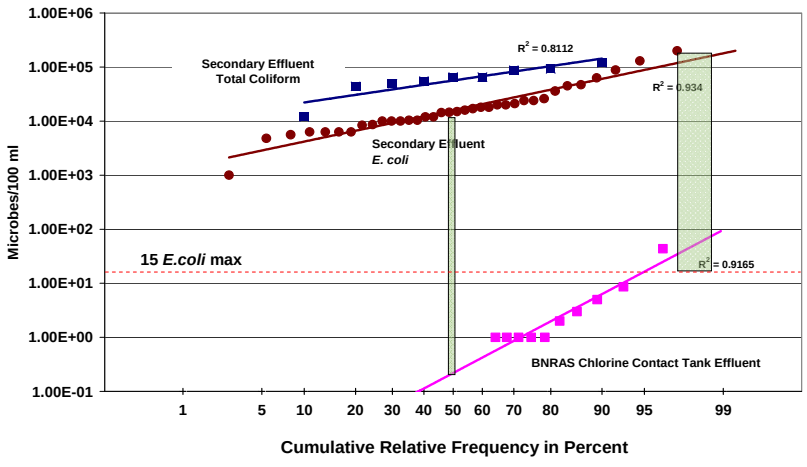
- 17 May to 10 July
- BNRAS base loaded @ constant flow
- Sampled at Secondary and Chlorinated BNRAS Effluent
- Tested for *E. coli*
- Evaluated observed & modeled results

***PCWMD performed study**

Modeling Approach

- Convert Data to Z Distribution
- Determine "average" removals
- Determine "extremes" of the distribution

BNRAS 27-Day Study



Four ND per Week Likely to be Met

- If reporting limit is 2 MPN/100 ml, 80 % of the time <2 with ~4.5 logs inactivation (modeled)
- 4 out of 7 = 57 % is BADCT req't
- Current BNRAS operations and contact basin design likely to meet 4 ND out of 7 samples per week

27-Day Observed Vs Modeled

Data Source	Samples	Median	Min	Max
E. coli detected in CCT Effluent (MPN/100 ml)	10	1.5	1	43.7
Observed Log Inactivation	10	4.05	2.29	4.26
Modeled Log Inactivation	10	>5	3	>5

These results indicate that bench-scale tests do not adequately represent the physical characteristics of the CCB…
…this implies that possibility of improving the full-scale system exists.

Meeting Max Limit may be Problematic

E. coli Max. = 15 microbes/100 mL
Fecal Max. = 23 microbes/100 mL

- From Kinetic Study
  - 200,000 = max *E. coli* observed and applying min kinetic log activation (3.5 logs) ➔ 66 *E. coli*

3.82 log is required for 95% meeting max

Meeting Max Limit may be Problematic

- From 27-day Study (under existing facility conditions)
  - 1 over *E. coli* Max out of 27 sample = 3.7 %
    For 365 days @ 3.7% ➔ 14 days of *E. coli* > Max*
  - 200,000 max *E. coli* observed + min log inactivation observed (2.29 logs) ➔ 1,025 *E. coli***

***This is based ONLY on a test performed in a 27-day summer condition**
****Worst case may be an unrealistic condition: highest secondary effluent *E.coli* coupled with lowest *E.coli* removal through disinfection (data does not reflect that this condition exists).**

Compliance Challenge for Meeting the Single Sample Maximum

Compliance Level (% of time)	Logs of Inactivation	Modeled Violations* of Max *E. coli* (Days/Year)
100	>4.12	0
95	3.94	18
90	3.7	36

***This is based ONLY on a test performed in a 27-day summer condition**
****Worst case may be an unrealistic condition: highest secondary effluent *E.coli* coupled with lowest *E.coli* removal through disinfection (data does not reflect that this condition exists).**

Study Vs Full Scale CCB Results

- 1.2 logs less inactivation by CCB at full scale
  - Min Kinetic Study = 3.5 logs removal
  - Min of full scale CCT = 2.29 logs removal
- This indicates that improvements to the CCB hydraulics (mixing and flow) may help provide the additional inactivation desired

Pima County Wastewater Management Department

GREELEY AND HANSEN

Part 2: CCB Chlorine Residual Decay Profile Results; Conclusions

Jeff Prevatt

Pima County Wastewater Management Department

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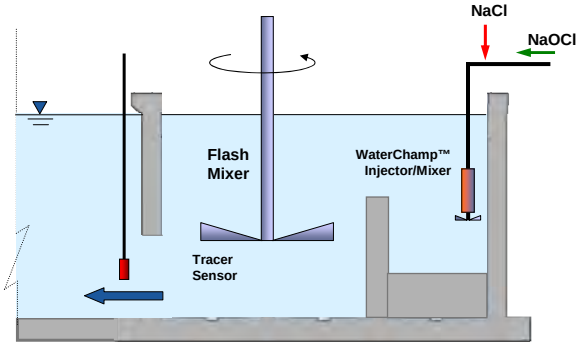
Part 3: CCB Velocity Profile Results; Conclusions

Jeff Prevatt

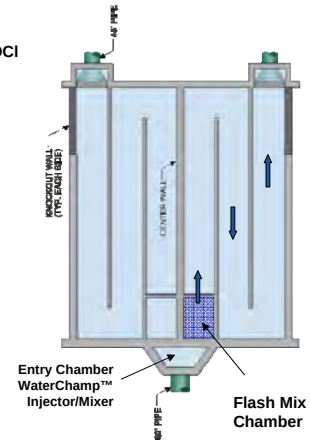
Part 4: Mixing Study – Protocol; Results; Conclusions

David Murray

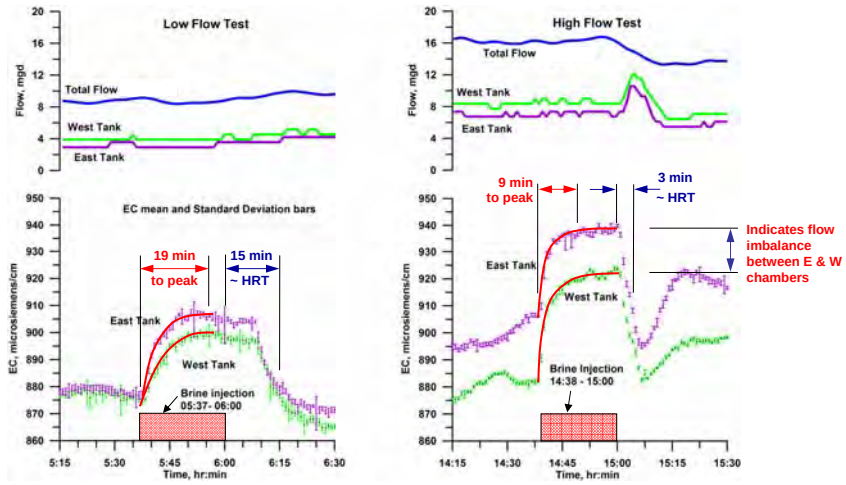
Disinfectant Mixing Analysis



Flash Mix Chamber



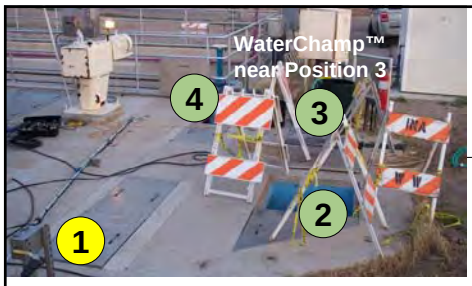
Disinfectant Mixing Analysis



Mixing Analysis

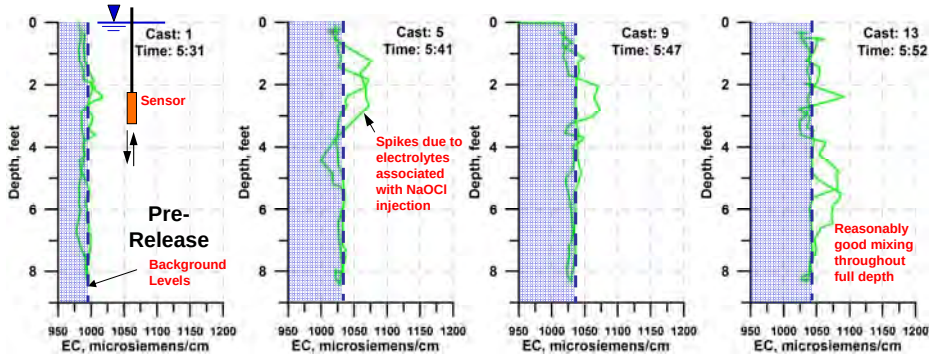
Entry Chamber Vertical Profiles

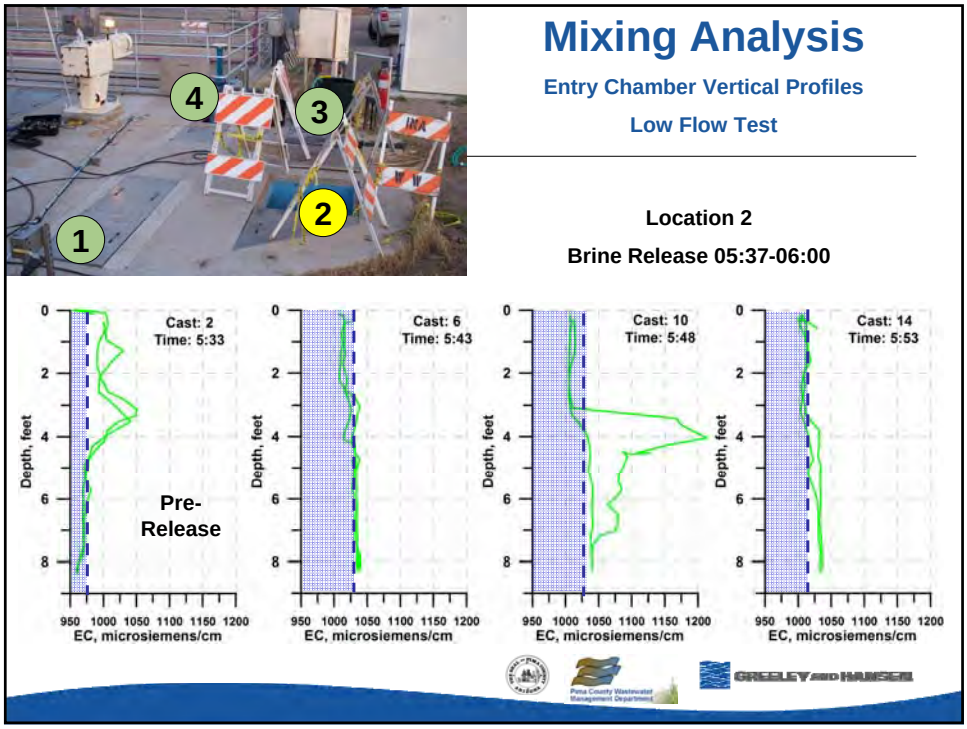
Low Flow Test

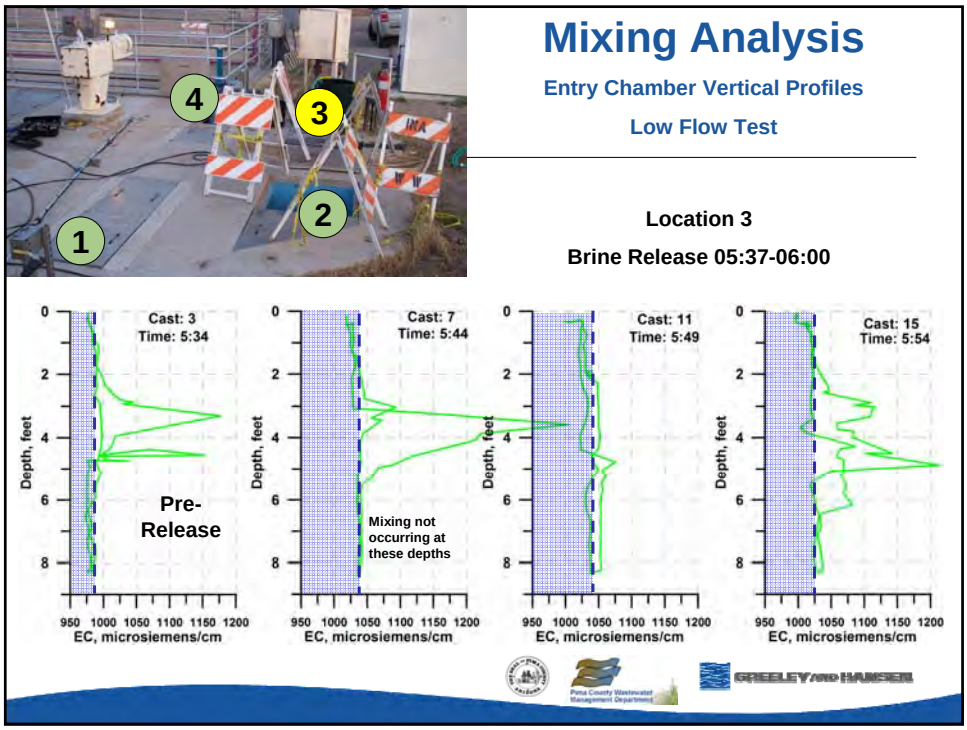


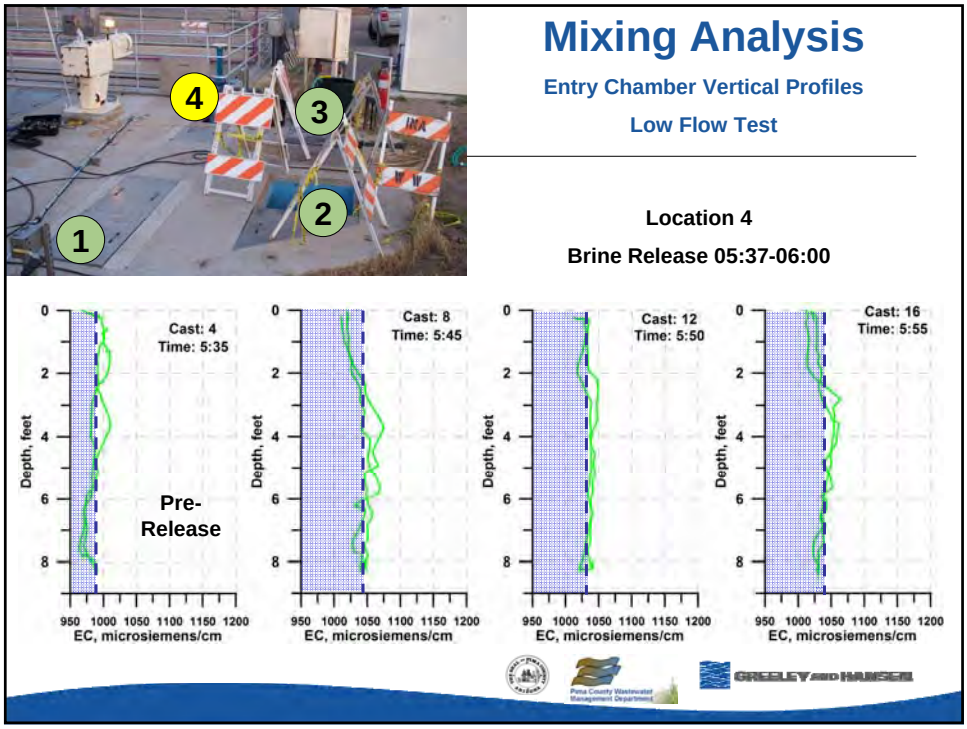
Location 1

Brine Release 05:37-06:00




Mixing Analysis
Entry Chamber Vertical Profiles
Low Flow Test
Location 2
Brine Release 05:37-06:00
1
2
3
4
Cast: 2
Time: 5:33
Pre-
Release
Cast: 6
Time: 5:43
Cast: 10
Time: 5:48
Cast: 14
Time: 5:53
Depth, feet
EC, microsiemens/cm
0
2
4
6
8
950 1000 1050 1100 1150 1200


Mixing Analysis
Entry Chamber Vertical Profiles
Low Flow Test
Location 3
Brine Release 05:37-06:00
1
2
3
4
Cast: 3
Time: 5:34
Pre-
Release
Cast: 7
Time: 5:44
Mixing not
occurring at
these depths
Cast: 11
Time: 5:49
Cast: 15
Time: 5:54
Depth, feet
EC, microsiemens/cm
0
2
4
6
8
950 1000 1050 1100 1150 1200


Mixing Analysis
Entry Chamber Vertical Profiles
Low Flow Test
Location 4
Brine Release 05:37-06:00
4
3
2
1
Cast: 4
Time: 5:35
Cast: 8
Time: 5:45
Cast: 12
Time: 5:50
Cast: 16
Time: 5:55
Pre-
Release
Depth, feet
EC, microsiemens/cm
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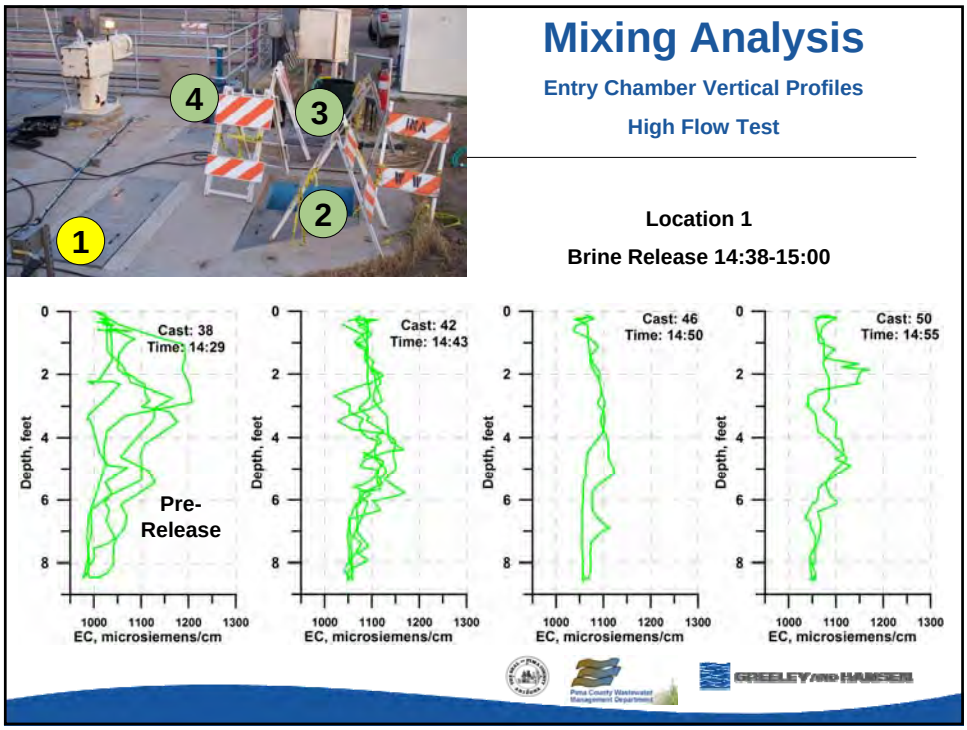
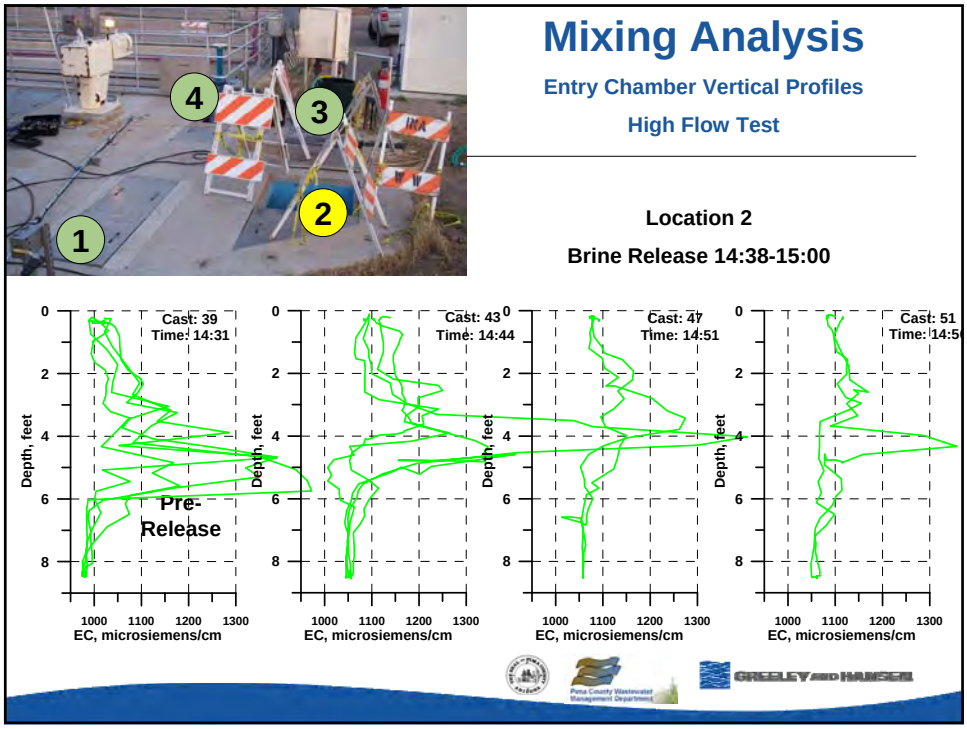
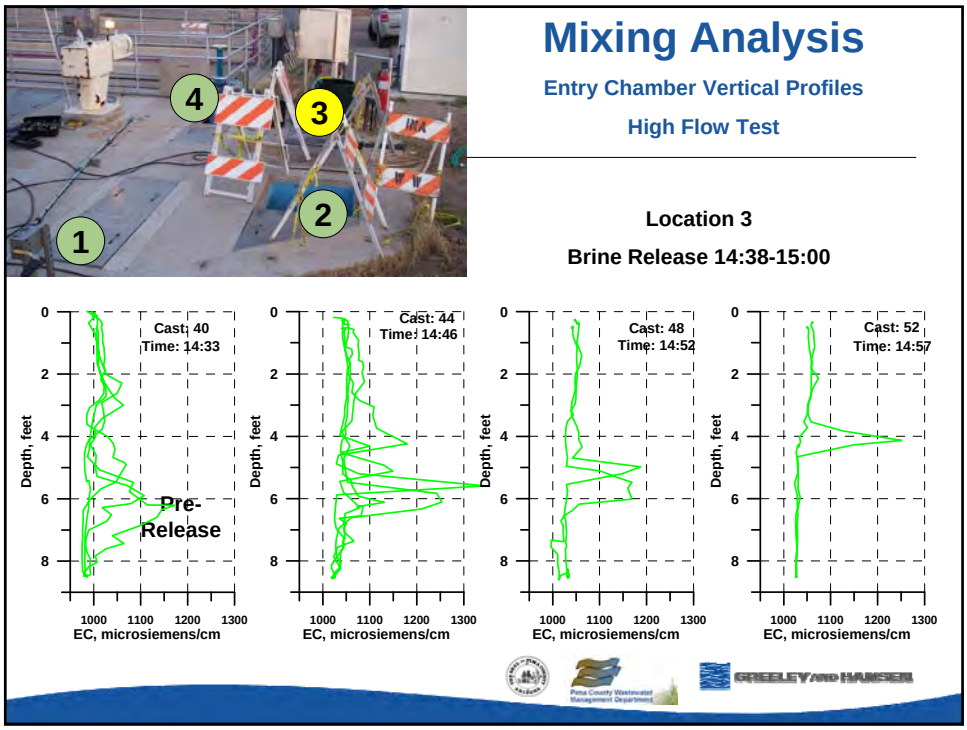
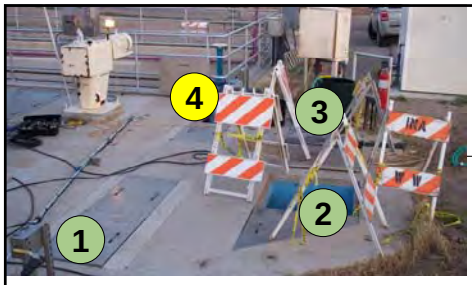

Mixing Analysis
Entry Chamber Vertical Profiles
High Flow Test
Location 1
Brine Release 14:38-15:00
4
3
2
1
Cast: 38
Time: 14:29
Cast: 42
Time: 14:43
Cast: 46
Time: 14:50
Cast: 50
Time: 14:55
Pre-
Release
Depth, feet
EC, microsiemens/cm
GREELEY AND HANSEN


Mixing Analysis
Entry Chamber Vertical Profiles
High Flow Test
Location 2
Brine Release 14:38-15:00
1
2
3
4
Cast: 39
Time: 14:31
Cast: 43
Time: 14:44
Cast: 47
Time: 14:51
Cast: 51
Pre-
Release
Depth, feet
EC, microsiemens/cm
0
2
4
6
8
1000
1100
1200
1300


Mixing Analysis
Entry Chamber Vertical Profiles
High Flow Test
Location 3
Brine Release 14:38-15:00
1
2
3
4
Cast: 40
Time: 14:33
Cast: 44
Time: 14:46
Cast: 48
Time: 14:52
Cast: 52
Time: 14:57
Pre-
Release
Depth, feet
EC, microsiemens/cm
0
2
4
6
8
1000
1100
1200
1300



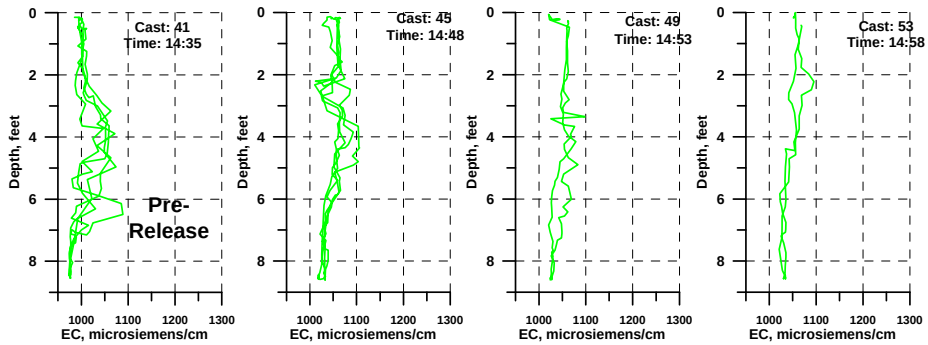
Mixing Analysis

Entry Chamber Vertical Profiles

High Flow Test

Location 4

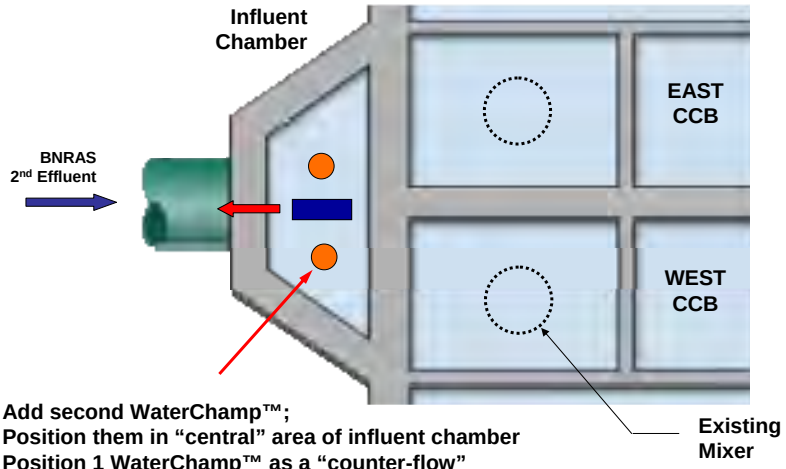
Brine Release 14:38-15:00



Conclusion from Mixing Study

- Mixing in the East and West chambers are similar in characteristic
- Mixing during low flow conditions is inadequate
- Mixing during high flow conditions is reasonable
- Vertical mixing in entry chamber is reasonable
- WaterChamp™ appears to be providing mixing but its position in the influent chamber is not ideal
- Modifications to the chamber should be done to reduce mixing time-to-peak and improve vertical mixing efficiency

Possible Modifications to Mixing Chamber



1. Add second WaterChamp™; Position them in "central" area of influent chamber
2. Position 1 WaterChamp™ as a "counter-flow"

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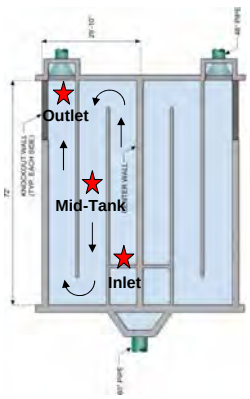
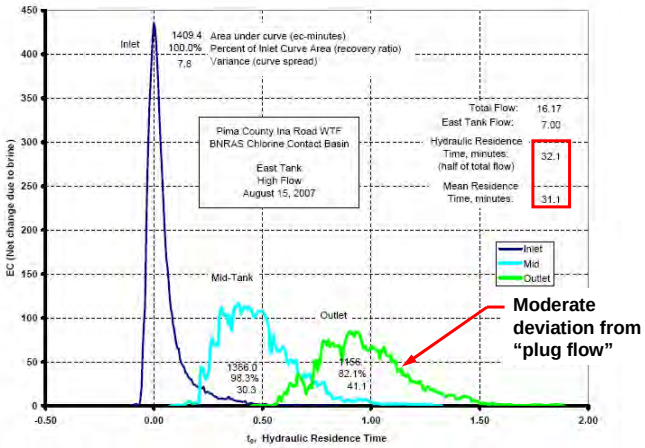
Part 5: Dispersion Analysis – Protocol; Results; Conclusions

David Murray

Dispersion Analysis

BNRAS East CCB – High Flow



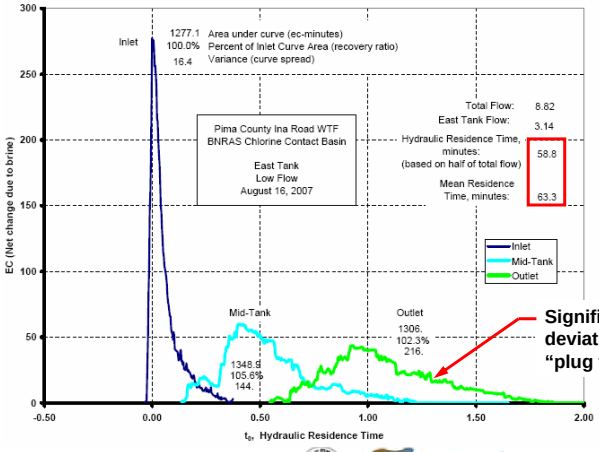


Moderate deviation from "plug flow"

Loss of tracer mass may be attributed to threshold in detection distance from sensor.

Dispersion Analysis

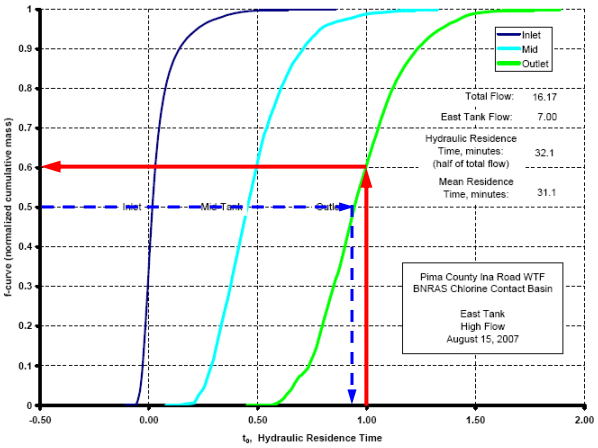
BNRAS East CCB – Low Flow



Significant deviation from "plug flow"

Dispersion Analysis

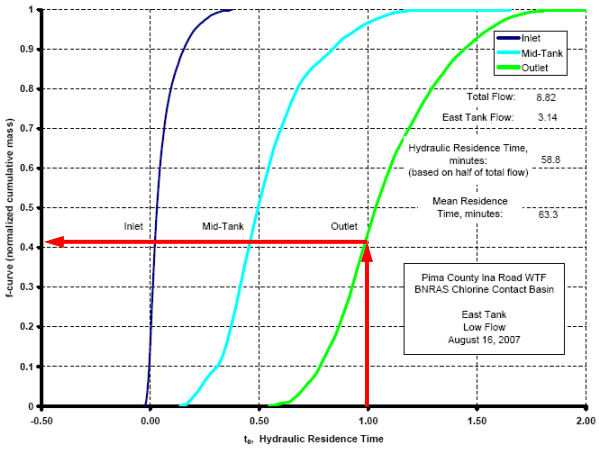
BNRAS East CCB – High Flow



60% of tracer mass passes outlet prior to when theoretical Hydraulic Residence Time occurs for this flow condition.

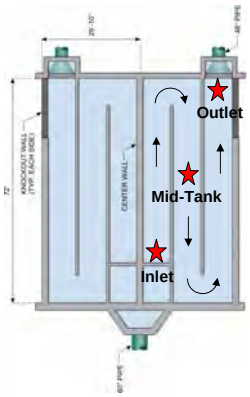
Dispersion Analysis

BNRAS East CCB – Low Flow

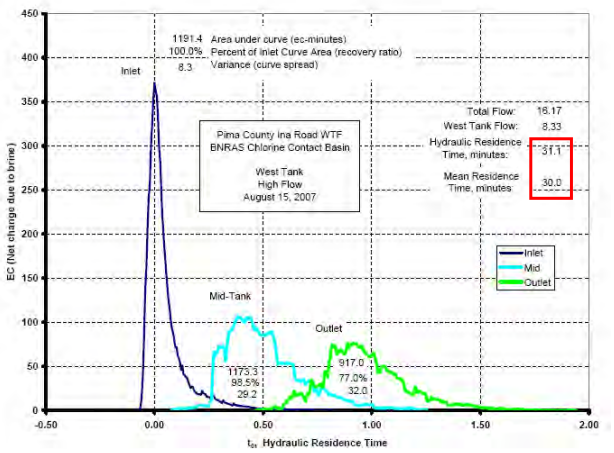


41% of tracer mass passes outlet prior to when theoretical Hydraulic Residence Time occurs for this flow condition.

Dispersion Analysis

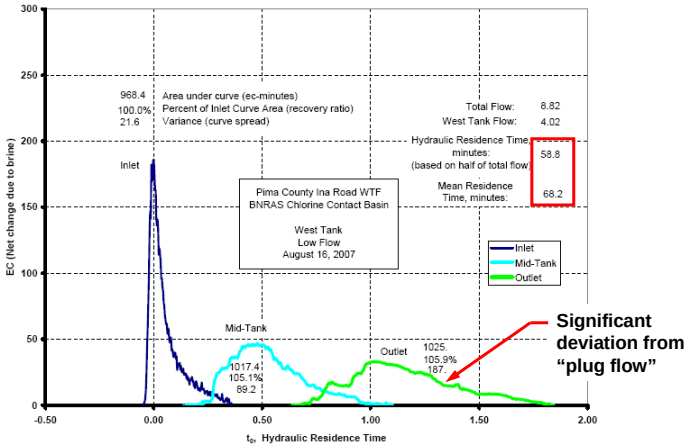


BNRAS West CCB – High Flow



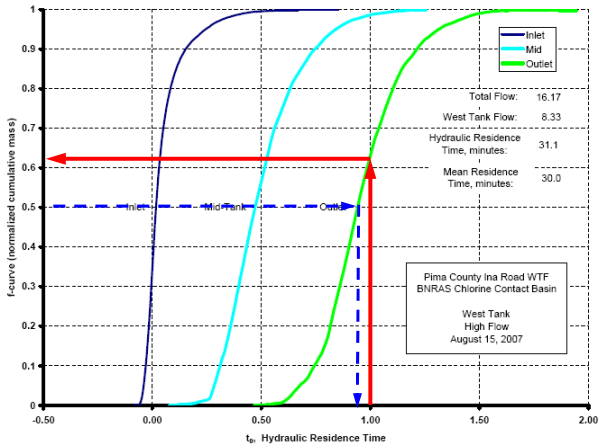
Dispersion Analysis

BNRAS West CCB – Low Flow



Dispersion Analysis

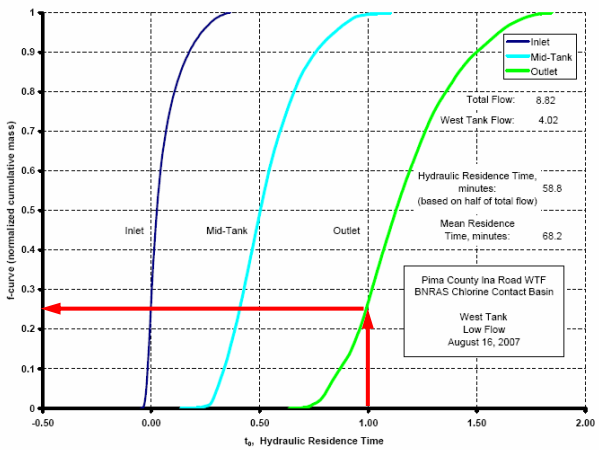
BNRAS West CCB – High Flow



62% of tracer mass passes outlet prior to when theoretical Hydraulic Residence Time occurs for this flow condition.

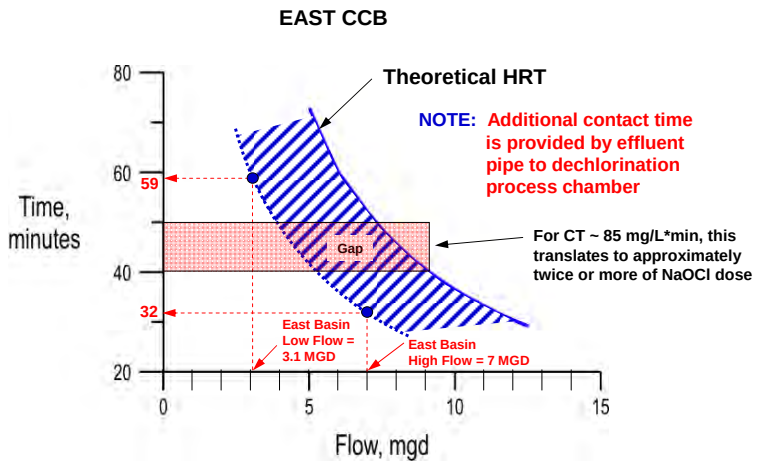
Dispersion Analysis

BNRAS West CCB – Low Flow

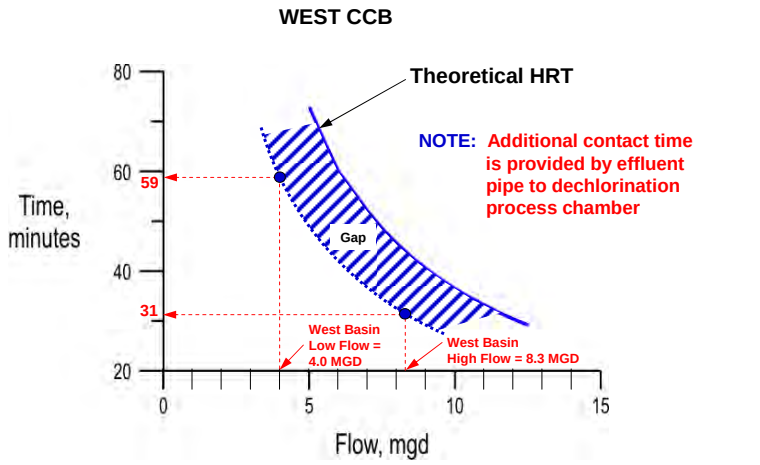


25% of tracer mass passes outlet prior to when theoretical Hydraulic Residence Time occurs for this flow condition.

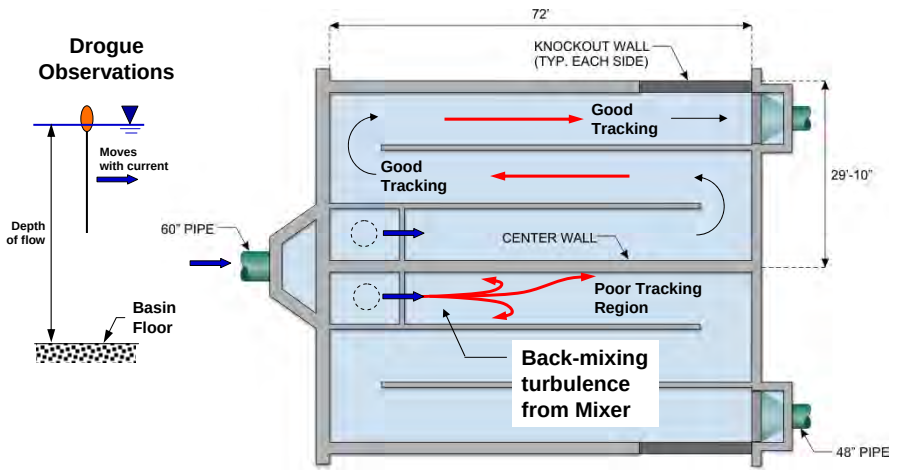
Dispersion Analysis



Dispersion Analysis



Drogue Observations



Conclusions from Dispersion Analysis

- Significant deviations from plug flow conditions exist during low flow periods; moderate deviations during high flow
- Flow regime falls below theoretical HRT under low and high flow conditions → short-circuiting
- Additional contact time is present in effluent pipe conveying flow to dechlorination point
- Severe turbulence caused by flash chamber mixer creates back-mixing in first pass of basin

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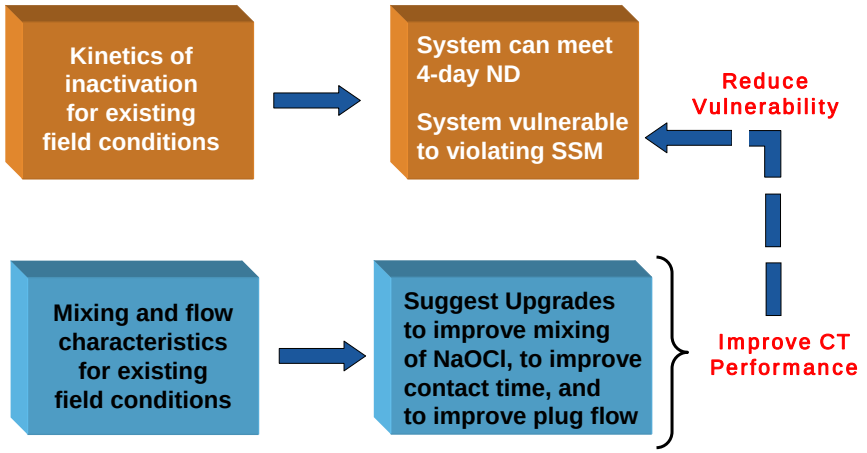
Part 6: Conclusions; Implications; Recommendations

Art Umble

What have we learned?



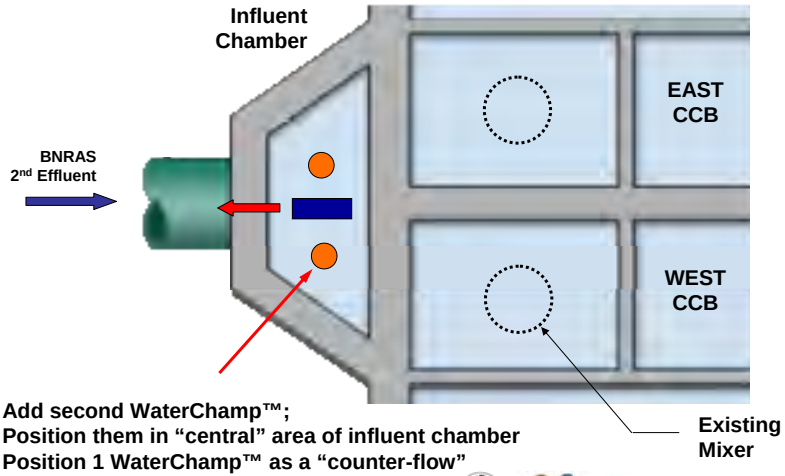
Recommendations

- Improvements to CCB mixing and contact time should result in improved inactivation kinetics
- What are these "improvements?"

Suggested System Modifications / Additions

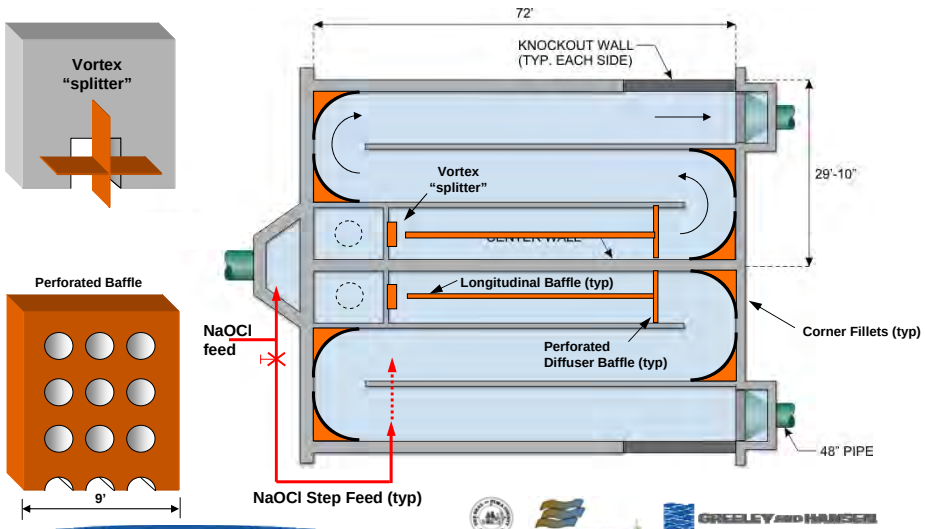
- Mixing chamber: WaterChamp™ Location & Geometry of Chamber
- Chlorine contact basin channels HRT increase
- pH Reduction
- Increases in chlorine dosage
- Increased frequency of basin cleanings
- Coating of basin walls and floor to resist bacterial growth
- Chlorination Step Feed??

Possible Modifications to Mixing Chamber



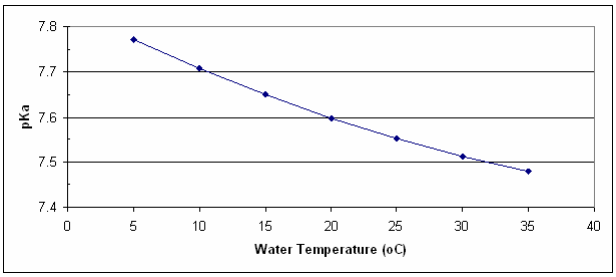
1. Add second WaterChamp™; Position them in "central" area of influent chamber
2. Position 1 WaterChamp™ as a "counter-flow"

Contact Basin Upgrade Concepts



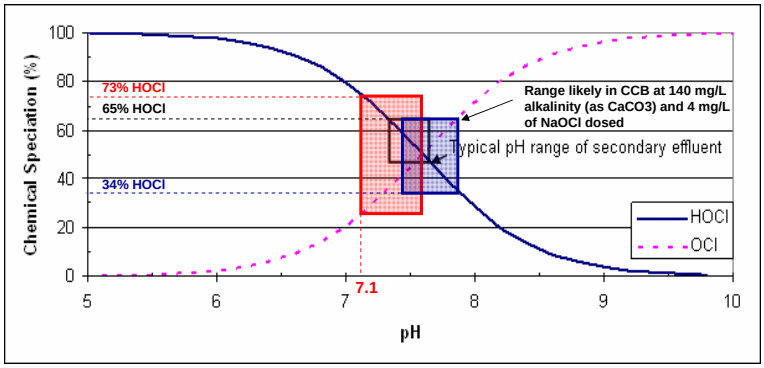
pH Adjustment

- Hypochlorous acid pK_a reduces as temperature increases



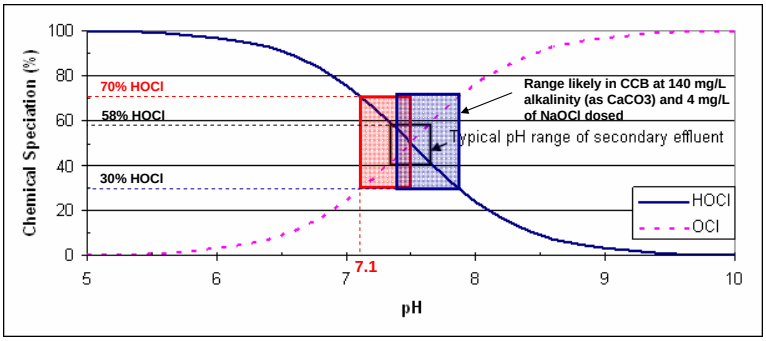
pH Adjustment

- Reduce pH to increase fraction of HOCl in bulk liquid



Reaction Equilibrium at 20ºC

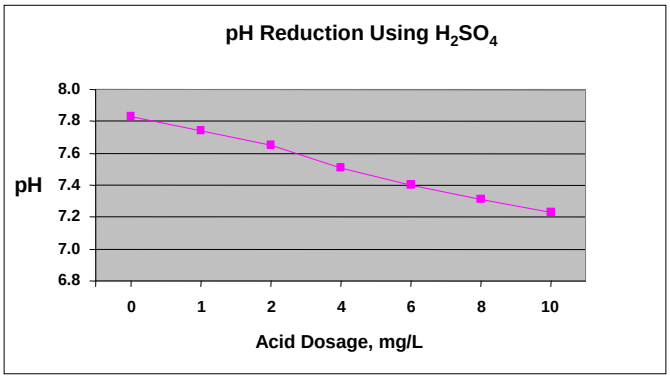
pH Adjustment



Reaction Equilibrium at 32ºC

pH Adjustment

- Add sulfuric acid (inexpensive → $100-$150/ton)



Recommendations

Question: **Can these improvements result in meeting maximum fecal and E.coli permit limits?**

Answer: **For 4-day ND?…Yes (assuming close monitoring)**
For SSMs?…not 100% of the time;
upgrades expected to reduce vulnerability

For vulnerability to violate WET? …out of scope
For vulnerability to production of DPB? …out of scope
For vulnerability to violate Chlorine residual? …out of scope

Strongly recommend that PCWMD laboratory study the WET, DPB and field Chlorine residual responses of the enhanced chlorination process.

Recommendations

- Laboratory "Jar Tests"
  - Establish the chlorine dosage necessary to meet required CT
  - Establish the level of DPBs generated that may impact either WET or APP in the future
- Field Full-Scale Test
  - Verify efficiency of dechlorination to meet residual compliance for chlorine residual.

Recommendations

- Proceed with modifications to the influent chamber, mixing chamber and CCB to improve the reliability of the process
- Consider decommissioning flash mixers
- Proceed with increased frequency of CCB cleaning to remove residual solids
- Proceed with additional bench and full scale testing (PCMWD)
- Confirm enhanced chlorination technology approach with ADEQ

Team Contacts

- Jerry Bish
  Greeley and Hansen LLC
  jbish@greeley-hansen.com
  602-575-5595
- Art Umble
  Greeley and Hansen LLC
  317-924-3380
  aumble@greeley-hansen.com
- Larry Leong
  Kennedy/Jenks Consultants, Inc.
  LarryLeong@KennedyJenks.com
  949-261-1577
- David Murray
  Brown & Caldwell, Inc.
  503-977-6603
  dmurray@brwncald.com
- Sam Jeyanayagam
  Malcolm Pirnie, Inc.
  614-430-2611
  sjeyanayagam@pirnie.com
- Jennifer Phillips
  Malcolm Pirnie, Inc.
  602-241-1770
  jphillips@pirnie.com
- Jeff Prevatt
  PCWMD
  520-579-6040
  jeff.prevatt@wwm.pima.gov
- Jim Doyle
  PCWMD
  520-744-4236
  jim.doyle@wwm.pima.gov

Appendix G

Enhanced Chlorination / De-Chlorination

Phase I – Literature Review and Assessments

Regional Optimization Master Plan
Enhanced Chlorination Study

Phase 1 – Literature Review and Assessments

Pima County
Wastewater Management Department

July 2007

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1. Introduction

1.1 Background

The Pima County Wastewater Management District (PCWMD) currently owns, operates and manages a number of wastewater treatment facilities. Over the past year, the PCWMD has been involved in the development of the Regional Optimization Management Plan (ROMP). This plan involves evaluation of the Pima County wastewater treatment facilities with several objectives including:

1) Capacity to accommodate the population growth throughout the region, and

2) Evaluation of the treatment technology necessary to achieve compliance with current and foreseeable future Arizona's environmental water quality standards for discharge of treated effluent to waters of the state or for reuse.

Addressing the disinfection of the plant effluent with respect to the latter objective is the focus of this report. The report examines the efficacy of the existing disinfection technology employed in achieving future compliance. The compliance standards are outlined in the State of Arizona's Administrative Code for environmental regulations. These are referenced as "Best Available, Demonstratable Control Technology" (BADCT) standards for disinfection. In addition, compliance with state's water quality standards for treated effluent chlorine residual and Whole Effluent Toxicity is required by the Arizona Pollutant Discharge Elimination System (AZPDES) permit issued to PCWMD. Additional potential issues of concern include formation of disinfection by-products and enteric virus removals to meet "Class A" water reuse standards.

1.2 PCWMD Objectives

The PCWMD has outlined three fundamental objectives for resolving the position of utilizing chlorination technology for disinfection at their major treatment facilities. These are:

- Meet the BADCT standards
- Meet a "Class A+" effluent quality discharge
- Minimize the necessity for an estimated $70 million expenditure for a filtration and ultraviolet radiation technology approach for disinfection

The set of studies described herein is focused on evaluating chlorination as a technology system for disinfection capable of meeting the objectives above reliably and consistently.

1.3 Study Description

The PCWMD desires to develop its position on meeting the BADCT standards and permit compliance requirements based primarily on evidence presented in three study documents:

1) Literature review on chlorination as a disinfection technology for achieving BADCT standards and AZPDES permit limits

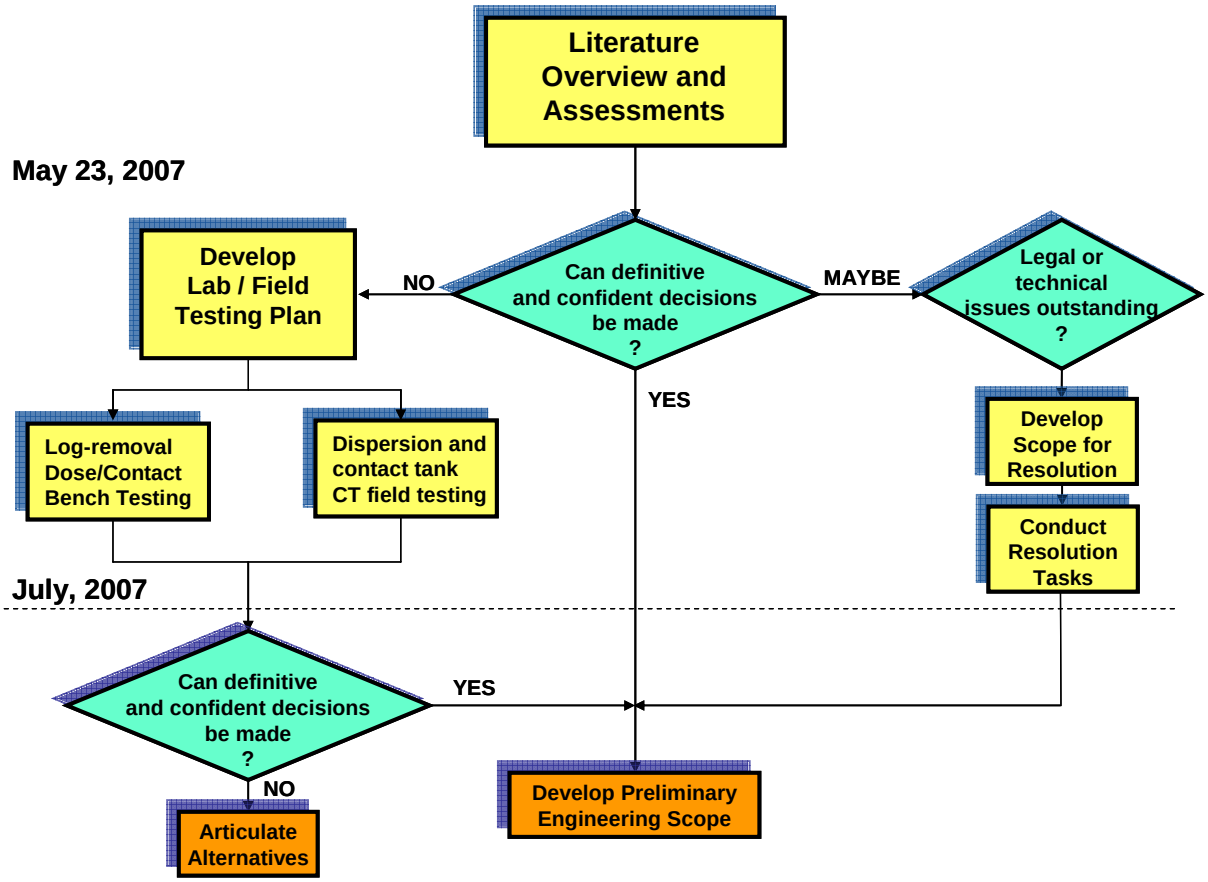
2) Analysis of data collected from laboratory and field studies to confirm and predict the technology performance; and

3) A basis of design, based on findings of research studies and design standards for improvements to existing chlorination facilities.

This report focuses on the results from the literature review. It also includes results of assessments of the existing conditions of the Roger Road Wastewater Treatment Plant (WWTP) and Ina Road Water Pollutin Control Facility (WPCF) disinfection facilities. The emphasis of the assessments is on the Ina Road WPCF since the ROMP calls for eventual replacement of the Roger Road facility.

The literature review and the existing condition assessments provide preliminary information toward the ultimate decisions regarding use of chlorination technology for disinfection. This information can be illustrated in a "decision-tree" process diagram, illustrated in **Figure 1-1,** and briefly described in **Section 1.3.1**.

Figure 1-1



1.3.1 Decision Process

With the information gathered from the literature and condition assessments, the PCWMD can decide if there is sufficient evidence to confidently pursue a chlorination system as the disinfection technology. If the decision is definitive, then the PCWMD would move directly to the conceptual design effort. However, if this determination cannot be definitively made, then additional laboratory and field studies are warranted. These studies would be designed to collect site-specific data related to the inactivation and destruction of potentially pathogenic microbes using the existing chlorination systems, or recommended enhancements to these existing systems. The PCWMD then has a second opportunity to decide if the additional gathered research data is sufficient to move forward with conceptual design. This report presents the findings from the literature review and the field assessments to allow the PCWMD to address the first decision point.

It is hereby noted that all discussion included in this report with respect to disinfection system performance is based on the context of the disinfection facilities at the Ina Road WPCF, with specific emphasis on the disinfection process as part of the existing Biological Nutrient Removal Activated Sludge (BNRAS) process train, otherwise known as the "East Plant" at Ina Road WPCF.

2. Literature Overview

2.1 Organization of Discussion

Results of the literature search and review are summarized in five categories:

- Discussion of the framework of the Arizona BADCT standards in the context of other states with similar regulatory mechanisms, namely Florida and California
- Overview of the "survey of practice" for disinfection in municipal wastewater treatment with respect to treatment train process
- Discussion of the current and future issues surrounding enhanced chlorination technology
- Discussion of the implications of the PCWMD's historical disinfection data from existing chlorination practices
- Proposed additional studies

2.2 Standards and Regulations

2.2.1 Arizona

Title 18 of the Arizona environmental regulations details the rules associated with the BADCT, the Aquifer Protection Program (APP), the national pollution discharge elimination system (NPDES) permitting process, water reclamation for a Class B+ Effluent quality. The basic compliance criteria for these rules as applied to disinfection technology are:

- Fecal coliform and E. coli limits:
  - Non-detect in 4 out of 7 samples per week
  - Single sample: < 23 fecal coliform/100 mL, or < 15 E. coli/100 mL
- Total Nitrogen: < 10 mg/L
- Disinfection by-products:[1] 0.1 mg/L total trihlomethanes (TTHMs) (with 0.08 mg/L as an "alert" level)
- Whole Effluent Toxicity
- Chlorine Residual:[2] < 8 µg/L on a monthly average; < 11 µg/L as a daily maximum

In terms of discharge permits, if a "Class A or A+" discharge quality is desired, monitoring of the effluent for viruses is required, along with associated limits.

2.2.2 Florida

In the State of Florida, "Chapter 62" has a similar set of regulations present with respect to discharge to surface water bodies and for water reclamation (i.e., discharge to a potable water supply). In general, Florida's criteria for disinfection technology are stringent and described in **Table 2-1**.

Table 2-1

Chlorine Contact Tank Influent (fecal coliform / 100 mL)	Required CT (mg/L•min)	Logs of Removal and (%)
≤1,000	At least 25	3 (99.9)
>1,000 – 10,000	At least 40	4 (99.99)
>10,000	At least 120	>4 (>99.99)

In addition, the Florida regulations limit Total Suspended Solids (TSS) in the chlorine contact basin influent to be less than 5 mg/L on a 30-day average. Similar to the Arizona standard on disinfection efficacy, the Florida standard requires that non-detect of fecal coliform be achieved in 75 percent of the samples in a 30-day period, and that each single sample must be less than 25 fecal coliform/100 mL.

A discharge permit in the State of Florida does include limits on specific microbes, i.e., Cryptosporidium and Giardia, when considering the reuse of water or when the discharge is to a drinking water source.

2.2.3 California

In the State of California, the concomitant regulations are found in Title 22, also known as the "Purple Book." California's criteria are based on Total Coliform and enteric viruses (e.g., poliovirus, hepatitis A, human rotavirus, etc.). This set of criteria imposes specific conditions on the reuse of treated water.

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[1] Cyanide will be regulated as a disinfection by-product because of its potential formation from chlorine-based reaction chemistry.
[2] NPDES permit requirement

The treatment goal under this standard for recycled water is a limit of <2.2 total coliform/100 mL for a disinfected secondary effluent, based on a 7-day median. Only one sample in a 30-day period can exceed 23 TC/100 mL, and a maximum for that sample of < 240 TC/100 mL. The reuse of this water is limited to surface irrigation of food crops where the edible portion is produced above ground and is not in direct contact with the recycled water.

For recycled water from tertiary treatment, the California regulations are stringent. In addition to meeting the < 2.2 TC/100 mL (same conditions as the treated secondary effluent), the regulations require the tertiary effluent to be filtered and have a contact time (CT) of 450 mg/L•min along with a modal contact time > 90 minutes under peak, dry weather design flow conditions. This technology must demonstrate at least 5 logs of removal for Ms2 or poliovirus. This level of treatment allows the water to be used for irrigation of edible root crops where the recycled water can be in direct contact with the edible portions. Additionally, these waters can be used for irrigating parks, playgrounds, residential landscapes, golf courses, and are applicable to groundwater recharge for reuse.

Discharge permits in California require monitoring for viruses when discharge is utilized for reuse. However, if the technologies employed achieve greater than 5 log removals, then no monitoring is required. The critical issue here is the definition of the "technology," which is set by the State's Department of Health and Safety rather than the Department of Environmental Quality.

2.2.4 Operational Issues

A set of phone interviews were conducted with operators of some of the Bardenpho facilities (comparable to the future PCWMD facilities) to determine if there were operational issues over and above compliance issues that favor one disinfection technology approach over another. In each case, no specific problems or violations were reported after a completed start-up procedure. However, several reported that the time for bringing the process under full operational control required 6 months to a year. Also, in a number of cases, operators reported experiencing problems with scum and floatables in the contact facilities. Finally, most operators stated that in order to meet a ≥ 4 day fecal coliform non-detect criteria, filtration was recommended.

2.2.5 Additional Current Issues

There appears to be evidence that consistently and reliably meeting maximum limits for fecal coliform and E.coli criteria (such as those outlined for PCWMD) is a technological and operational challenge. This also does not seem dependent on whether or not filters are used with either a chlorine or UV-based disinfection system approach.

When considering the process of enhanced chlorination, in which higher chlorine doses along with longer contact times, additional compliance requirements may arise. These relate mostly to complying with WET test criteria for chlorine residual, ammonia, and sulfite (resulting from dechlorination systems). With the increased chlorine dosages, there is the higher probability of increases in chlorinated disinfection by-products (THMs and haloacetic acid (HAA5s)). There is also the possibility that cyanide would be included in this disinfection by-products (DBP) group of regulated compounds.

2.2.6 Potential Future Issues

The regulatory horizon is not clear as to what new regulations on treated effluents will be issued over the next few years. However, in Arizona, it is possible that enteric viruses will be added to the regulation for discharge waters slated for greater than Class A quality reuse as potable aquifer recharge. In Florida, it seems possible that enterovirus will be added to the regulations for water recycling programs and a lower THM/HAA5 limit. These lower limits on DBPs may be actually lower than those imposed for drinking water standards. In California, for groundwater recharge recycling programs, the inclusion of N-methyl-D-aspartic acid (NDMA) is possible, as well as new, much lower limits on THMs/HAA5.

2.3 Survey of Practice

2.3.1 Disinfection

In the United States, chlorination technologies have dominated disinfection practices in the municipal wastewater treatment industry for decades. However, that dominance has been declining in recent years, primarily due to changes in environmental regulatory policy and shifts in public's perception for what is safe practice in utilizing hazardous chemicals. Thus, there is has been an increase in the application of ultraviolet (UV) radiation as a disinfection technology. Figure 2.1 illustrates the breakdown of disinfection practices across the US (based on 2006 data).

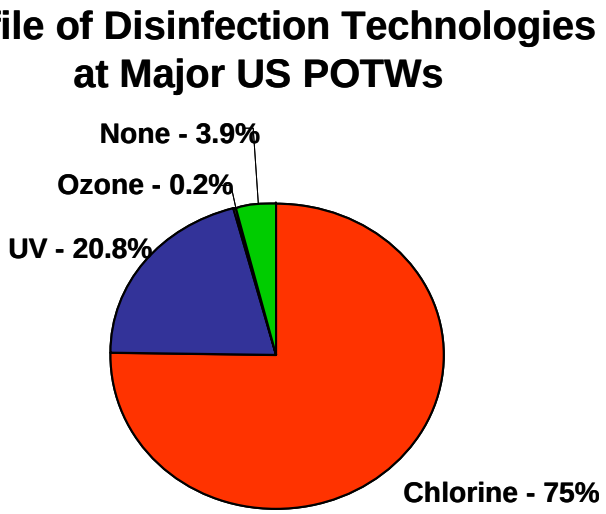
When considering the comparison of the PCWMD facilities at Ina Road WPCF and Roger Road WWTP to comparable facilities across the US in terms of disinfection practice, in general UV makes up less than 18 percent of the technologies employed. This is depicted in **Table 2-2.**

Table 2-2

Treatment Plant	Flow Range (mgd)	No. of POTWs	No. of Plants Utilizing UV
Roger Road	22 - 42	149	25
Ina Road	40 - 60	67	10
Combined	72 - 92	18	1

It is interesting that though UV appears to be gaining favor in the US, there remains an inverse correlation between size of plant and utilization of UV as the disinfection technology. This may be related to higher capital and O&M costs generally associated with larger installations.

Figure 2-1



2.3.2 Treatment Process

Currently, the Ina Road BNRAS facility utilizes a nutrient removal system similar to the future Bardenpho treatment process. A Bardenpho process designed to maximize reduction of total nitrogen from the wastewater stream typically consists of a minimum of a treatment train of 4-stages in series. In the United States today, there are 45 major POTWs (design flow rates of 1 - 24 MGD) that utilize the Bardenpho process. The State of Florida dominates in the number of Bardenpho plants with 22, followed by Maryland with 8. Nine states, which include Arizona, have one or two such plants. (Interestingly, of these 45 major plants, 12 employ UV as the disinfection technology.)

2.3.2.1 Relationship of Process and Disinfection Technology to Microbial Violations

The Bardenpho process is generally considered capable of producing a high quality secondary effluent. This high quality should improve the efficiency of the downstream disinfection process, and thus translate to fewer violations of the permit for microbial criteria. A summary of these findings is given in Table 2-3. From this data, of the 17 Bardenpho plants with microbial performance violations, 11 were plants that utilize chlorination with filtration. However, only 3 Bardenpho plants that practice only chlorination experienced violations. The type of violation is also important to note. Of the violations listed, the most common was violation of the single sample maximum. Only one Bardenpho plant showed a violation of a periodic average. It should be noted that conclusions cannot be drawn from this information with respect to relationship between disinfection technology and violation. It is not known in any of the cases listed the cause of the violation. However, what the information does show is that merely adding filtration to either UV or chlorination disinfection technology is not a fail-proof guarantee against violation.

Table 2-3

Disinfection Technology	Flow Range (mgd)	No. of POTWs	No. of POTWs with Microbial Violations of Maximum*	No. of POTWs with Microbial Violations of Periodic Average*
UV	17	1	1 (6)	0
Filtration + UV	12, 15	2	1 (2)	0
Chlorine	4 - 22	3	1 (1)	0
Filtration + Chlorine	6 - 24	11	8 (25)	1 (1)

( ) = total number of violations for category

2.3.2.2 Relationship of Process and Disinfection Technology to WET Violations

Because the Whole Effluent Toxicity (WET) test is an element of compliance, the violation of a WET test from these same 17 Bardenpho plants was examined. The results are shown in Table 2-4. Similar to the microbial violations, the violations of WET were found to be highest at the Bardenpho plants that use filtration with chlorination. This could be argued as significant since these occurred at 10 different plants. On the other hand, though the plants having only chlorine as their disinfection technology made up the majority of other WET violations (6 water flea violations and 4 minnow violations), these each occurred at only one facility. Again, the information in **Table 2-4** indicates that merely adding filtration ahead of either UV or chlorination disinfection technology is not a fail-proof guarantee against a WET violation.

Table 2-4

Disinfection Technology	Flow Range (mgd)	No. of POTWs	No. of POTWs with WET Violations of Water Flea*	No. of POTWs with WET Violations of Minnow*
UV	17	1	1	0
Filtration + UV	12, 15	2	1	0
Chlorine	4 - 22	3	1 (6)	1 (4)
Filtration + Chlorine	6 - 24	11	10 (23)	5 (25)

( ) = total number of violations for category

2.3.2.3 Relationship of Process and Disinfection Technology to THM Violations

There are few plants in the US that currently operate under permits with limits for total trihalomethanes (disinfection by-products). Of the seven facilities found in this study to have such limits, each is configured with filtration followed by chlorine for disinfection. Thirty-seven disinfection by-product violations (TTHM and dichlorobromomethane, primarily) have been reported from these seven facilities. Perhaps more significantly, the violations for 6 out of the 7 facilities correlated closely with violations of maximum concentration limits and with WET operational issues

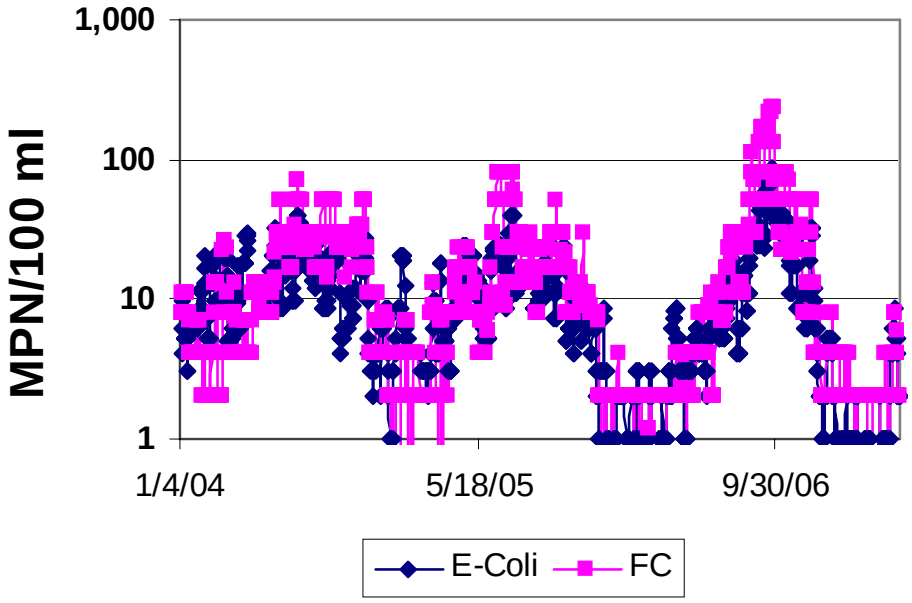
2.4 Implications from Preliminary Analysis of PCWMD Performance Data

As the PCWMD continues forward with consideration of utilizing an enhanced chlorination technology approach for its wastewater treatment facilities, it is important to conduct a cursory review of the available disinfection performance data from current operations in the context of the literature findings. From this review, and using a statistical approach, inferences can be made as to whether or not the enhanced chlorination approach could be successfully applied (meaning reliable and consistent in meeting standards) at the PCWMD facilities.

This review focuses on Ina Road WPCF performance data from the period of January 2004 through April 2007. The first step in this review is to develop a frequency distribution of the available data. This analysis involves tabulating the MPN/100 mL for fecal coliform and E.coli into categories of percent of occurrence. These are then plotted on log-scale as a function of percent of occurrence.

Figure 2.2 is a plot of the disinfected effluent data provided by PCWMD. The general trend of this data follows seasonal patterns, with higher values in the summer months, corresponding to higher temperatures and wet weather conditions.

Figure 2-2

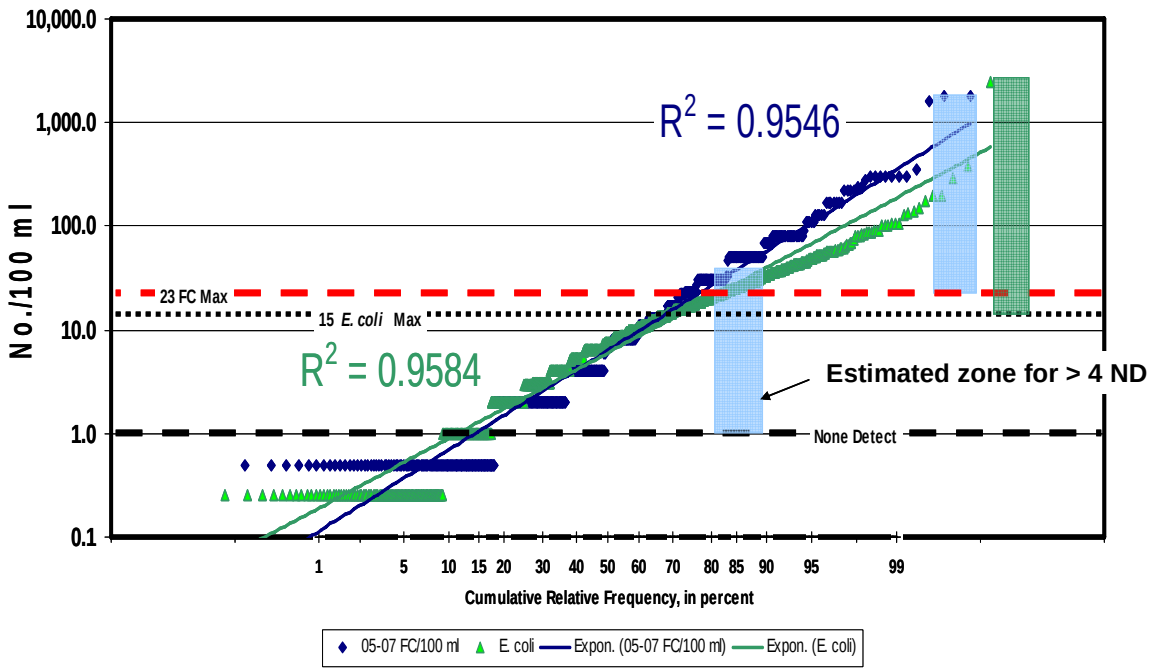


This data for both fecal coliform and E.coli were found to follow a log-normal distribution. This data was then plotted into a cumulative frequency distribution diagram, illustrated in **Figure 2-3**. Implications for PCWMD from this frequency distribution are important to recognize. Several most probable number (MPN) levels are noteworthy. First, is the threshold of 1 MPN. This threshold essentially represent the non-detect level. So, in order to reliably meet the 4-day non-detect requirement, the majority of the fecal coliform data (probably at least 75% to 85%) would need to plot below this line. Of the data analyzed, approximately 20% of the fecal coliform samples historically fall at or below this level.

Secondly, approximately 70% of the E.coli data falls below the threshold of the maximum limit of 15 MPN/100 mL and approximately 75% of the fecal coliform data falls below the threshold of the maximum limit 23 MPN/100 mL. Any fecal coliform and E.coli value plotted above these respective thresholds represent potential violations of a maximum limit under the BADCT standard. Here again, in order to sustain reliable, fail-proof compliance, 100% of the fecal coliform and E.coli data would need to plot below the 23 MPN and 15 MPN lines, respectively.

Results of this plot point to the number of logs of removal that must be reached in order to have the cumulative relative frequency consistently fall below the thresholds. For the data analyzed, an additional 1.5-log removal of would be necessary to consistently achieve the 4-day fecal coliform non-detect standard. To reliably achieve the < 23 MPN maximum limit, an estimated additional 2 logs of removal would be necessary. For E.coli, approximately 2.2 logs of additional removal performance would be necessary to meet the < 15 MPN maximum limit.

Figure 2-3



Close observation of the results of this frequency distribution analysis is that only a few outlier points of fecal and E.coli plot above 1000 MPN. These outlier events make up less than 0.5% of the data. If these points are removed from the analysis, the increase in log-removal necessary to meet the maximum limit requirements is less, i.e., approximately, 1.2 and 1.4 for fecal coliform and E.coli, respectively. This raises several important questions for the PCWMD to address.

1. What level of risk of maximum limit violations (of the sort that make up these few high value outliers) should the PCWMD be willing to accept?
2. Is there a point in the cost/benefit analysis, beyond which, the cost to provide facilities to ensure consistent and reliable compliance that includes the outlier events returns no additional benefit to the PCWMD?
3. Should the PCWMD build enough facilities as much as necessary to ensure maximum probable compliance?

It is important to note that the data presented in Figures 2-2 and 2-3 represent microbial samples taken from the blended effluent from the BNRAS and the High-Purity Oxygen (west) plant, and therefore the exact contributing source is unknown. But literature does indicate that upstream process does play a role

when determining the level of log-removal necessary.[3] Biological nutrient removal systems appear to achieve at least 1-log lower fecal coliform count in the effluent when compared to conventional activated sludge systems. This is outlined in **Table 2-5**. Because the PCWMD employs a biological nutrient removal process, it is likely that the actual log-removal required will be lower than what is shown in **Figure 2-3** since what is presented is a blended effluent condition.

Table 2-5

Secondary Effluent	FC / 100 mL	Estimated Log-Removal to 4-day ND
Activated Sludge	29,300	4.7
Nitrified Activated Sludge	37,000	4.8
Biological Nutrient Removal	3,600	3.8

2.5 Studies to Establish Kinetics of Microbial Inactivation on PCWMD Effluent

Results of the data analysis discussed Section 2.4 suggest that a decision to accept the enhanced chlorination as the appropriate process for PCWMD and to proceed directly to a conceptual basis of design effort for the enhanced chlorination process (first critical decision point in the flow-chart diagram shown in Figure 1-1) would be premature at this juncture. Therefore, the following additional studies are recommended to provide additional information to support an informed decision.

2.5.1 Disinfection Kinetics

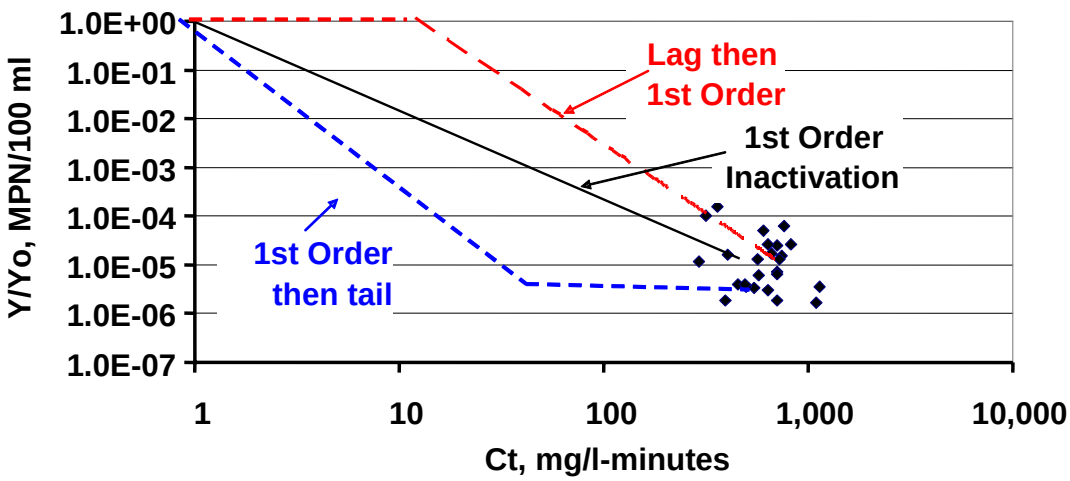
Degree of inactivation of microbes under exposure to an oxidizing (disinfecting) agent depends on both the dose of the agent and time that the organism is held in contact with that agent. Mathematical models exist to describe this relationship and provide valuable insight into the effectiveness of a given disinfectant. A model known as "Crick's Law" is perhaps the most widely used. This maps the relationship between the concentrations of viable organisms present, with respect to an initial concentration, as a function of the time that the organisms are exposed to the disinfectant and the dose applied to create the exposure. A true "1st Order" response plots as a straight line on a log-log plot. However, such models do not take into account the variability in characteristics commonly found in wastewater effluents. The more common response for wastewater effluent can be illustrated in Figure 2-4 (hypothetical data shown).

Effective disinfection would be representative of a 1st Order inactivation relationship. With respect to the PCWMD facilities, if the disinfection kinetics show a true 1st Order relationship, perhaps effluent filters would not be necessary. However, as the figure illustrates, there are often departures from this relationship, represented by the "lag" or the "tail" responses. In the case of the "lag" followed by a relative 1st Order response, this represents a condition where particulate constituents in the suspending liquid react initially with the disinfectant, and essentially render the disinfectant inactive for a period of

[3] Rose, J., et al., WERF 2004

time. The implication of this for the PCWMD would be an adjustment to the disinfectant dose being applied. In the opposite, or "tail" case, this is reflective more of the presence of large particles in the water column shielding the organisms from the disinfectant. The slope of this "tail" is reflective of the size distribution of particulates that are present. With respect to the PCWMD facilities, a kinetic response with the "tail" could be an indicator that effluent filters would be a necessity.

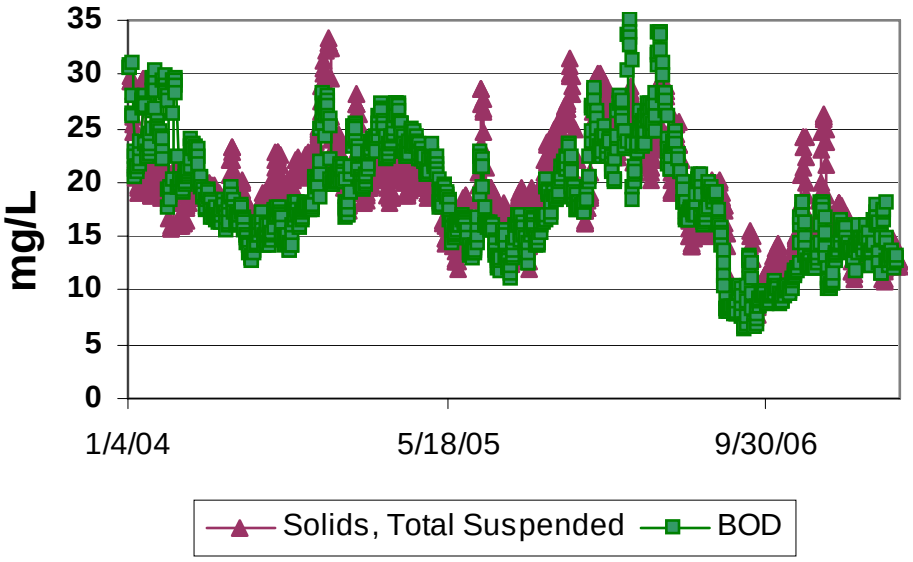
Figure 2-4



It is not uncommon for the kinetics to show a combined response between these two phenomena. **Figure 2-5** shows the effluent TSS and biochemical oxygen demand (BOD) data from the Ina Road WPCF. This data illustrates that TSS does indeed fluctuate with season, presumably concomitant with seasonal flow variation and therefore may influence disinfection kinetics. (Again, it is recognized here that the effluent TSS and BOD values reflect the combined BNRAS and HPO plant effluents).

Results of the kinetics analysis provides insight into the design of a chlorine disinfection system, both in terms of the initial mixing of the chlorine with the bulk liquid, and with the contact time required for reaching the desired inactivation levels.

Figure 2-5



2.5.1.1 Recommendation: Disinfection Kinetics Study

It is recommended that the PCWMD conduct a bacteriological inactivation study to establish the kinetics associated with the PCWMD effluent. It is recommended that the BNRAS secondary effluent[4] at the Ina Road WPCF be used as the source for the kinetics evaluation. Pragmatically, this test establishes the overall contact time, "T" in the "CT" product necessary to meet the BADCT.

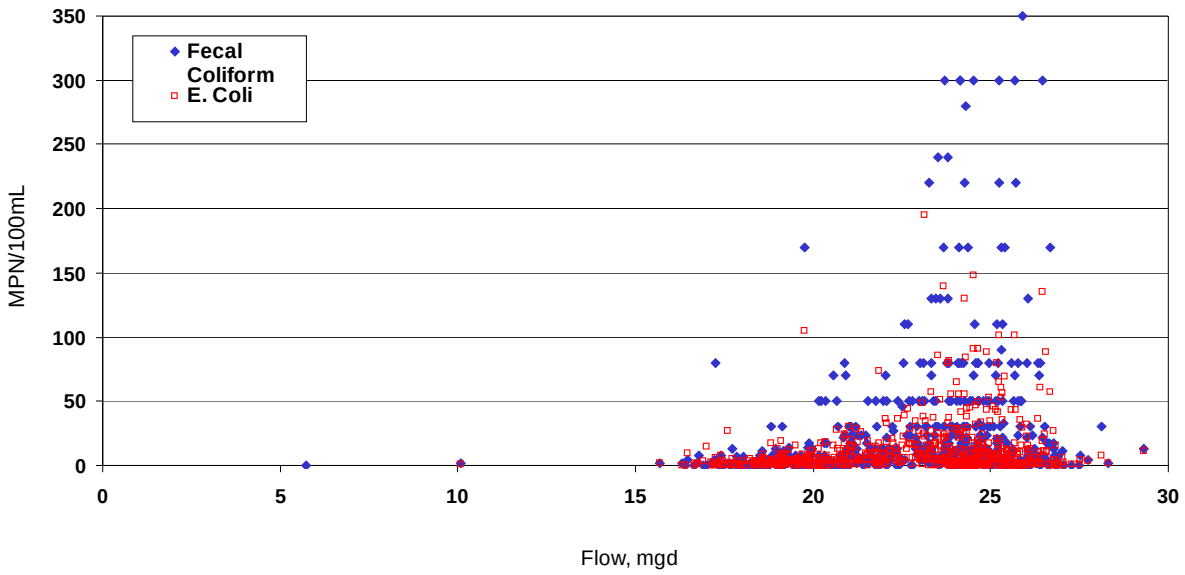
This study would pull samples from the fully mixed region of the chlorine mixing chamber immediately upstream of the chlorine contact basin and use "bench holding times" to simulate the chlorine contact time. The test should be conducted for both fecal coliform and E.coli. It is recommended that the test be repeated through at least seven independent sampling events, with multiple replicates of fecal and E.coli runs for each set. This ensures reasonable integrity for the statistical analyses. To set the baseline concentrations (C_o) of the target organisms, an unchlorinated, unfiltered sample must be drawn upstream of the mixing chamber and chlorine injection point. To examine the kinetic effects of increased TSS that may be present, it is recommended that this baseline concentration sample be drawn from the secondary clarifier having the poorest performance. As an alternative, a TSS spike can be added to the baseline sample to simulate high solids conditions. To enhance the analysis, it is further recommended that methods be used that can detect fecal coliform to levels less than 0.02 MPN/100 mL.

[4] The PCWMD master plan calls for the new facilities to be designed and constructed as Bardenpho, but operated as a BNRAS, similar in process configuration to that of the existing "east" plant at Ina Road.

2.5.1.2 Recommendation: Microbial (Fecal Coliform and/or E.coli) Characterization Study

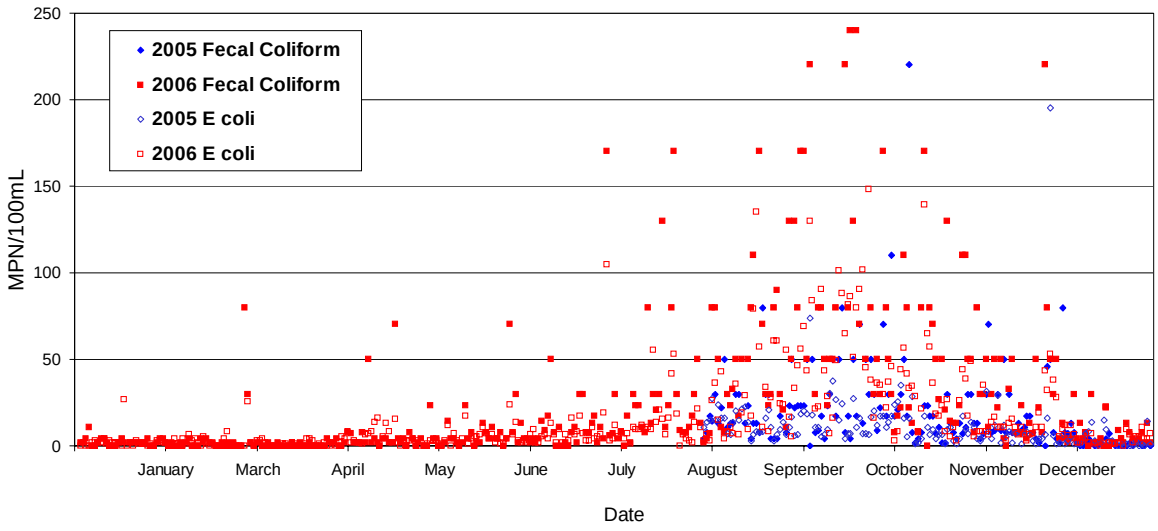
It is clear from the historical data provided by PCWMD that there exists a degree of variability in the effluent concentrations of the target organisms throughout different times of the year. This variability refers to variability in influent flow. Generally, higher TSS is attributed to higher flows. This is evidenced by the data shown in **Figure 2-6,** where a correlation exists between plant flow and microbial counts in the final effluent at the Ina Road facility.

Figure 2-6



The data shown in **Figure 2-7** shows the relationship between microbial counts in the effluent with different times of the year. Though this figure seems to imply that the summer months represent a significant challenge on disinfection performance, this data set is somewhat misleading. During the latter months of the summer of 2006, the new BNRAS facility (east plant) at Ina Road was brought on line. During that time, disruption to normal operation was inevitable resulting in microbial counts higher than normal. However, operators do confirm that summer conditions do pose more stress on the chlorination system than at other times of the year.

Figure 2-7



It is important, then, to examine the disinfection effectiveness in the context of this variability. This study consists of measuring the concentration of the target microbe(s) at a point immediately upstream of the chlorination injection/mixing and immediately upstream of dechlorination. The efficiency of the dosage combined with the contact time results in a total inactivation (i.e., total logs removed). Essentially, this test establishes the necessary residual concentration "C" of the disinfectant, for the "CT" product. This residual is typically measured at the end of the contact "flow path" just prior to dechlorination.

This study will provide the evidence necessary to support or refute meeting the 4-day non-detect BADCT criteria. If it is found that > 6 logs of removal is necessary (particularly under conditions of high flow and high TSS) to ensure the 4-day non-detect can be reliably met, then it is probable that the enhanced chlorination process is not the appropriate disinfection process for this treatment plant. If, on the other hand, it is found that < 4 logs of removal (again, particularly under high flow and solids conditions) is required to sustain a 4-day non-detect compliance, then it is possible that enhanced chlorination may indeed be the right choice, and that filtration may not be necessary. For a removal level somewhere between these two "targets," filtration will likely need to be considered.

Ideally, a collection of between 10 and 30 data points (each collected under a variety of flow and suspended solids conditions) would sufficiently characterize the inactivation response of the target organisms under the chlorination dose and contact times provided by the existing system.

It is recommended that this test be performed on the BNRAS secondary effluent.

2.5.1.3 Availability of Laboratory Facility to Conduct Kinetics Studies

The Ina Road WPCF laboratory facility consists of three divisions: microbiology, nutrients, and organics. In general, analyses are completed within one week of sample and lab reports are available within two weeks. All QA/QC functions are performed by a separate group, and QA/QC of analytical equipment is conducted daily with calibrations conducted monthly.

The challenge for the laboratory in conducting the microbial tests described above is available incubator space. Consequently, it is the laboratory staff's preference to conduct E.coli testing rather than fecal coliform. It is recommended that the PCWMD consider augmenting laboratory services, if necessary, to conduct the above tests. Currently, as demand requires, the laboratory facility does contract analytical services to an outside source (Aquatic Consulting & Testing, Inc., Tucson, AZ).

The Whole Effluent Toxicity (WET) testing was initially performed on-site. But in 1999, the Arizona DEP issued a waiver that reduced the WET test requirements. Since then, this test has been contracted to an outside laboratory (GEI Consultants, Inc., Littleton, CO). However, the new permit requires an increase in the WET test frequency. The PCWMD is therefore considering resumption of on-site WET testing. Depending on the timing of the WET testing, this should be taken into consideration with respect to the resources required for the above described studies.

3. System Assessments

3.1 Existing Disinfection Facilities[5]

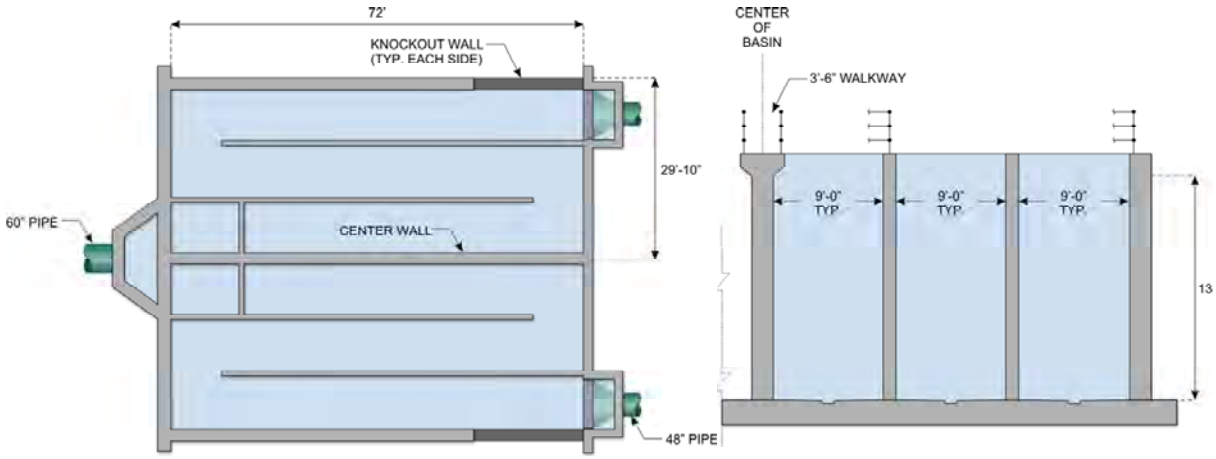
At the Ina Road WPCF, two parallel treatment process trains exist. The "west" plant is a conventional high-purity oxygen (HPO) process rated fro 25 mgd. The "east" plant is a biological nutrient removal activated sludge (BNRAS) process rated at 12.5 mgd. Currently, the BNRAS plant is operated at a constant, steady-state flow (flatlined), while the HPO operates under diurnally fluctuating flowrates. Each treatment train is served by its own hypochlorite disinfection system (including instrumentation and controls). Effluent from each chlorine contact basin is then combined prior to dechlorination and final discharge. Compliance of microbial criteria is monitored downstream of the dechlorination point, just prior to final discharge.

3.1.1 BNRAS Plant Disinfection System

The chlorine-based agent used for disinfection is hypochlorite. The contact basin for the BNRAS plant consist of two parallel, square flash mix chambers (outfitted with both a vertical turbine mixer unit and a Water Champ® for hypochlorite injection), followed by two parallel, serpentine plug flow contact channels. Secondary effluent flow is split evenly between the two parallel configurations. The schematic plan and cross section of this system is shown in **Figure 3-1**.

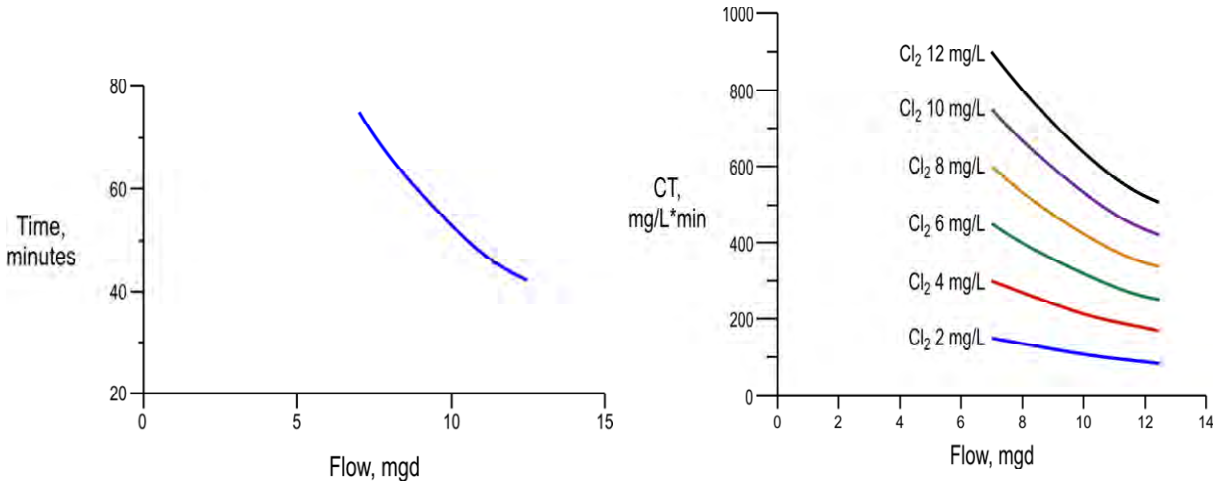
[5] The PCWMD master plan calls for decommissioning the existing Roger Road WWTP and replacing it with a new facility. Therefore, this report does not address disinfection facilities at Roger Road WWTP.

Figure 3-1



Understanding the hydraulic characteristics of the geometry of this basin system is critical to the issue of determining if an enhanced chlorination system is the most appropriate technology to reliably and consistently achieve the BADCT standards. Hydraulic retention time (HRT) as a function of flowrate provides the theoretical basis for establishing CT. This is depicted in the graphs in **Figure 3-2** for the flow ranges typically seen through the BNRAS process.

Figure 3-2



These graphs indicate that for flows ranging from 7 to 12.5 MGD, the theoretical HRT ranges from approximately 75 minutes to 40 minutes, respectively. Approximately 40 and 20 minutes of additional residence time for contact are provided to the 7 mgd and 12.5 mgd flowrates, respectively, to account for the travel time in the 48-inch discharge pipe that conveys the flow from the basin to the dechlorination chamber. **Table 3-1** shows the range of theoretical CT values applicable to this facility under a range of chlorine residuals. The highlighted row represents the typical target of operation practiced currently by the PCWMD for the BNRAS plant.

Table 3-1

Chlorine Residual[a]	BNRAS Flow[b]	HRT_t[c]	CT_t[d]	BNRAS Flow	HRT_t	CT_t	BNRAS Flow	HRT_t	CT_t
2.0	7.0	75	150	10.0	55	110	12.5	40	80
4.0	7.0	75	300	10.0	55	220	12.5	40	160
6.0	7.0	75	450	10.0	55	330	12.5	40	240
8.0	7.0	75	600	10.0	55	440	12.5	40	320
10.0	7.0	75	750	10.0	55	550	12.5	40	400
12.0	7.0	75	900	10.0	55	660	12.5	40	480

NOTE: a = mg/L; b = mgd; c = theoretical HRT of basin only, minutes; d = theoretical CT, mg/L•min

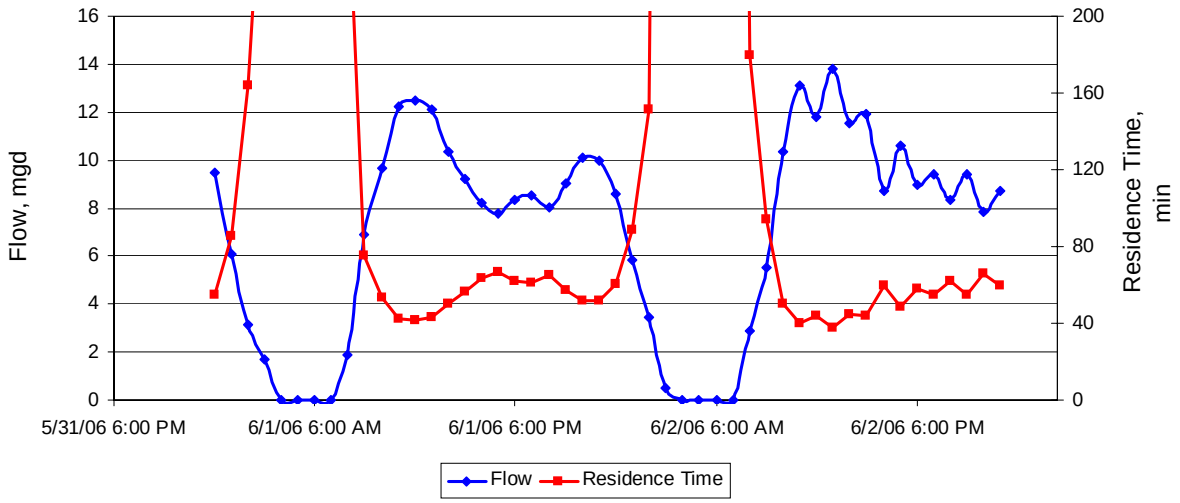
Another observation of the BNRAS chlorination system is that the total chlorine residual registers primarily as free chlorine. This is because the current operation of the BNRAS process achieves essentially full nitrification. Therefore, the amount of chlorine applied to the disinfection process would be beyond the theoretical breakpoint. The applied dosage is likely in the range of 2.5 mg/L. This breakpoint concentration is consequently relatively low.

It is important to note that the presence of significant concentrations of free chlorine increases the potential for the formation of disinfection by-products (THMs) that can have compliance implications. This is particularly critical when employing an enhanced chlorination process because the amount of chlorine dosed is generally much higher than what is being practiced in the current system.

3.1.2 HPO Plant Disinfection System

Similar to the BNRAS chlorination system, the HPO (west) plant's system also utilizes hypochlorite as the disinfecting agent. The chlorine contact basin consists of a serpentine plug flow contact basin. The major difference between the BNRAS and the HPO systems is that the HPO system sees a variable flowrate, reflective of the typical diurnal fluctuations entering the Ina Road WPCF. Because the BNRAS is flatlined at a constant rate, it is not uncommon for the HPO facility to see essentially zero flow for periods of the daily lowest flows in the early morning hours. The theoretical hydraulic residence time for the HPO basin therefore varies widely because of these highly variable flow conditions. Results are illustrated in **Figure 3-3**. For those periods when flows through the HPO reach zero, the theoretical HRT has no physical meaning. This is an important observation because during these periods the chlorine contact basin enters stagnant conditions. Significant residual decay is possible during this time, permitting microorganisms to grow. Secondly, because of the highly variable flow, there is a greater opportunity for solids to enter the basin during high flows, thereby shielding microbes from chlorine exposure.

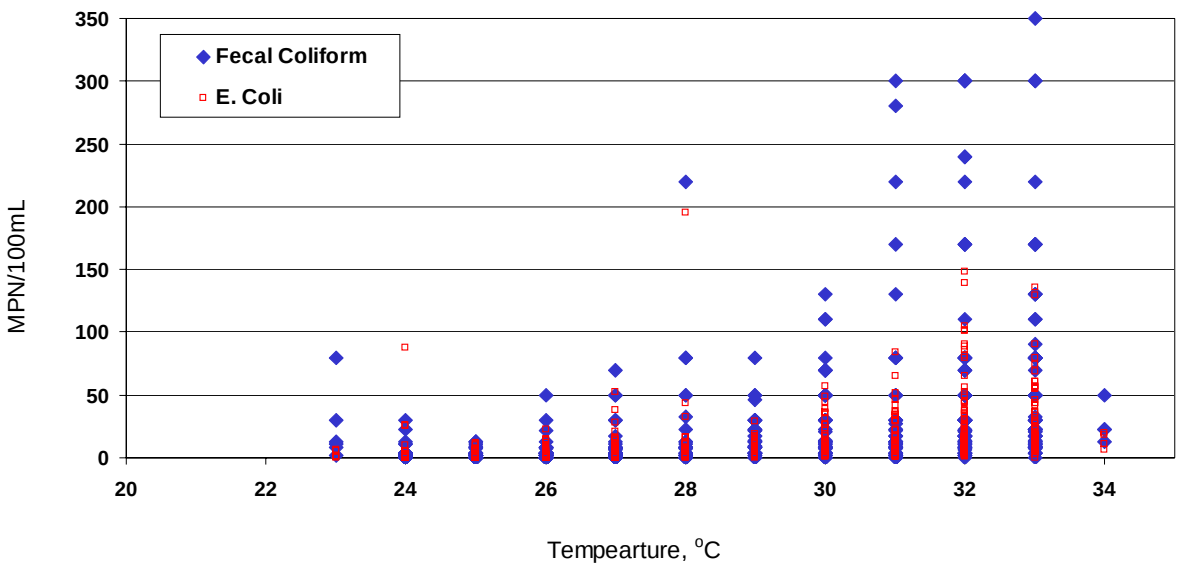
Figure 3-3



In the HPO case, the total chlorine residual consists mostly of combined chlorine, indicating that the HPO plant does not fully nitrify as is expected. Combined chlorine is a less effective disinfectant than free chlorine. Though the chlorine dose applied to the HPO secondary effluent is currently relatively low, it is likely that a much higher dose would be needed to reach breakpoint. Current data indicates that the applied chlorine dose is in the range of about 6.5 mg/L in order to sustain a combined residual of around 2 mg/L.

It should be noted that disinfection at the Ina Road WPCF is also affected by water temperature. In general, data provided indicates that higher fecal coliform and E.coli counts in the disinfected effluent correlate closely with increases in water temperature. This is shown in **Figure 3-4.** This phenomenon may be attributed to several factors. First, at higher temperatures, there is an increase in microbial activity. Secondly, the intense sunlight in the summer months photochemically breaks down available chlorine (primarily in the upper 18-24 inches of the flow depth), rendering the chlorine weaker in disinfection effectiveness.

Figure 3-4



3.2 Studies to Establish Hydraulic Characteristics to Support Enhanced Chlorination

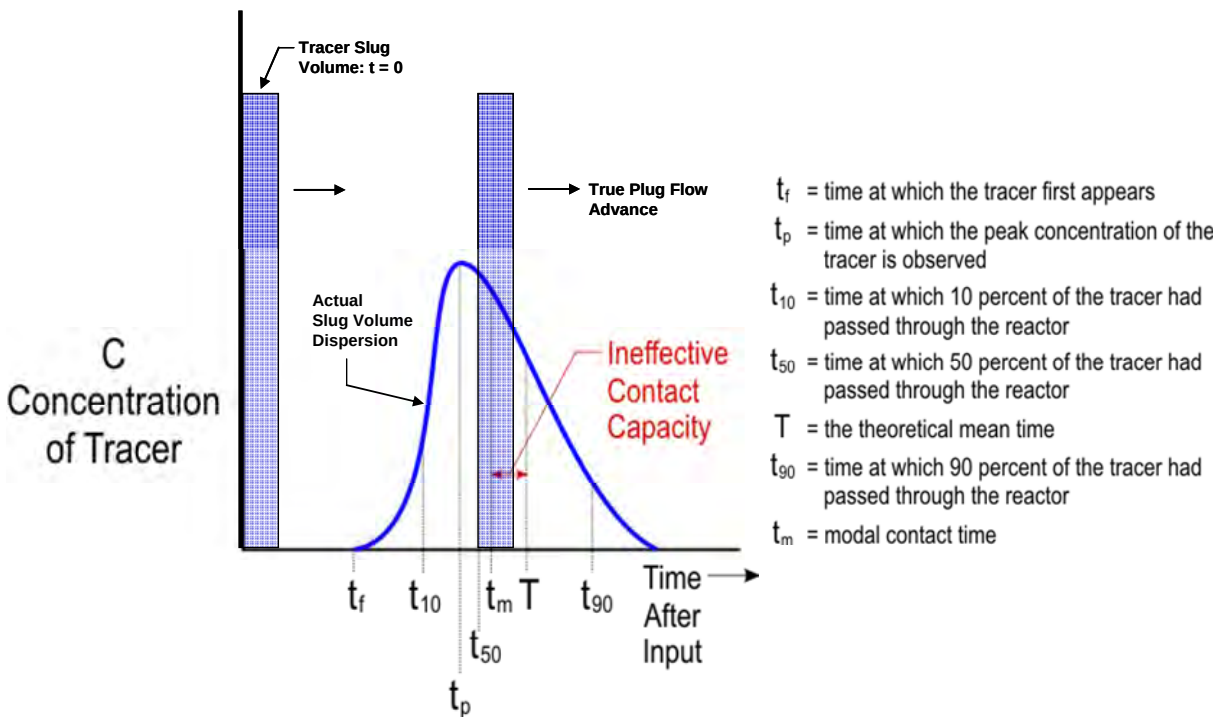
Results of the field assessment of the Ina Road WPCF disinfection facilities indicate that consistent and reliable compliance with BADCT standards requires a thorough evaluation of the existing BNRAS chlorine contact basin hydraulics. Basin hydraulics holds a significant influence over the true time that the target organisms are exposed to the disinfectant dosage.

Hydraulic influence on disinfection efficiency is best described by two fundamental regimes: mixing efficiency and plug flow. In the case of mixing, it is critical that the injected chlorine be thoroughly mixed with the water column of secondary effluent as rapidly as possible at the point of injection. In the secondary effluent there are a number of constituents other than the target organism that create a high demand for chlorine. Therefore, efficient mixing improves the opportunity for chlorine to come in contact with more of the target organisms rather than being lost to other constituent demands. This has an impact on chlorine dose and the resulting downstream contact time required for inactivation reactions to reach completion. It is important, then, to understand how the geometry or the mixing chamber, along with the mixing devices used influence the initial chlorine distribution throughout the water column.

Conventional design of chlorine contact basins provides a large length-to-width ratio to develop as close to a true plug flow condition as possible. In theory, plug flow conditions maintain an optimal concentration of disinfectant in contact with the target organism because plug volume experiences little dispersion. In reality, however, some dispersion of the plug volume does occur. The geometry of the constructed physical tank determines the degree of dispersion. Because of dispersion, some of the flow in a given control plug volume will advance through the basin at a rate faster than the theoretical rate, while other parts of that same volume will pass through slower. These phenomena are a result of different velocities occurring throughout the water column. For example, velocities can differ at the surface than at

the bottom due to temperature gradients changing the fluid's viscosity. Or, friction from containment surfaces creates drag forces on the fluid volume resulting in variable velocity across the flow cross-section. Furthermore, when flows change direction, "dead zones" in the flow path can result. Such unavoidable physical conditions result in a basin flow that can vary significantly from a true plug condition. Such phenomena can be demonstrated with the use of "tracers," which are compounds that do not react throughout the flow path and whose concentration can be tracked along the flow path. This is illustrated in **Figure 3-5**.

Figure 3-5



From this figure several elements are key. First, in a true plug flow system, concentrations of the tracer remain constant as it passes along the flow path. But, in actual physical systems, because of the velocity variations along the flow path, this slug volume "spreads" out, or disperses along the flow path. That portion of the tracer mass that passes out of the system first (noted as t_f in the illustration), in advance of the theoretical hydraulic residence time (noted as T), indicates a "short-circuit" in the flow. The mass passing through last is representative of that portion of the tracer that got "trapped" in zones of low velocity or back-mixing due to localized turbulence. In the figure, this is represented in part by the point noted as t_{90}, which is the time it took for 90% of the trace mass to pass through the system.

Compliance standards generally require the basin contact time used in the "CT" calculation be based on the basin's modal contact time rather than the theoretical contact time. The further a basin's hydraulic regime is from a true plug flow condition, the more will be the spread between the theoretical and modal.

It is important, then, to measure this spread because it provides valuable information for design of the basin.

3.2.1 Field Studies

3.2.1.1 Recommendation: Mixing Efficiency Evaluation

It is recommended that the PCWMD evaluate the efficiency of the rapid mix chamber for the BNRAS chlorination system. This test would utilize a tracer injected through the existing Water Champ® pump and sensors located at different points throughout the mix chamber to measure concentrations of tracer from time of injection. Results of this test will provide important insights into the capability of the existing mixing system to fully mix the disinfectant into the water column in light of the geometrics of the chamber. Furthermore, these results will provide insights into what improvements, if any, to the chamber would be warranted to improve the mixing efficiency.

3.2.1.2 Recommendation: Characterization of Plug Flow

It is recommended that the PCWMD undertake a study to evaluate the degree of dispersion that currently exists in the BNRAS chlorine contact basin. This study would utilize a tracer compound injected into the water column through the Water Champ® pump with sensors located at strategic points along the length of the chlorine contact basin to measure concentration of tracer with time. It is recommended that this test be run under high flow conditions since this will create the least residence time overall and result in the most dispersion due to higher degrees of turbulence in the flow regime. Results of this test will provide the data necessary to calculate the modal contact time for use in true “CT” calculation. Additionally, these results will provide insights into what improvements, if any, to the basin would be warranted to move the flow regime to a more plug-flow-like condition.

3.2.1.3 Recommendation: Basin Flow Velocity Profile

It is recommended that the PCWMD undertake a study that profiles the flow velocity throughout the water column along the basin length. This study would utilize a flow meter instrument that measures flow velocity electronically or mechanically. The profile of the velocity should be done over the entire depth at various points along the basin length. Results of this study will provide insights into where short-circuiting or back-mixing is occurring. These results will provide insights into what improvements, if any, to the basin would be warranted to improve the flow to achieve a more constant velocity throughout the depth profile. This enhances the plug flow conditions. These profiles should be run at both low and high flow conditions.

3.2.1.4 Recommendation: Disinfection Decay Rate

It is recommended that the PCWMD conduct a study that examines the rate and amount of chlorine residual decay along the basin flow path. A sample should be drawn first immediately downstream of the rapid mix chamber to establish the initial residual concentration. Additional samples should then be taken at various points along the basin flow path and the residual measured. It is recommended that samples at each location be taken at several depths. The PCWMD currently owns a HACH® DR2800 unit for measuring chlorine residual. This would be appropriate for this study. The manufacture’s specified detection limit for this instrument is 10 ppb, but the actual method detection level is calibrated at 29 ppb.

Results of this analysis will provide insight into the actual effectiveness of the inactivation upstream as the water moves through the basin with time. These results will also provide insights into what improvements, if any, to the basin would be warranted to improve the sustainability of appropriate chlorine residual concentrations throughout. These profiles should be run at both low and high flow conditions.

4. Conclusion

4.1.1 Concluding Opinion

From the literature and assessment findings discussed in this report, the following basic conclusions can be drawn.

- Employment of an enhanced chlorination process for disinfection has a reasonably high probability of success in meeting the current BADCT standards
- Without filtration as a precursor process to disinfection, it is likely that the enhanced chlorination system can consistently meet the 4-day non-detect criteria for fecal coliform; but it is unlikely that it will not consistently meet the maximum limits for fecal coliform and E.coli
- Concern is raised with fully nitrified effluents resulting in free chlorine being the dominant residual species; this has implications on disinfection by-product formation that may impact reliable compliance with WET or other permit limits.

4.1.2 Recommendations

It is recommended that the PCWMD conduct a number of laboratory and field studies to better characterize the system's capability in meeting the BADCT and permit requirements. These include:

- Disinfection kinetics study
- Target organism characterization study under variable flow and solids conditions
- In-situ disinfectant mixing study
- In-situ dispersion study
- In-situ velocity profile study
- In-situ chlorine residual decay study

Appendix G

Enhanced Chlorination / De-Chlorination

Phase II – Field Studies

Pima County
Wastewater Management Department
Regional Optimization Master Plan

Enhanced Chlorination Study
Phase II – Field Studies

October 2007

GREELEY AND HANSEN

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Executive Summary

Pima County Wastewater Management Department (PCWMD) has been developing a regional master plan for the collection and treatment of wastewater to address the growing demands for wastewater services throughout its entire service area. An element of this planning is determining what wastewater treatment processes will be most effective in meeting the needs and objectives of the department while at the same time satisfying requirements regulating the ultimate reuse of the treated wastewater throughout the course of the planning horizon period.

The quality of the treated wastewater effluent defines its ultimate reuse, and a critical quality element is the degree to which potentially harmful bacteria and other microorganisms are destroyed prior to discharge. The State of Arizona has adopted a set of technology-based standards that must be achieved for an effluent to be considered acceptable for discharge. These are known as "Best Available, Demonstrated Control Technology," or BADCT, standards. The current BADCT standards can be summarized as follows:

> the treated effluent must maintain a level of quality whereby the presence of the target microbial organism, *Escherichia coli*, shall not be detected in at least 4 out of 7 samples taken daily over a 7-day calendar week, and, the maximum allowable presence of *E.coli* in any single sample shall not exceed 15 MPN/100 mL.

There are currently a number of disinfection technologies available capable of consistently and reliably achieving the degree of effluent quality required by the current BADCT. Among these are filtration followed by ultraviolet (UV), ozonation, advanced oxidation (using mixed oxidants), membranes, and enhanced chlorination. PCWMD carefully evaluated the alternatives and determined that both the filtration/UV and the enhanced chlorination processes best suited its planning objectives. However, because of the high capital, operational and maintenance costs associated with the filtration/UV process, PCWMD determined that an evaluation of the feasibility of enhanced chlorination as the disinfection process for its wastewater treatment facilities was justified.

PCWMD's evaluation of the enhanced chlorination process is the subject of this report. The evaluation includes literature reviews along with a series of bench-scale and full-scale studies conducted at the East Biological Nutrient Removal Activated Sludge (BNRAS) Plant at the Ina Road Water Pollution Control Facility in Tucson, Arizona. The bench-scale studies established the baseline kinetics for the chlorination process. The full-scale studies estimated the performance limitations of the existing system in meeting current BADCT under specific conditions. The concluding opinion from this feasibility evaluation is that the enhanced chlorination technology is acceptable for implementation as the preferred technology for existing and proposed disinfection systems at PCWMD wastewater treatment facilities within the jurisdiction of PCWMD.

Together these studies provide the information necessary to establish: 1) recommendations for improvements and upgrades to the existing disinfection system at the East BNRAS Plant at Ina Road WPCF necessary to achieve current BADCT requirements, and 2) a set of criteria guidelines for the design of future PCWMD wastewater disinfection facilities to reliably and consistently achieve BADCT standards as currently promulgated

1. Introduction

1.1 Background

Pima County Wastewater Management Department (PCWMD) currently owns, operates and manages a number of wastewater treatment facilities. Over the past year, PCWMD has been involved in the development of the Regional Optimization Management Plan (ROMP). This plan involves evaluation of the Pima County wastewater treatment facilities with key objectives including:

1. Collection and treatment capacities to accommodate population growth throughout the region, and

2. Evaluation of the treatment technology necessary to achieve compliance with Arizona's current and foreseeable future environmental water quality standards for discharge of treated effluent to waters of the state or for reuse.

Addressing the disinfection of the plant effluent with respect to the latter objective is the focus of both the Phase I and Phase II reports. Phase I involved two key elements. First, an investigation of the published literature on disinfection processes was conducted. The purpose was to establish the relationship between the process of chlorination of wastewater effluent and compliance with standards that regulate the water quality for discharges of treated effluent. The objective was to identify facilities comparable in size and process configuration to that of the Ina Road Water Pollution Control Facility (WPCF) and categorize the processes used for treatment and disinfection in the context of their respective compliance standards. Secondly, Phase I gathered information on the existing conditions chlorination facilities at the Ina Road WPCF. This information provided guidance for recommendations on studies necessary to assess the feasibility of an enhanced chlorination process at Ina Road capable of reliably meeting the "Best Available, Demonstrated Control Technology" (BADCT) standards for disinfection set by the State of Arizona. The compliance standards are outlined in the State of Arizona's Administrative Code for environmental regulations.

The results of the literature review in Phase I provided the following general conclusions:

- Employment of an enhanced chlorination process for disinfection has a reasonably high probability of success in meeting the current BADCT standards;

- Without filtration as a precursor process to disinfection, it is likely that the enhanced chlorination system can consistently meet the 4-day non-detect criteria for fecal coliform; but it is unlikely that it will consistently meet the maximum limits for fecal coliform and *E.coli*;

- Concern is raised with fully nitrified effluents resulting in free chlorine being the dominant residual species; this has implications on disinfection by-product formation that may impact reliable compliance with WET or other permit limits.

The results of the field assessments in Phase I generated a set of recommendations for studies to be conducted to better characterize the system's capability to meet the BADCT requirements and establish

the scope of enhancements to the physical disinfection system components and process necessary to ensure consistent BADCT compliance. These were:

- Disinfection kinetics study
- Target organism characterization study under variable flow and solids conditions
- In-situ disinfectant mixing study
- In-situ dispersion study
- In-situ velocity profile study
- In-situ chlorine residual decay study

This Phase II report examines the disinfection efficacy of the existing disinfection technology (chlorination by liquid sodium hypochlorite) employed at the BNRAS (East) Plant at the Ina Road WPCF for achieving future compliance with the BADCT standards for disinfection. The study results reported herein focus only on the inactivation effectiveness of the existing disinfection system for *E.coli*. Specifically, these standards are non-detectable in 4 out of 7 samples per calendar week and a single sample maximum of 15 *E.coli*/100 ml.

Issues surrounding compliance with the state's water quality standards for treated effluent chlorine residual and Whole Effluent Toxicity as required by the Arizona Pollutant Discharge Elimination System (AZPDES) permit issued to PCWMD were not part of these field studies. Similarly, potential issues of concern regarding the formation of disinfection by-products and enteric virus inactivation to address compliance with meeting "Class A" water reuse standards (through the Aquifer Protection Permit) were not addressed in these studies.

The set of study results described herein focus on assessing enhanced chlorination as a technology system for disinfection capable of meeting PCWMD's microbial inactivation compliance objectives reliably and consistently.

1.2 Study Descriptions and Protocols

As described in the Phase I report, two types of studies in Phase II were conducted: 1) evaluation of the kinetics of microbial inactivation for the secondary effluent using bench and full-scale studies; and 2) evaluation of the mixing of the injected chlorine with the influent, the subsequent flash mixing, and the flow regime characteristics of the existing BNRAS chlorine contact basin (CCB). The set of field studies recommended in Phase I involving chlorine residual decay along the flowpath of the CCB and vertical profiles of the flow velocity in the CCB channel were not conducted in Phase II.

Protocols typical of these types of studies are detailed in **Appendix A** of this report. Data analyzed from these studies was collected during the period between May 1 and August 31, 2007.

1.3 Study Participants

The raw data supporting the kinetics studies was collected by PCWMD laboratory staff. Microbial testing was conducted by PCWMD laboratory staff in PCWMD laboratory located at the Ina Road WCPF. Staff also collected information on physical and chemical characteristics of the secondary effluent (such as water pH and temperature) to define baseline conditions. Methods of laboratory analysis were in accordance with the most recent edition of *Standard Methods*.

Participation in these studies by PCWMD operations staff was also significant. The mode of operation currently employed for the BNRAS plant is a "flat-lined" flow condition. For the period between August 2 and August 17 the operations staff modified the raw wastewater pumping operations to simulate the typical influent diurnal pattern through the BNRAS plant. This simulated a more "realistic" condition for the operation of the disinfection process under study, and is reflective of future operations for this facility.

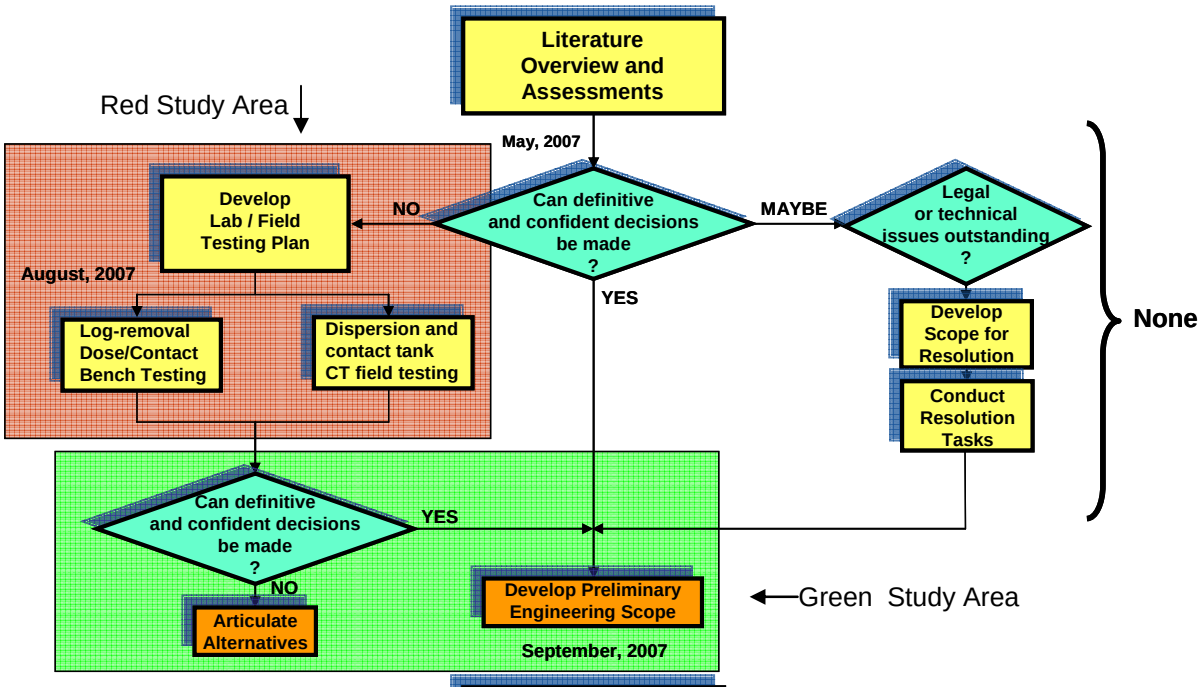
A team of consultants were available to assist PCWMD staff in developing the study protocols and in preparing for the studies. This consultant team was responsible for data analysis and interpretation, and in developing the conclusions and recommendations. These consultants included professionals from the following firms:

- Greeley and Hansen Engineers
- Kennedy/Jenks Consultants
- Brown and Caldwell
- Malcolm Pirnie Environmental Engineers and Consultants

1.4 Decision Process

The decision-making process used for this Enhanced Chlorination Study is repeated here from the Phase I report and is shown on **Figure 1-1.**

Figure 1-1
Decision Process for Enhanced Chlorination Evaluation



The red and green-shaded areas indicate the portion of the decision process related to the studies addressed in this report. A key element in this process is the decision point on whether or not to proceed with the enhanced chlorination technology process. It should be noted that PCWMD indicated that no unresolved technical or legal issues with respect to regulatory framework remain that would inhibit the decision-making steps (as indicated on the right side of decision flowchart).

2. General Technical Approach

2.1 Technical Concepts of the Studies

The primary objective with utilizing chlorine as the disinfectant is achieving the appropriate "CT" (chlorine residual concentration measured at the contact basin outlet x contact time within the basin) range that ensures the degree of inactivation of microbes necessary to comply with the BADCT standards. The amount of chlorine residual measured is related to the kinetic behavior of the inactivation reactions. The actual dosage required to achieve that residual can then be inferred from these results. The contact time is determined from analyzing the characteristics of the mixing of the disinfectant into the bulk liquid and the subsequent flow regime that influences the amount of time the target organisms are in direct contact with the disinfectant. The combination of these two parameters defines the CT. The amount of CT required is therefore the primary parameter driving decisions for design of the chemical feed system and the contact basin.

The focus of these studies was on *E.coli* as the target organism, and determining the appropriate CT for reliably achieving the degree of inactivation of this organism necessary to meet the BADCT standards at the final effluent's point of compliance monitoring.

2.2 Disinfection Kinetics

Kinetics refers to the rate, or speed of a reaction. Important to this rate is the time that the target organism is in contact with the disinfectant, i.e., the longer the contact time, the greater the degree of kill. This can be represented schematically on **Figure 2-1** for chlorine as the disinfectant. The relationship between the contact time and the applied dose of disinfectant is illustrated by the slope of the line.

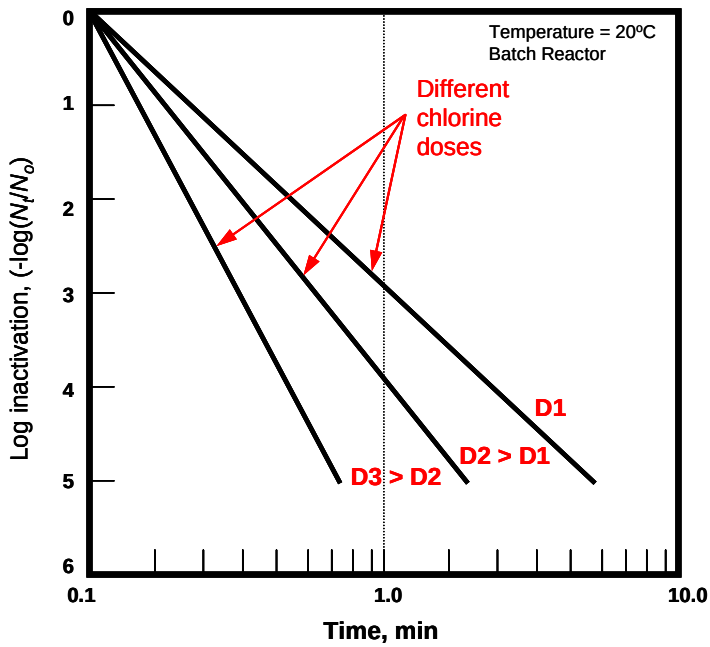
Under ideal conditions, when no outside interferences are present, the rate of change in the concentration of organisms with time is a function of both the number of organisms present and the concentration of the disinfectant residual at any given time. An example of a mathematical model describing this is given in Equation 2-1 (derived from work done by Crick and Watson in the early 1900s). When the solution to this differential equation plots as a straight line on a log-log graph, the inactivation reaction is said to be "1st Order."

$$(dN_t / dt) = - k' C^n N_t, \qquad \textbf{Eq. 2-1}$$

where: (dN_t / dt) = the rate of change in the concentration of organisms with time;
k' = coefficient of die-off
C = concentration of disinfectant measured at time, t
n = coefficient of dilution
N_t = number of organisms at time, t

In the normal environmental conditions encountered in the disinfection of wastewaters, deviations from the mathematical model's ideal conditions are typical. In chlorination systems, these deviations can be related to the microbes' ability to resist the disinfecting power of the chlorine, the presence of organic or inorganic compounds that create a demand for the chlorine, and the presence of particulate matter that encapsulates the organism thereby shielding it from coming into contact with the chlorine. The results of the kinetic response deviate from the ideal response as shown in the figure below.

Figure 2-1[1]
Ideal 1st Order Inactivation in Response to Variable Dose



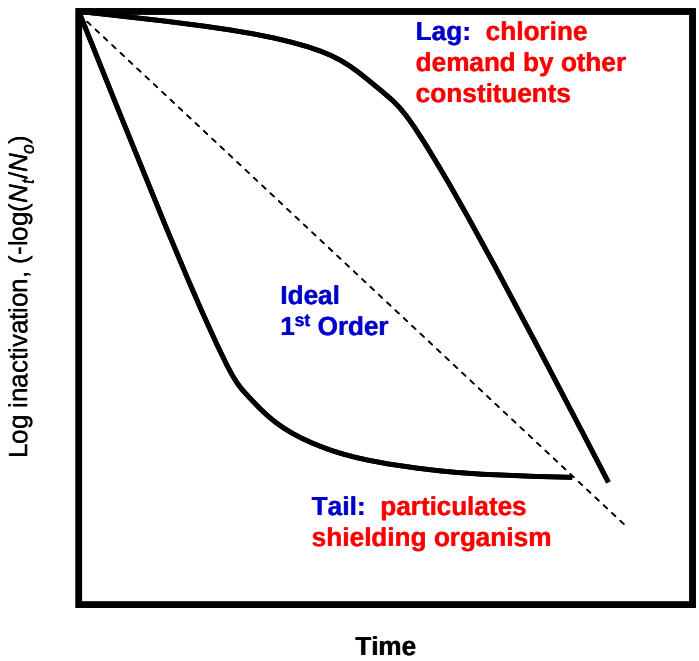
In the disinfection of treated wastewater effluents, the kinetic response is influenced by the type and efficiency of the upstream treatment process. For instance, when significant numbers of higher trophic organisms are present, such as protozoa and algae (sometimes referred to "multiple-hit organisms"), then more chlorine is needed for their destruction before inactivation of the target organism begins to dominate. Another example is when the upstream biological treatment process only partially nitrifies. In this case, the presence of ammonia and/or nitrite in the secondary effluent entering the disinfection facility will immediately react with the available chlorine and form chloramines which are less effective in disinfection power. This results in less free chlorine being available for immediate activity and inactivation of the target organism is delayed. This is illustrated with the "lag" curve.

On the other hand, if total suspended solids are present in the secondary effluent, these tend to provide a "shield" for the target organisms that may be embedded within the floc particle. As a result, these organisms may escape destruction altogether. This is the case with the "tail" curve illustrated in **Figure 2-2.** For this case, the inactivation of the exposed target organisms is immediate. But once these are destroyed the remaining concentration of viable organism declines slowly or not at all due to the shielding effect of the solids. It should be noted that this "tail" curve can also be indicative of the variety of microbial species present, some having a higher sensitivity to chlorine and others being more resistant. For this situation, the "tail" curve illustrates how the more sensitive organisms are destroyed immediately upon exposure, while the more resistant survive much longer. Because of the heterogeneity of species in a typical domestic wastewater, such kinetic behavior is not unexpected.

[1] Wastewater Engineering: Treatment and Reuse, 4th Edition; Metcalf & Eddy, (2003) McGraw-Hill, pg. 1224

The development of the kinetic behavior establishes a "model" by which predictions can be made on the "theoretical" magnitude of microbial inactivation that might be expected if exposed to a given dose of chlorine for a given period of time for this specific disinfection system. The model is very useful because it shows what performance levels are probable, which can then be compared directly with what is actually observed in the field. For instance, if the model predicts that a specific magnitude of inactivation is expected for a given dose and contact time, but the actual observed inactivation in the field is less, then the logical conclusion is that the enhancements to the full-scale system may be necessary in order to bring its performance closer to the model's "theoretical" predictions.

Figure 2-2
Deviations from Ideal 1st Order Inactivation



2.2.1 Kinetic Model Development for BNRAS

To develop the kinetic behavior of the existing disinfection process on the BNRAS secondary effluent, a series of 9 separate trials were conducted over 9 separate days.[2] For each trial, a bulk sample was collected just outside the flash mix chamber of the basin (and therefore subjected to the initial chlorine dose applied by the system at the time of sample). Then, at specific intervals of time from 5 to 90 minutes, individual samples were drawn from the bulk sample, neutralized and tested for Total Coliform and *E.coli*. Enumeration of these target organisms was performed in triplicate on each interval sample and the results average and then plotted.

[2] Sampling and laboratory analysis conducted by PCWMD staff

Because *E.coli* is a subset of Fecal Coliform (FC), and FC a subset of Total Coliform (TC), one would expect some general relationship between the concentrations of these in treated effluent. Indeed, under ideal conditions, as a general rule, TC exceeds FC by approximately 1 log, and FC exceeds *E.coli* by approximately 1 log. Therefore, standard protocol for these types of kinetics studies is to test for TC, FC and *E.coli*. Doing so provides a QA/QC check on the analysis. Due to the fact that the methodology for analyzing FC requires different incubation conditions (and therefore more incubator space), limitations in laboratory resources mandated that the kinetics studies run for the BNRAS disinfection be performed only for TC and *E.coli*.

The set of samples taken over the 9-day period to develop the kinetic model were collected while the BNRAS plant was being operated in an average "flat-lined" daily flowrate of 12.7 MGD (minimum day rate of 12.19 MGD and a maximum day rate of 14.09 MGD). The chlorine dosage applied during these tests ranged between a minimum of 2.88 mg/L and a maximum of 5.12 mg/L of NaOCl as chlorine. The average wastewater temperature at the time these samples were taken ranged from a minimum of 29.7^{o}C to a maximum of 31.1^{o}C, with an average of 30.6^{o}C, and the pH averaged 7.1-7.2. The secondary effluent average suspended solids concentration at the time these samples were taken was < 5 mg/L. The corresponding turbidity of the treated effluent during the test period was less than 2 NTU. This secondary effluent TSS is reflective of good performance of the upstream processes. Obviously, disinfection can be less effective when effluent suspended solids concentrations are much higher than this value.

2.2.2 Full-Scale Kinetic Analysis of BNRAS Secondary Effluent

With the behavior of inactivation kinetics established, the next step was to relate this to the inactivation behavior observed in the full-scale disinfection system. For this analysis, 27 paired samples were collected between the period of May 17, 2007 and July 10, 2007. Each pair consisted of a sample of the BNRAS secondary effluent and the West chlorine contact basin effluent. As with the bench-scale kinetic study, these samples were analyzed for Total Coliform and *E.coli.* The difference in the numerical values from the influent and effluent establishes the "actual" log-inactivation performance being achieved by the system under the environmental conditions present at the time of sampling. By aggregating the data from all valid samples, the result is a range of inactivation efficiencies that can be plotted. From this plot, the degree of actual logs of inactivation being achieved can be estimated for the average, the maximum, and the minimum inactivations. It is important to note that inherent in these results are the variations in flow and process conditions occurring at the time of sampling.

The full-scale kinetic tests were conducted while the BNRAS plant was being operated in a "flat-lined" flowrate mode of in similar fashion to that described in Section 2.2.1 above.

Results and implications from both the bench-scale and full-scale studies are detailed in Section 3 of this report.

2.3 Analysis of Existing Mixing and Flow Characteristics of Chlorine Contact Basin

The time of exposure of an organism to a disinfectant influences its rate of inactivation. Therefore, it is important to understand the operation of the existing chlorine injection system, the initial bulk mixing of the fluid immediately following chlorine injection, and the characteristics of the flow following the initial mixing in the downstream channel of the BNRAS chlorine contact basin.

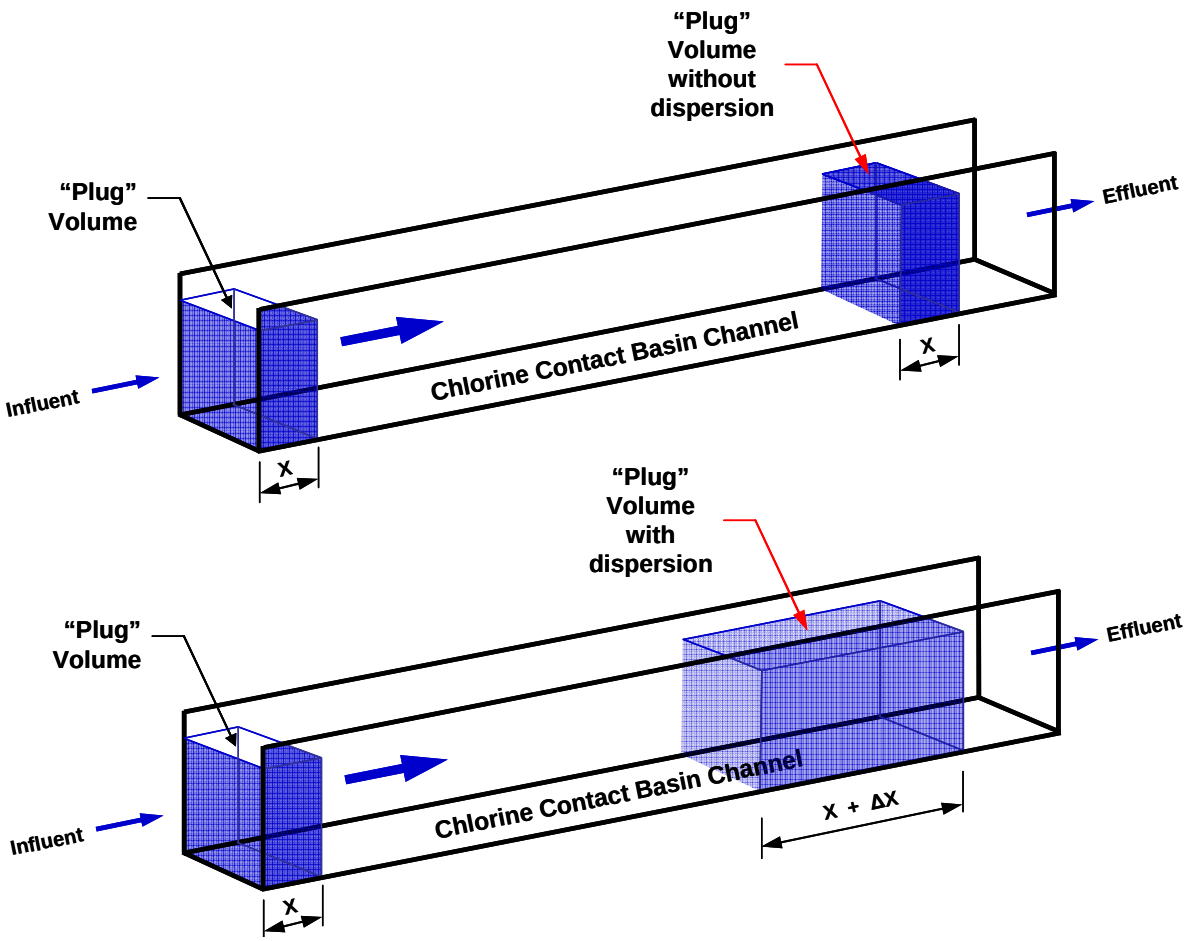
The chlorine injection step and the subsequent intense mixing are crucial to the inactivation of the target organism. As a general rule, efficient injection/mixing regimes that create intense turbulence can increase the overall inactivation efficiencies by as much as 2 logs. Equally as critical is the flow regime downstream of the mixing. Most chlorine contact basins are designed and constructed to operate in a "plug flow" mode. The closer the flow regime is to ideal plug flow, the greater the efficiency of overall inactivation. The greater the length-to-width ratio of the flow channel, the more closely the flow approaches plug flow. For the BNRAS facility, this ratio is approximately 20:1. This value is considered acceptable but at the lower end of the standard for chlorine contact basin design which typically ranges from 20 to 40:1.

Under ideal plug flow, the target organism is held in contact with the disinfectant's maximum residual concentration for the maximum time possible for a given flowrate. If, however, the "plug" volume is dispersed as the flow moves through the contact chamber, the result is a shorter exposure time (due to the hydraulic short circuiting) of the microbes to the disinfectant residual concentration, thereby reducing the overall effectiveness of the disinfection process. This concept is depicted in **Figure 2-3**. In this illustration, a non-reactive compound enters the basin as a plug. Due to non-ideality of flow, the plug volume disperses as it moves through the channel toward the outlet. Near the outlet of the channel, the concentration of the conservative compound at any given point in the dispersed plug is significantly less compared to any point in the non-dispersed plug at the head end of the channel (lighter shade of blue of the dispersed volume at the downstream end represents the lower concentration). In a chlorine contact tank, even if ideal plug flow is achieved, the concentration of the chlorine residual will still be less in the non-dispersed plug volume when it reaches the outlet due to constituent demands and decay of the chlorine itself. Therefore, any deviation from ideal plug flow in a chlorine contact basin results in a more pronounced impact on the disinfection effectiveness.

No physical structure is capable of achieving an ideal plug flow condition. The following are examples of conditions that influence the degree of deviation of a channelized flow regime from ideal plug flow.

- Friction from the channel walls and floor vary the flow velocity across the flow cross section;
- Square corners in rectangular channels built in a serpentine configuration often cause "dead zones" in the flow path;
- Surface winds can create eddy currents that result in back-mixing;
- Temperature gradients can alter the density of the fluid thus affecting its flow characteristic;
- Variation in plant flowrate affects degree of short-circuiting.

Figure 2-3
Concept of Dispersion from Ideal Plug Flow

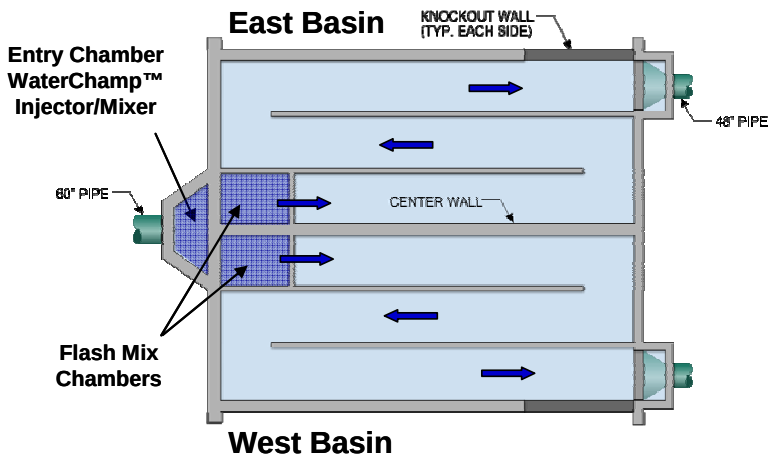


2.3.1 Full-Scale Mixing Analysis of BNRAS Chlorine Contact Basin (CCB)

A tracer methodology was applied to analyze the mixing efficiency of the chlorine injection chamber and the subsequent flash mix chamber of the BNRAS CCB. The location of these two chambers is illustrated on **Figure 2-4** for the BNRAS CCB. The tracer used was sodium chloride (NaCl), a conservative compound that does not react with chlorine and other constituents in water. The concentration of the tracer was monitored by measuring the change in conductivity with time. The salt tracer was injected through the existing WaterChamp™ mixer unit in the "entry" chamber located immediately upstream of the flash mix chamber. The conductivity sensor was first used to profile the tracer over the depth of the injection chamber following injection. The effectiveness of the injection pump in dispersing the chlorine throughout the fluid was determined by the degree of uniformity of the detected tracer throughout the

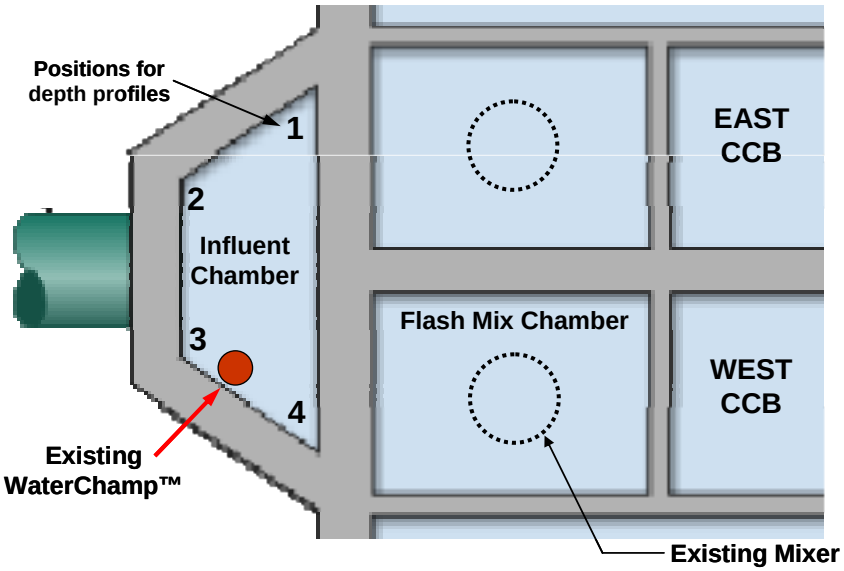
depth at four different locations within the entry injection chamber at specific time intervals following injection. An illustration of these profile locations in the influent entry chamber is shown in **Figure 2-5**.

Figure 2-4
Schematic of Existing BNRAS Chlorine Contact Basin



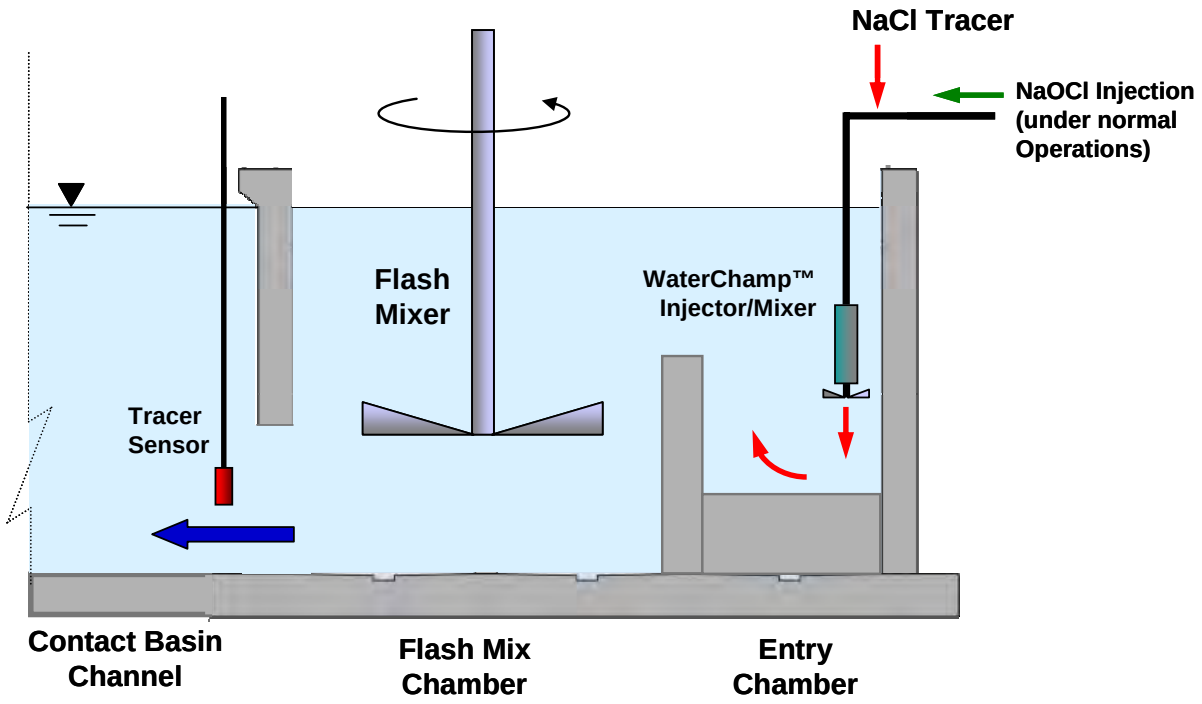
The standard practice of the plant operators for chlorine injection is to inject the sodium hypochlorite (NaOCl) directly into the flow through the WaterChamp™ mixer/pump. However, on the day this tracer analysis was conducted, the WaterChamp™ was not being used for chlorine injection due to a maintenance issue with the pump. The chlorine was instead injected through the existing inductor unit as part of the original chlorinator injector system. This unit is located in close proximity to the WaterChamp™. During the tracer tests, the WaterChamp™ mixer was running but not providing the chlorine injection. The tracer salt was then injected through the WaterChamp to simulate the chlorine injection. The results of the tracer study then, do reflect the WaterChamp's™ ability to mix the contents of the entry chamber.

Figure 2-5
Location of Existing WaterChamp™ Injector/Mixer Unit



Following the chlorine injection in the entry chamber, the flow passes into the flash mix chamber where it is vigorously mixed with a vertical shaft propeller mixer. To determine the effectiveness of this flash mixing, the conductivity sensor was placed at the downstream side of the outlet orifice from the mixing chamber. An illustration of the position of the tracer sensor for the flash mixing data collection is shown in **Figure 2-6**.

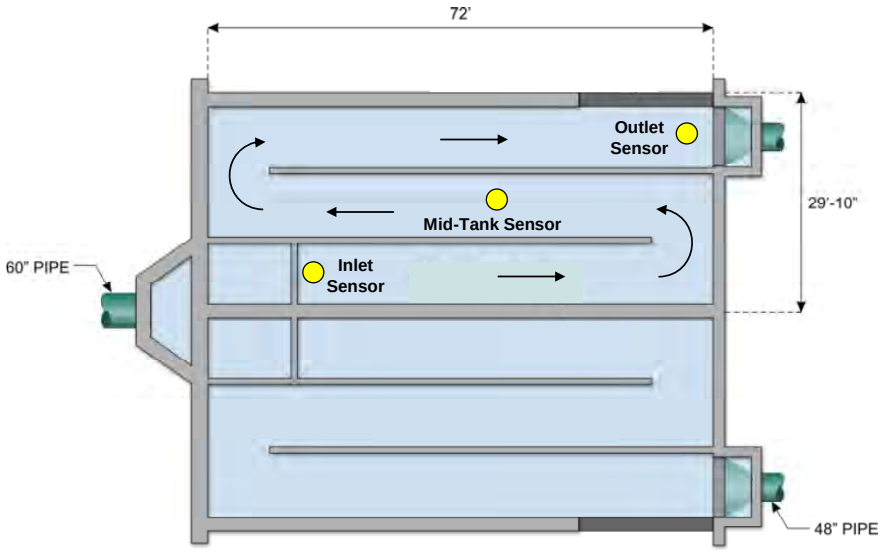
Figure 2-6
Schematic Cross Section of Influent and Flash Mix Chambers



2.3.2 Full-Scale Dispersion Analysis of BNRAS Chlorine Contact Basin

To evaluate how near the channel flow was to ideal plug flow, a NaCl tracer was again used. Three sensors were placed in the channel: immediately downstream of the flash mix chamber, at the mid-point of the channel run length, and just upstream of the effluent weir at the end of the channel run length (see **Figure 2-7**). This was done for both the East and West basins. The brine tracer was introduced through the WaterChamp™ in the entry chamber, typically for a duration of about one minute. Conductivity was monitored at each of these three sensors before tracer was injected to establish the background condition. It was continuously monitored from the time of tracer injection until well after the injection ceased and readings measured at the outlet sensor returned to background levels. The results and implications of these full-scale dispersion studies are detailed in Section 3.

Figure 2-7
Tracer Sensor Locations for Dispersion Analysis

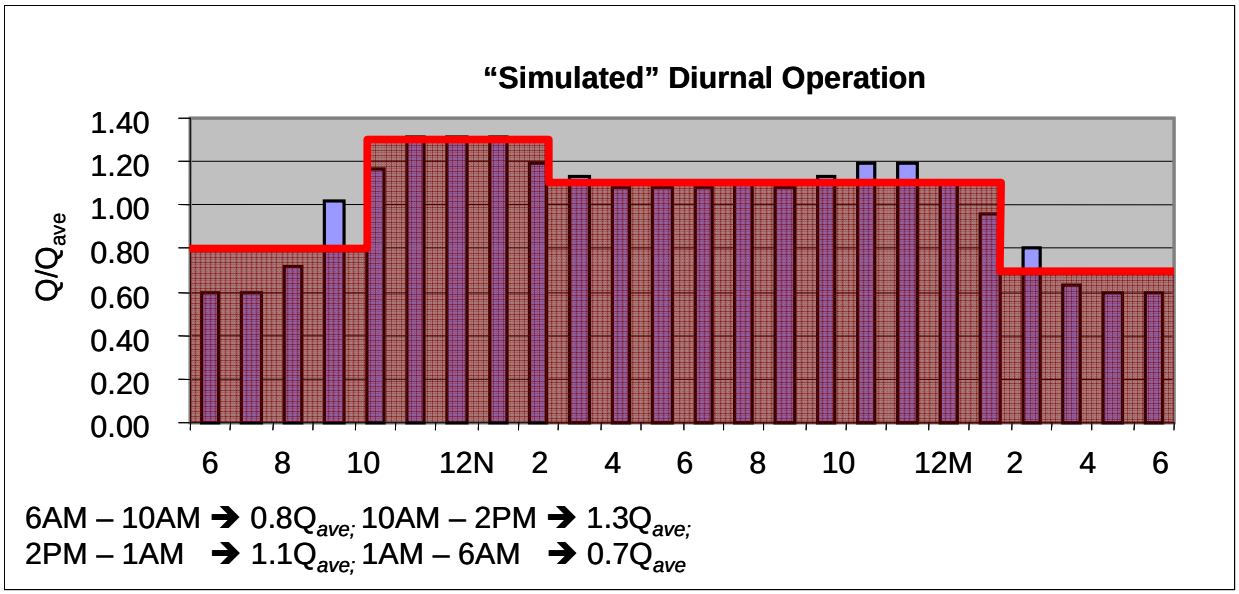


2.3.3 Simulating a Diurnal Flow Pattern

As previously mentioned, the mixing and flow regimes within the CCB vary depending on the plant flow rate at any given time. Therefore, one would expect that there would be a difference in flow characteristics during periods of low flow compared to those of high flow.

The current practice for the BNRAS plant is to operate in a "flat-lined" flow condition. A constant flow of approximately 10 to 12 MGD is processed through the BNRAS plant. In the future, however, the BNRAS facility will operate under normal diurnal conditions, and disinfection will need to be effective under variable flow conditions. Therefore, the project team developed an operational strategy to "simulate" a diurnal flow pattern through the plant. The pattern, illustrated schematically in **Figure 2-8**, was derived from recent historical influent flow data provided by PCWMD. Operators of the BNRAS facility implemented this pattern by manipulating the number of influent pumps in operation at specific times throughout the day.

Figure 2-8
Simulated Diurnal Flow through BNRAS



For both the mixing and dispersion analyses, these tests were conducted during periods of highest flow and lowest flow on the simulated diurnal flow pattern.

3. Results

3.1 Disinfection Kinetics

Disinfection kinetics were evaluated through bench-scale procedures and full-scale measurements. Results from the 9-day bench-scale kinetics and 27-day full-scale kinetics studies are provided below.

3.1.1 Kinetics Behavior

Results from the 9-day bench-scale kinetics study are plotted on **Figure 3-1** and **Figure 3-2**, for Total Coliform (TC) and *E.coli*, respectively. Shown in these figures are the survival ratios of TC or *E.coli*, presented as N/N_0 in log scale, as function of CT. Note that chlorine dosage rather than chlorine residual was used in the CT calculation. Since chlorine dose is higher than chlorine residual due to chlorine demand, this is a conservative approach to estimate the required CT level for a certain efficiency of inactivation.

Figure 3-1
Bench-Scale Results: Inactivation Kinetics – Total Coliform: 9-Day Study

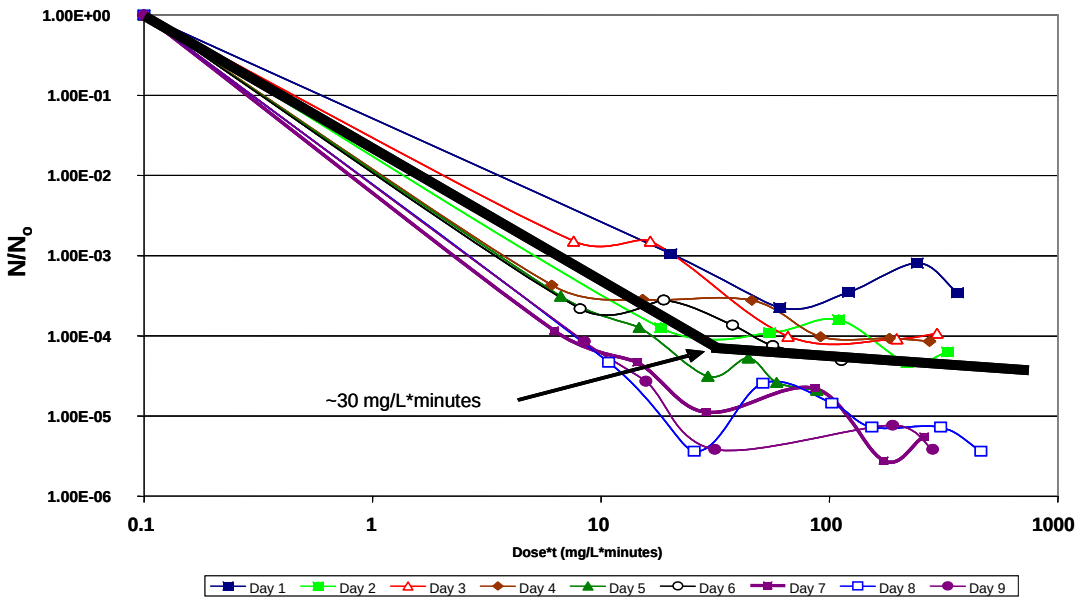
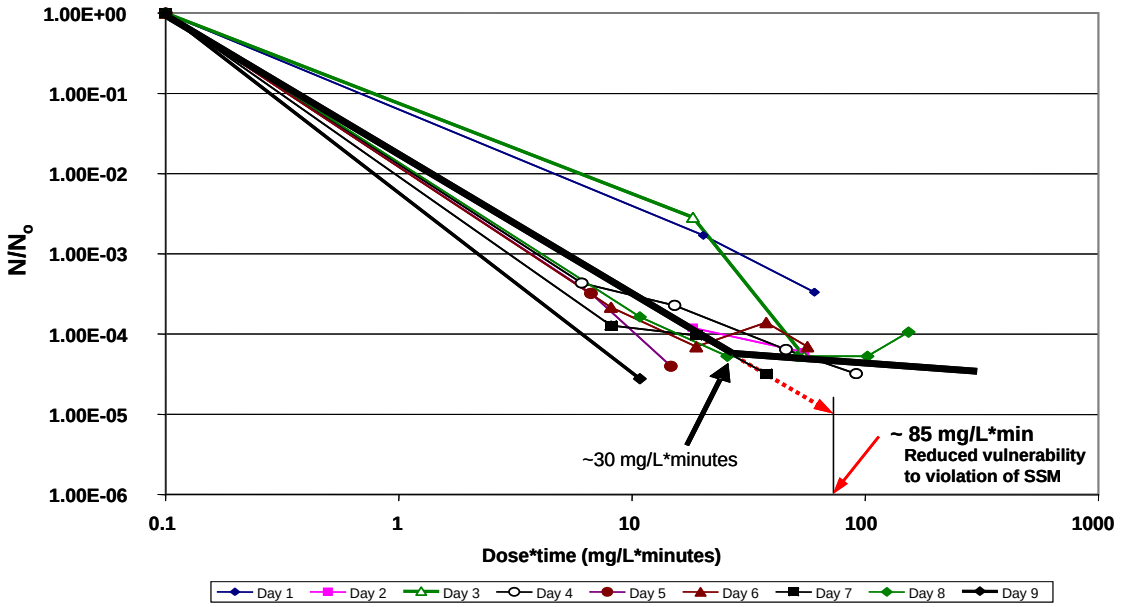


Figure 3-2
Bench-Scale Results: Inactivation Kinetics – *E.coli*: 9-Day Study



The TC kinetics indicates a "tailing" behavior for the inactivation. A trending line (heavy black line) procedure was applied to illustrate the "average" response. For approximately the first 20 minutes of contact time (assuming a chlorine residual of 2 mg/L), the inactivation activity exhibits a 1st Order behavior. But the data then levels out, leaving an "elbow" in the response, and departing from an initial 1st Order reaction. This "elbow" occurs at a CT value of approximately 30 mg/L*minutes, and corresponds to a log inactivation of greater than 4. The presence of the "tail" beyond the elbow depicts a much slower 1st Order response. To explain this slower portion of the disinfection kinetics, the commonly found mechanism is that presence of suspended solids in the secondary effluent. These solids provide some degree of "shielding" of the target organisms from the chlorine inactivation. This "tail" can also represent the resistance of some organisms to chlorine, thereby delaying their inactivation.

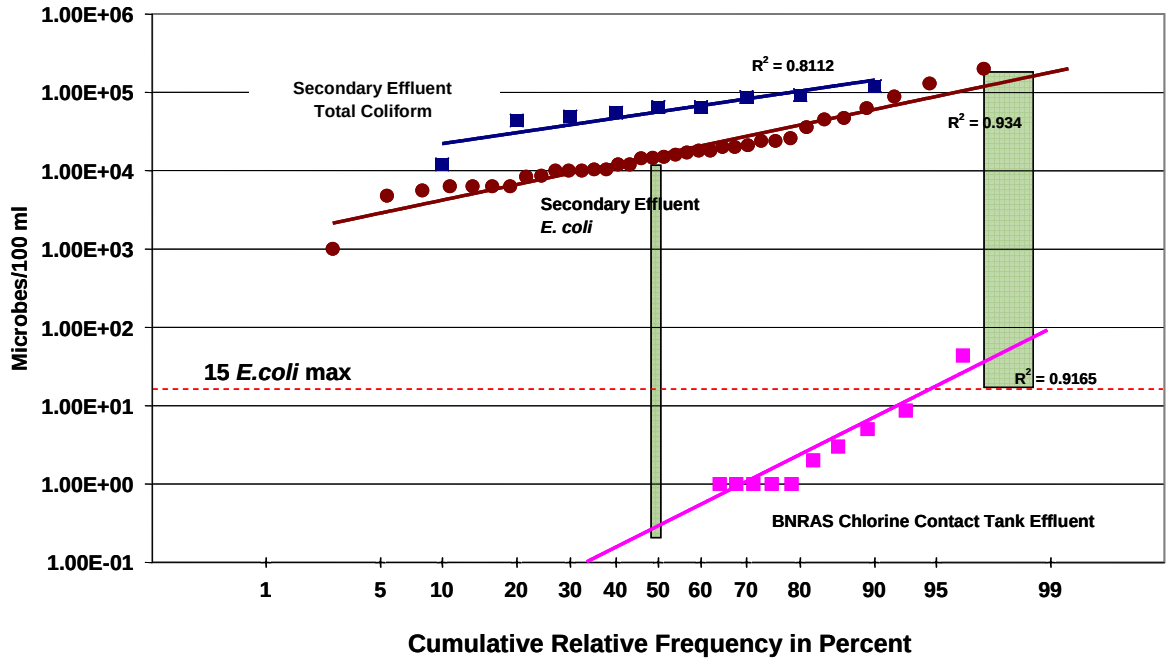
From the bench-scale results for inactivation kinectics a similar behavior is exhibited for *E.coli* inactivation. Because a number of the *E.coli* samples had non-detect results, a "tail" appeared in only two of the nine days. Knowing that *E.coli* is a subset of TC, then we would assume the *E.coli* to follow a similar inactivation behavior as TC. However, the end points on average lie in the 30 mg/L*minutes CT range, similar to that of the TC response, with the log inactivation also being greater than 4. Therefore, the bench-scale results also show the elbow at the 30 mg/L*minutes CT point, and a "tail" having the same slope as that of the TC response. This is a conservative approach since in general one would expect to see the influent CCB *E.coli* concentrations at about two logs less than TC.

The kinetic behavior of inactivation established by these bench-scale results provide important information regarding the magnitude of CT required of the system to achieve the target inactivation levels required by the BADCT. The next step, then, is to analyze the inactivation performance of the existing full-scale system to determine if it is capable of meeting the BADCT. If it is determined that existing full-scale system cannot be relied upon to meet the standards consistently, then enhancements are necessary. These enhancements involve increasing the CT. The amount of increase is provided by the information generated from the bench-scale model.

3.1.2 Full-scale Kinetics Response

Data from the 27-day full-scale study was analyzed and converted to frequency of occurrence ranked by percentile. Using this distribution method, one can determine the "average" inactivations, as well as establish what inactivations are likely for data lying near the "extremes" of the data set. The converted data from the 27-day full-scale is shown in **Figure 3-3**. Performance data is provided in **Appendix B.** During the study, approximately 40% of the effluent *E.coli* counts were found to be "non-detect." These were recorded as "< 1" and though not shown on the graph, were included in the sequencing analysis. Also, to broaden the sample base, the set of 9 secondary effluent samples used in the bench-scale kinetics analysis were included as part of the secondary effluent characterization in this analysis. In the 27-day study figure the solid lines are the "modeled" results and the data points are the observed. The modeled lines are an excellent representation of the observed data as indicated by the very high R^2 values. The modeled results can then be used to project with confidence the extreme conditions, i.e., the portion of the data > 95 percent of the "Z" distribution.

Figure 3-3
Full-Scale Results: Inactivation Kinetics: 27-Day Study



As is evident from the solid lines (the model predictions), the full-scale system is modeled to achieve nearly 5 logs of inactivation of *E.coli* under average conditions (comparing secondary effluent *E. coli* with CCB effluent at the 50th percentile). Even at the 80th percentile, the inactivation is greater than 4.5 logs. This is significant with respect to the BADCT compliance of achieving "non-detect" (ND) 4 out of 7 weekly calendar days. The BADCT requirement means that compliance is met when "non-detect" occurs in at least 57% of the samples during a given 7-day period. Because the reporting limit for compliance is 2 MPN/100 ml, then from this data analysis, the existing full-scale system achieves this requirement 80% of the time. Therefore, the modeled results predict that the current BNRAS design and operation is expected to consistently meet the BADCT's 4 out of 7-day ND requirement.

The graphic also reveals that there are times when the concentration of *E.coli* in the CCB effluent exceeds the BADCT's maximum single sample concentration limit. This maximum limit, 15 colonies per 100 ml, is shown on the graph for reference (dashed red line). The degree of log-inactivation corresponding to the highest *E.coli* concentration detected in the CCB effluent occurs near the 96th percentile. At this point, the modeled inactivation rate is approximately 3.5 logs. This is a critical result. The basic message here is that the existing system is vulnerable to exceeding the BADCT's single sample maximum limit for *E.coli*. To achieve 100% compliance with the single sample maximum limit, an inactivation of more than 4.12 logs would be needed (illustrated by the green bar).

Although only one observed point (i.e., one day out of the 27 days that were tested) on this graph exceeds the maximum limit of 15, this represents one out of 27 samples, or 3.7%. The implication here is that using this observed frequency for a year (365 days), the single sample maximum could be in violation as

much as 14 days. Taking this a step further, applying the 3.5 log-inactivation (modeled inactivation from Full-Scale Results: Inactivation Kinetics: 27-Day Study) to the maximum secondary effluent *E.coli* concentration observed during the study (200,000), would result in a maximum CCB *E.coli* concentration of 66 MPN/100 ml.

The comparison of the degrees of log-inactivation predicted by the frequency distribution model of Full-Scale Results: Inactivation Kinetics: 27-Day Study to that actually observed in the field is tabulated in **Table 3-1**. As indicated, the model's prediction of the degree of log-inactivation exceeds those actually observed for the full-scale system. These results indicate that the bench-scale tests do not adequately reflect the true field conditions, i.e., the physical conditions of the full scale CCB. The implication here is that there is a strong possibility that changes to the full scale system could result in log-inactivation increases necessary to meet all the BADCT requirements.

Table 3-1
Observed Versus Modeled *E.coli* Inactivation for Existing System

Data Source	No. of Samples	Median	Minimum	Maximum
E.coli* detected in CCB effluent (MPN/100 ml)	**10**	**2**	**1**	**44**
Log-inactivation Predicted by model	**10**	**> 5.0**	**3.0**	**> 5.0**
Log-inactivation Observed in full-scale system	**10**	**4.05**	**2.29**	**4.26**

*MPN values rounded to nearest integer

It is very important to take note of the minimum observed log-inactivation value shown in the table, 2.29 logs. This is significantly less than the 3.5 discussed above, a difference of approximately 1.2 logs. This value of 2.29 was the lowest observed *E.coli* inactivation observed during the 27 day trial. For each day, the influent was divided by the effluent to the CCB. There were 10 days when there was a detectable concentration of *E.coli* in the CCB effluent.

To examine the potential impact of the performance of the CCB from another angle, a modeling approach was taken, i.e., the poorest observed inactivation performance (2.29 logs) was applied to the maximum observed *E.coli* CCB influent (200,000/100 ml). If this event ever occurred with the current operation, there would be a concentration of 1,025 MPN/100 ml *E.coli* in the CCB effluent. It should be noted that in review of the observed data set that in fact, in general, the highest CCB effluent *E.coli* concentrations were observed when their paired samples from the BNRAS secondary effluent exhibited among the lowest *E.coli* concentrations.

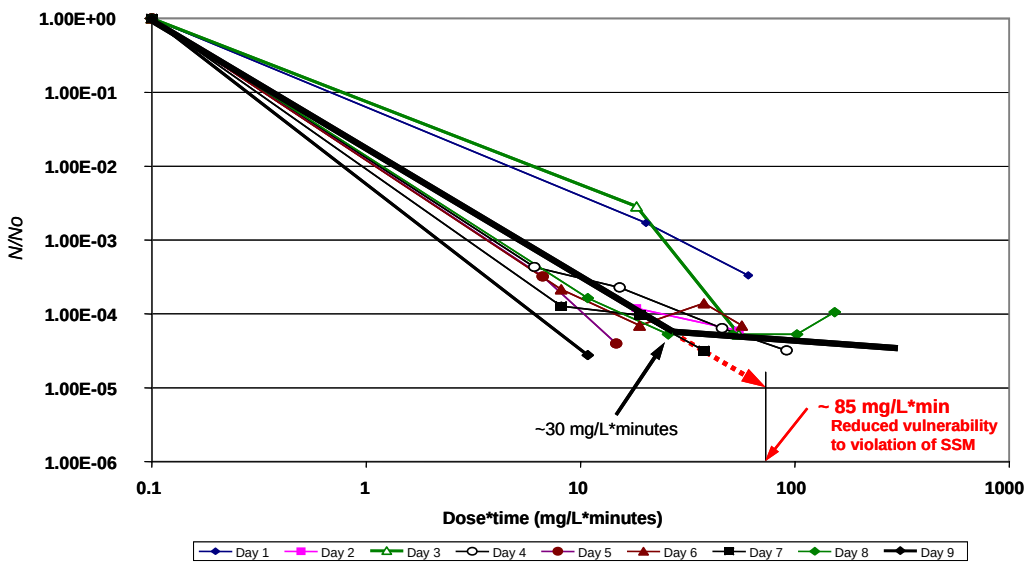
It is noted here that compliance with the maximum *E.coli* limit criterion is subject to the upstream secondary treatment process performance. These analyses were conducted on samples taken at a time when the upstream final clarifiers were performing well, i.e., delivering a treated effluent with total suspended solids below 5 mg/L. Client furnished *E. coli* field data is provided in **Appendix C**.

Therefore, without filtration prior to disinfection, it is crucial that the upstream process be constantly monitored to ensure that its performance delivers the highest quality effluent (especially in terms of TSS) as practical under all flow conditions.

Furthermore, the results of these full-scale kinetic studies are generated from just 27 samples taken from the existing system while operating under "flat line" hydraulic conditions, and taken during that time of year when conditions for optimal disinfection efficiency are least favorable (summer). Therefore, these results do reflect a more realistic "worst case" scenario for this existing system. The consideration of this type of "worst case" condition is appropriate for this overview analysis. The reason is that there were uncertainties with respect to the specific conditions surrounding the plant operations and the secondary effluent quality (such as presence or absence of ammonia, nitrite and nitrate, total suspended solids, water temperature, etc.) during the sampling period.

It is evident from the observed field results that the existing system is vulnerable to violating the single sample maximum criterion. Therefore, enhancing the ability of the existing chlorine system's delivery and reaction environment is necessary. As mentioned earlier, this enhancement must come in the form of an increase in CT. To address this CT enhancement, the *E.coli* inactivation information previously presented is included in **Figure 3-4.**

Figure 3-4
***E.coli* Inactivation Kinetics for CT Projection**



As stated previously, in order to ensure compliance with the single sample maximum criterion, a log-inactivation of greater than 4.12 is necessary. According to the statistical model's predictions (based on the observed field inactivation responses), meeting the single sample maximum requires at least 5 logs of inactivation. Therefore, examining the inactivation kinetics behavior for *E.coli* depicted in the CT

projection figure and extrapolating the 1st Order portion of the response beyond the "elbow", 5 logs of inactivation at a CT of approximately 85 mg/L*minutes can be obtained. This is graphically illustrated in the CT projection figure. Because of the various uncertainties associated with the operational conditions of the plant during the sampling periods, it is recommended that the target CT for achieving the single sample maximum compliance be set at 100 mg/L*minutes at maximum flows.[3]

It is also important to recognize that CT is a function of temperature. In cold temperatures the CT needs to be higher due to slower reaction rates. However, chlorine decay rates in colder temperatures are less than those in warm temperatures. As a result, the slower decay rates in a sense compensate for the slower reactivity rates. The specifics of these relationships were not part of this study. Therefore, assuming the CT target of 100 mg/L*minutes provides a margin necessary to take temperature into account.

Achieving this increase in CT is a function of both the chlorine dosage applied to the system and the subsequent mixing and contact time in the CCB. Increasing dosage is an operational change of minor consequence. Improving the mixing conditions and increasing the contact time in the CCB are modifications that involve mechanical equipment upgrades for the mixing and additional structural elements within the basin itself. These are discussed in more detail in Section 4.

3.1.3 Conclusions from Kinetics Studies

Several conclusions can be drawn from these kinetics studies with respect to BADCT compliance. These are:

- The existing BNRAS chlorine disinfection system is capable of meeting the 4-out-of 7 weekly calendar days Non-Detect permit condition during the test period. On average, it currently meets this more than 80% of the time. The BADCT requires it to be met only 57% of the time.
- Under the current operating conditions and physical facilities, the existing BNRAS chlorine disinfection system is vulnerable to violations of the single sample maximum criterion for *E.coli* (15 MPN/100 ml).
- Bench-scale inactivation kinetics analyses provide guidance information on the amount of CT necessary in the full-scale system to achieve consistent BADCT compliance.
- Modifying the existing BNRAS chlorine disinfection system to reliably achieve a CT capable of meeting the single sample maximum criterion for *E.coli* is necessary and appropriate course of action.
- A CT of at least 100 mg/L*min at maximum flow conditions should be used as the minimum target for sizing and implementing any improvements to the BNRAS chlorine disinfection system to enhance its current performance to ensure compliance with the BADCT single sample maximum criterion for *E.coli*.

[3] It is important to note that the target of 100 mg/L*min at maximum flows implies that the CT for the average flow condition would be likely more in the 140 mg/L*min range.

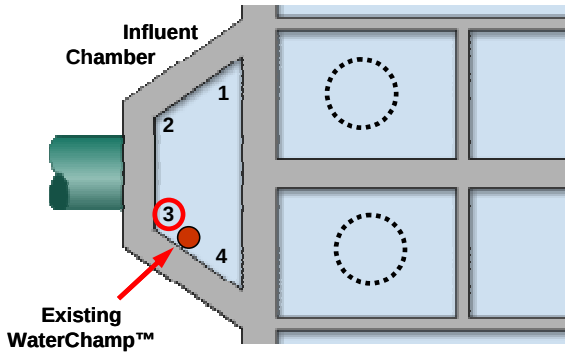
3.2 Mixing and Dispersion Field Studies

Field studies were conducted on the east BNRAS chlorine contact basin to determine mixing efficiencies. The results of the mixing and dispersion studies are provided below.

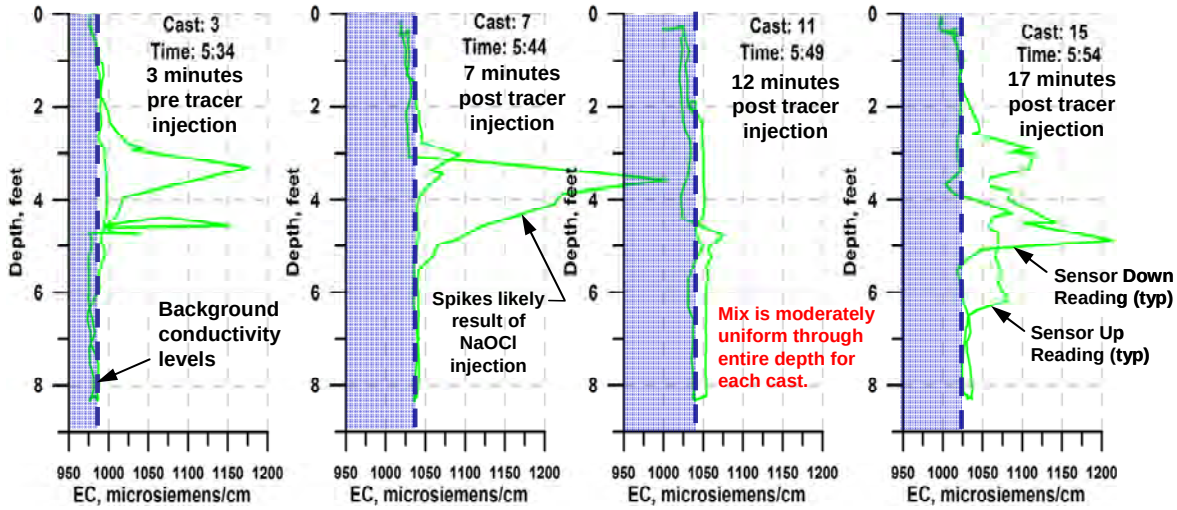
3.2.1 Results from Mixing Analysis of the Entry Chamber for Chlorine Injection

Examples of the results of the tracer injection/mixing study conducted for the entry chamber to the CCB during low flow conditions are shown in **Figure 3-5**. (This particular graph depicting the mixing conditions at position "3" is one of a series of tests run. Tracer compound was injected for a period of 23 minutes through the existing WaterChamp™ mixer/pump located near position "3". Tracer unit sensors were then lowered into the entry chamber to its full depth (approximately 9 feet) at each of the four locations shown in the figure below, and at the times shown relative to the time of tracer injection. Tests were run for both the low flow and high flow conditions, corresponding to 8.8 MGD and 16.2 MGD, respectively, for all four positions. Conductivity readings were taken while the sensor was lowered to the chamber depth and while being raised back to the surface. (This is reason for the two lines appearing on each cast graph.) One "round trip" of the sensor is known as a "cast."

Figure 3-5
Vertical Mixing Profiles: Influent Chamber: Low Flow Condition



Location 3
Brine Release 05:37-06:00



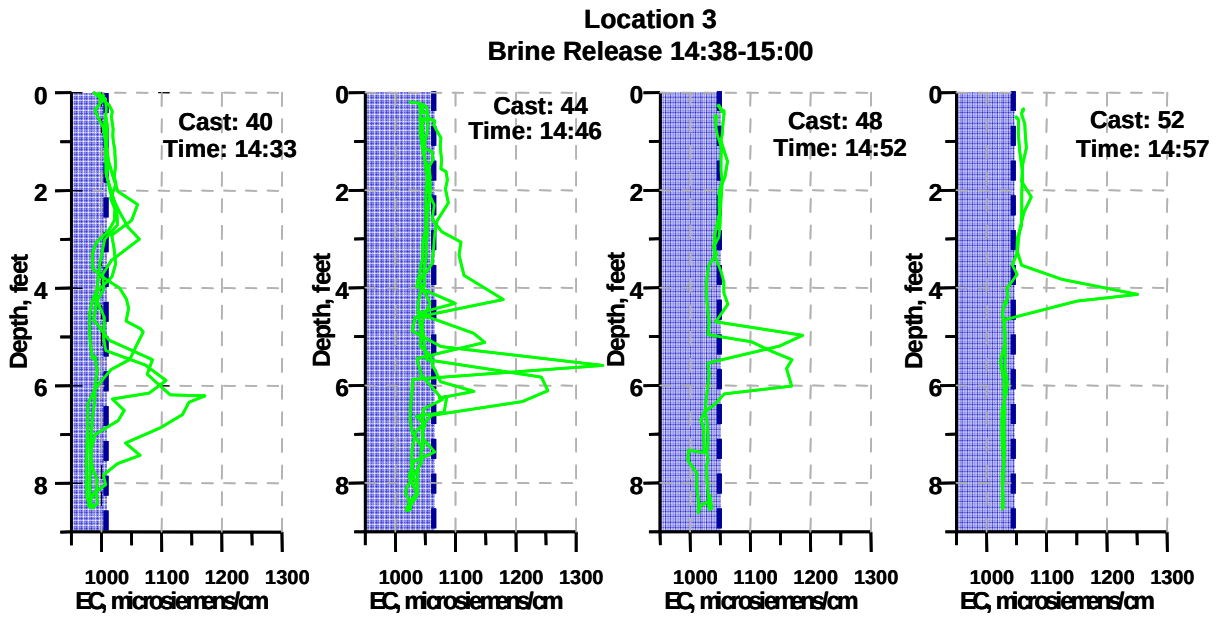
At a depth of about 4 to 5 feet, we observe significant localized spikes in the conductivity readings even before tracer was injected. The likely explanation for these is that the sensors were picking up the influence of the injection of the NaOCl coming into the chamber through the chlorine induction system. The added sodium chloride is what the sensor is reading.

With the spikes "removed" from the data, the remaining data can be reasonably represented by the blue shaded areas. Prior to the time of tracer injection, one observes the background conductivity levels in the chamber. There is a rise in the average conductivity level shown at Cast 7, which is 7 minutes following the start of tracer injection. This rise is relatively uniform throughout the entire depth of the chamber. At 12 minutes post-injection this characteristic remains relatively steady, still reasonably uniformly mixed throughout the depth. At 17 minutes post-injection, there is slight overall decrease in tracer concentration, yet still reasonably uniform throughout the depth. Therefore, in this low flow condition,

the WaterChamp™ mixer/injector unit seems capable of providing reasonably uniform mixing throughout the chamber depth.

Figure 3-6 illustrates the results of a second test at the same position "3" except that this test was run under high flow conditions. Again, the general result is that the tracer appears to be relatively uniformly mixed throughout the chamber depth. However, close observation of the vertical mixing profiles shown below indicates that the concentration of tracer declines slightly at the lower depths compared to the upper depths (see Casts 44 and 48). This indicates that during high flows the WaterChamp™, in its current position orientation, is less capable of mixing uniformly at all depths. This may be indicative of some degree of short-circuiting through the chamber in high flow. The complete summary for the responses at each of the 4 positions are given in **Appendix D**. Each of these illustrates similar responses.

Figure 3-6
Vertical Mixing Profiles: Influent Chamber: High Flow Condition



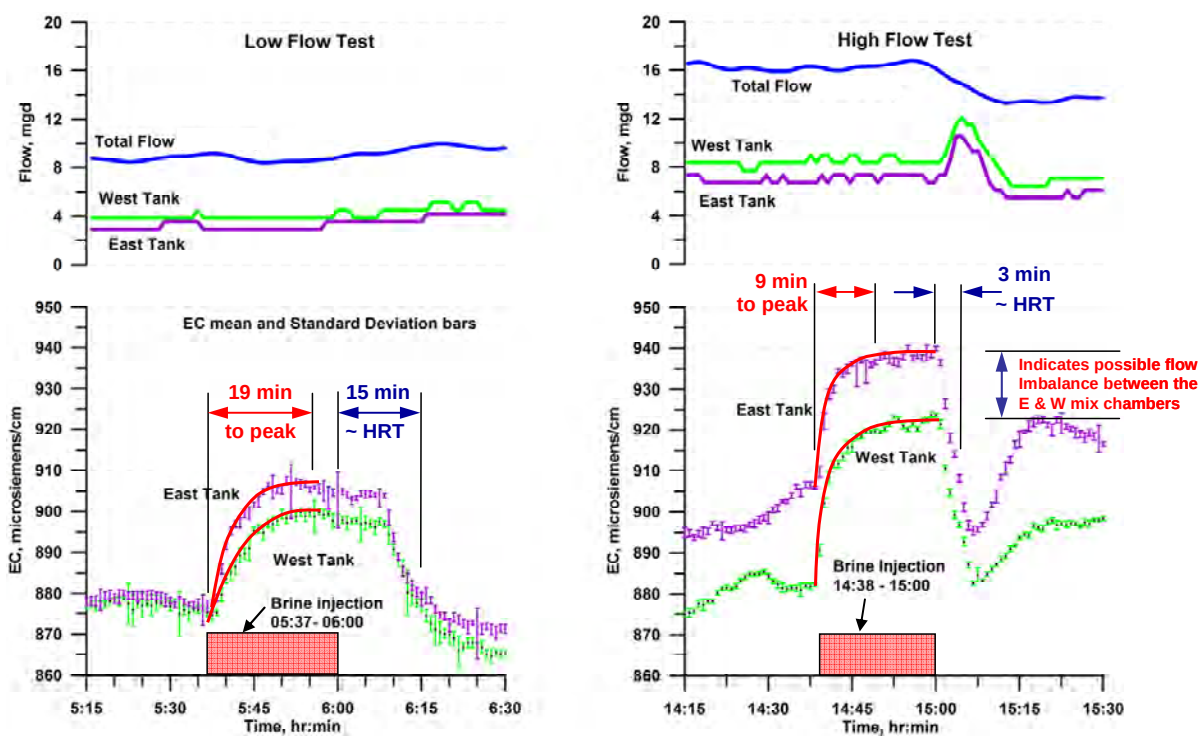
The data indicates that the WaterChamp™ unit is capable of providing reasonably uniform mixing of the entry chamber. However, its performance under the high flow conditions could be better. Its current location near the wall likely hinders some of the jetting action of the propeller due to the interference from the adjacent wall. This interference hinders the even distribution of the mixing energy into all parts of the chamber and throughout its depth, primarily in high flow conditions. The implication here is that in high flow, the chlorine may not be as evenly distributed as it could or should be to ensure optimal opportunity for disinfection effectiveness downstream.

3.2.2 Results from Analysis of Flash Mix Chamber

To gauge the efficiency of mixing provided by the vertical shaft propeller mixers in the flash mix chamber, a conductivity sensor was placed at the outlet orifice of the flash mix chamber and a salt tracer introduced again at a constant rate through the WaterChamp™ in the entry chamber for a period of about 22 minutes. The results of the low and high flow responses are shown in **Figure 3-7**.

A metric of mixing efficiency in this chamber is the time required for the tracer to reach a peak. The more rapid the time-to-peak, the more efficient is the mixing. Also, the hydraulic residence time of the chamber is another gauge of the mixing efficiency. This is most easily estimated by monitoring the time required for the conductivity readings to reach background levels after the tracer injection is ceased. This time is then compared against the theoretical hydraulic residence time for the flow rate at the time of the test.

Figure 3-7
Tracer Study Results: Mixing Regime: Flash Mix Chamber



For the low flow condition, the time-to-peak is estimated at 19 minutes, and the HRT at 15 minutes. Similarly, for the high flow conditions, the time-to-peak is estimated at 9 minutes and the HRT at 3 minutes. A brief lag would be expected in the tracer detection due to the tracer being injected in the entry chamber. However, even accounting for this, the 19-minute time-to-peak during the low flow condition is excessive. This is indicative that back-mixing is occurring in this chamber and is probably being caused

by the large flash mixer unit drawing water back into the chamber via the outlet orifice. In the high flow condition, the time-to-peak is reduced but still longer than an ideal response.

With respect to hydraulic residence time, for the low flow rate condition of approximately 4 MGD passing through the chamber, the estimated HRT is 15 minutes. The theoretical HRT for the mix chamber at this flowrate is approximately 2 minutes, or about 13% of the observed. Similarly, in the high flow condition (~8 MGD), the estimated HRT is 3 minutes. The theoretical HRT for this condition is less than 1 minute, or about 33% of the observed. Clearly, the mixing regime in this chamber is being influenced by significant back-mixing, again, probably caused by the turbulence from the vertical mixers. It appears that the mixer draws flow from the channel immediately downstream of the chamber outlet back into the chamber, thereby delaying the tracer's time to peak and the HRT. The physical implication is that this back-mixing will likely disrupt plug flow characteristics in the channel downstream of the chamber. These results would imply that the action of the vertical mixers may be a hindrance to conditions necessary for optimal disinfection system performance.

Finally, the tests revealed differences in the conductivity readings between the East and West flash mix chambers. These are delineated in the tracer study results. Though differences are present in both low and high flow period, the effect is accentuated during the high flow. A logical explanation for these differences is an imbalance in flow through the two parallel flash mix chambers. Because flow balance analyses were not part of this study effort, the cause of the apparent imbalance was not determined. But it is important to note that this observation was made.

3.2.3 Results of Dispersion Analysis of Chlorine Contact Basin

To initiate the dispersion tests, tracer salt was again injected through the WaterChamp™ unit. Three sensors located at equal intervals along the length of the CCB were used to monitor changes in conductivity with time following injection. The first sensor was centered just outside the outlet orifice, a couple feet above the bottom. The mid-tank sensor was centered in the channel at mid-depth, about 7 feet below the surface. The third sensor was placed at the discharge weir crest just below the water surface. **Figure 3-8 and Figure 3-9** are examples the dispersion test results for the East CCB during low and high flow periods.

Figure 3-8
Dispersion Results – East Basin: Low Flow Condition

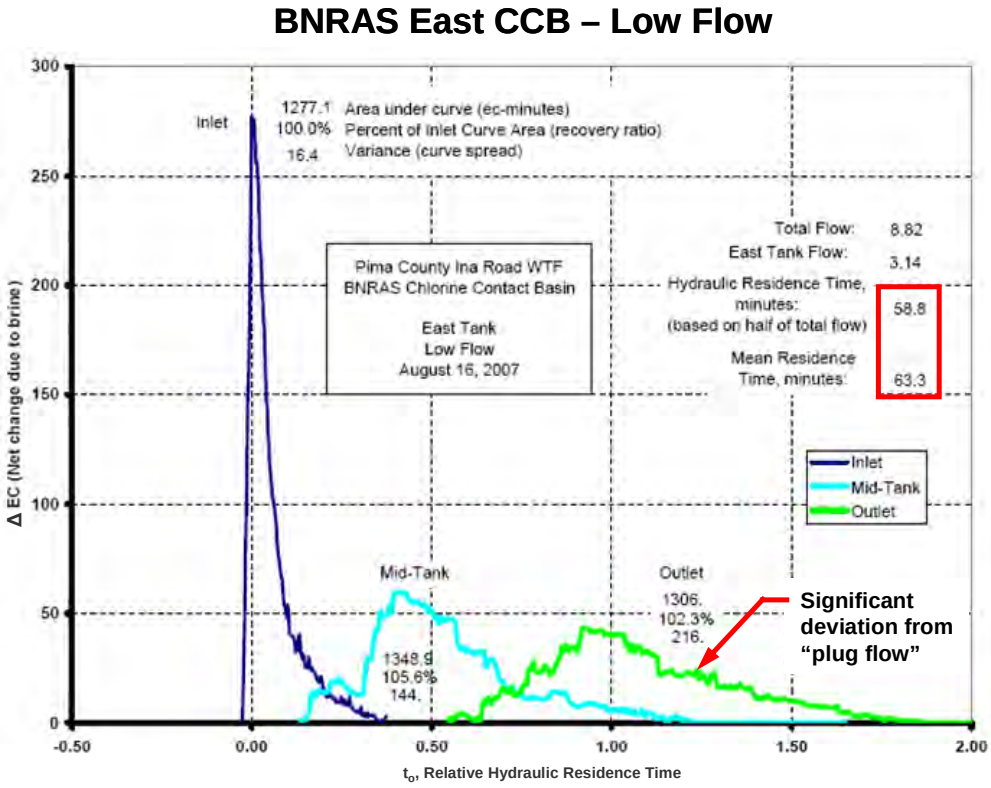
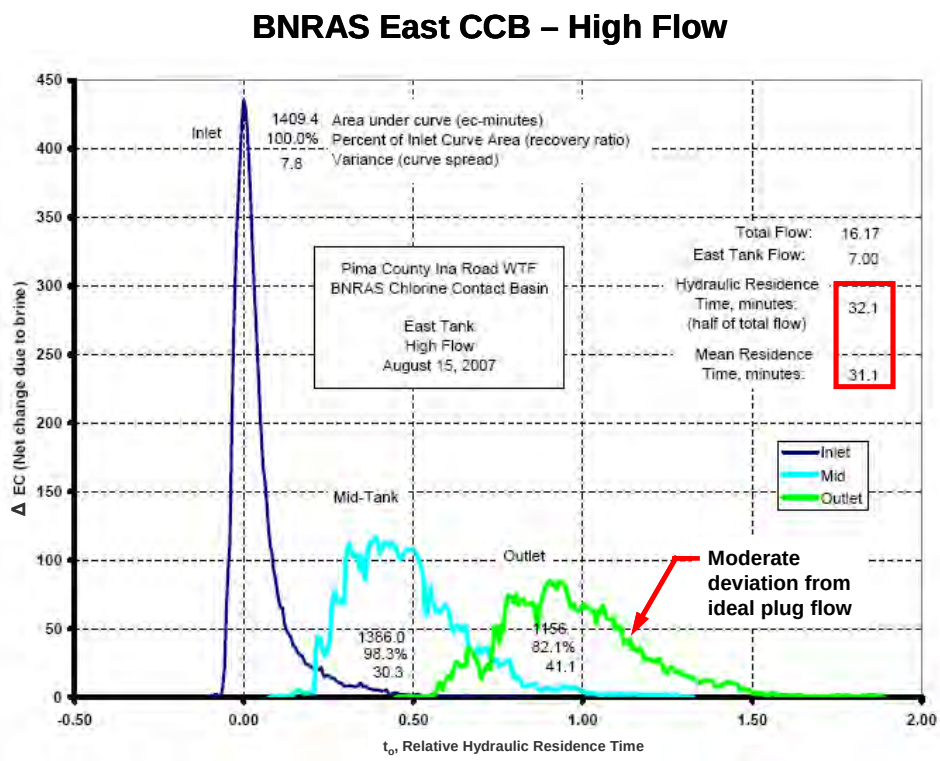


Figure 3-9
Dispersion Results – East Basin: High Flow Condition



The three sensors describe the flow regimes at their respective locations over time. At the mixing chamber outlet location, the peak is narrow and very high. However, even at this location, one observes a "tailing" of the tracer out of the chamber. This affect is an indication that back-mixing is occurring already at this location, another indicator that the vertical mixers are the likely cause. It is interesting to note the significant degree of decline in the peak between the mixing chamber outlet and the Mid-Tank location. This is evidence of considerable back-mixing and loss of a plug flow characteristic in the initial pass of the CCB serpentine channel. However, the peak at the Outlet location shows minimal decline to that compared to the peak at the Mid-Tank. This would imply that this portion of the CCB channel flows in a relatively uniform manner compared to that of the initial pass of the serpentine channel. A qualitative confirmation of this is given in Section 3.2.4 when the results of the drogue observations are discussed.

These dispersion analyses provide insight into the actual hydraulic characteristics for the basins operating under these particular flow rates. By examining the tracer response at the Outlet location, we see that in both low and high flow conditions a portion of the tracer mass passes the outlet location in advance of the theoretical HRT. This is depicted by the "rising limb" of the curve. This indicates that some short-circuiting of the flow volume is occurring. This could be due to more rapid flow velocity at the surface compared to that next to the floor of the channel. With respect to disinfection effectiveness, for that portion of the flow volume that short-circuits, the amount of time the target organism is exposed to the chlorine residual is diminished from its intended design exposure time.

Additionally, the dispersion results show that for both low and high flow conditions there are also portions of the mass passing the outlet beyond the theoretical HRT. This is depicted by the "falling limb" of the curve. This indicates the presence of back-mixing and/or stagnation, likely due to eddy currents along walls and "dead zones" in corners of the rectangular channel cross section. With respect to disinfection effectiveness, for that portion of the flow volume that stagnates in the basin, there will be decay of the chlorine residual, reducing the disinfecting power on the target organisms in those zones.

These observations have implications for disinfection effectiveness. Improvements to the basin are necessary to improve the nature of the plug flow, i.e., reduce the degree of dispersion. These improvements bring the HRT closer to the theoretical during all flow conditions. Doing so allows better control of meeting the target CT. But, variable flow conditions create operational challenges in sustaining the target CT. At low flow, the "T" naturally increases and one might presume that the corresponding chlorine dose could be decreased (from average dose) in order to sustain the CT target. But since "C" represents the chlorine residual at the basin outlet, it is quite possible that indeed the dosage may have to be increased to compensate for any residual decay that may occur. Conversely, at high flow, the "T" naturally decreases, and one might presume that the corresponding chlorine dose should be increased (from average dose) to sustain the target CT. Again, because the "C" represents the chlorine residual, an increase in dosage would be appropriate because a higher residual compensates for the shorter HRT. But this higher residual also requires a concomitant increase in the dosage of the dechlorination agent.

The dispersion test results need confirmation. This can be done by normalizing the tracer mass and plotting it as cumulative mass at each point with time. Examples of this are given in the companion graphs shown **Figure 3-10 and Figure 3-11** for the low and high flow conditions for the West basin. (The complete set of these companion graphs is provided in **Appendix E**).

Figure 3-10
Dispersion Results: Cumulative Mass Curve – West Basin: Low Flow

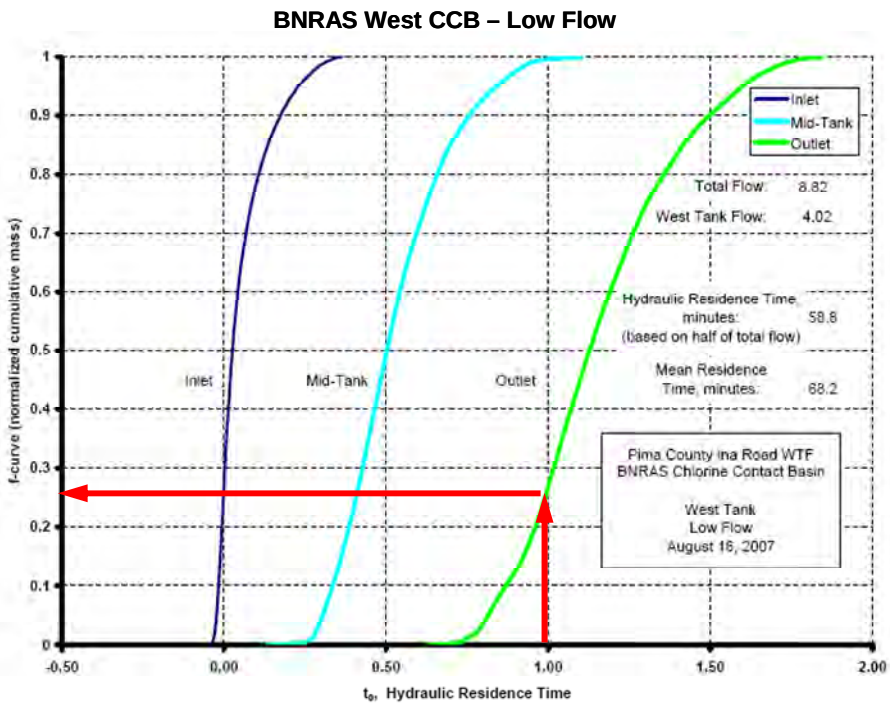
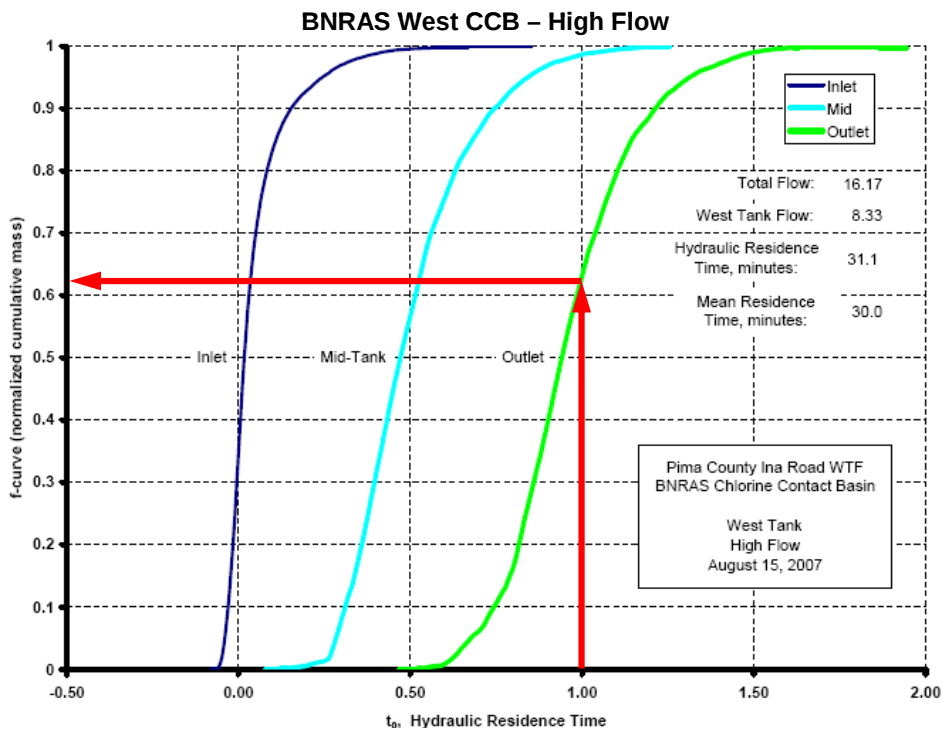


Figure 3-11
Dispersion Results: Cumulative Mass Curve – West Basin: High Flow



For conditions near ideality, the cumulative curve would be essentially vertical at each of the three locations measured. Deviation from vertical is an indication that a back-mixing/stagnation and/or a short-circuiting condition exists for a particular state of flow.

First, consider the low flow condition in the West CCB. Clearly, the cumulative curve deviates significantly from vertical, indicating a less than ideal plug flow condition. The first detection of tracer at the outlet occurs at about 0.75 of the theoretical HRT. Approximately 28% of the tracer mass passes the basin outlet prior to the theoretical HRT (corresponding to the "rising limb" of the plot for dispersion results - East Basin: Low Flow Condition), while the remaining 72% passes after the theoretical HRT (corresponding to the "falling limb" of the dispersion results – East Basin: Low Flow Condition plot). The final reading of tracer occurs at about 1.8 of the theoretical HRT. Interpreting these results, then, we can say that 28% of the flow volume short-circuits while the majority, i.e., 72% of the flow volume "stagnates" during a low flow condition. So, the dispersion of the plug flow in low flow indicates that while the majority stagnates in the CCB, there is still a significant portion of the flow volume that short-circuits (nearly a third). Furthermore, despite the amount of apparent stagnation, both the peak of the tracer mass and the centroid of the dispersed trace mass pass the outlet in advance of the theoretical HRT.

Next, we consider the high flow condition in the West CCB. Here, again, there is a deviation from the ideal plug flow condition. But, in contrast to the low flow curve, the high flow is closer to a vertical configuration. Therefore, it can be argued that the CCB responds closer to ideal plug flow in the high

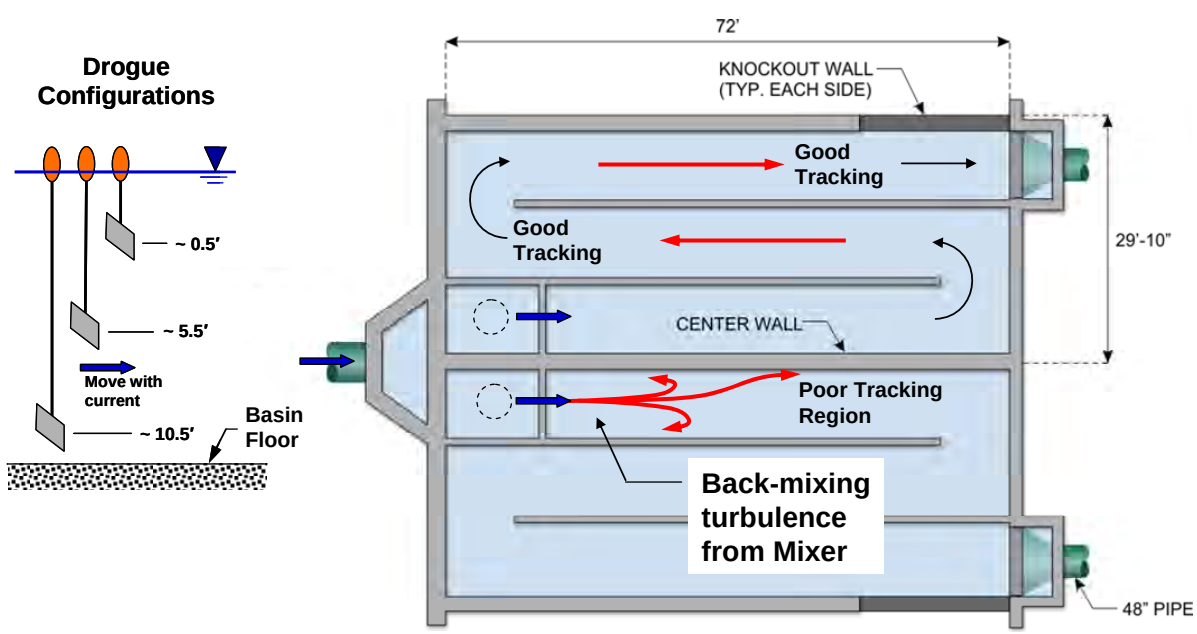
flow condition than in the low flow condition. In the high flow condition, the first tracer is detected at about 0.6 of the theoretical HRT, with approximately 62% of the tracer mass passing the outlet in advance of the theoretical HRT. This leaves the remaining 38% to pass after the theoretical HRT, with the last tracer being detected at about 1.6 HRT. As with the low flow, both the peak of the tracer mass and the centroid of the dispersed tracer mass pass the outlet well in advance of the theoretical HRT. As expected, in the high flow condition, short-circuiting is the dominant characteristic of the flow regime in the channel. Similar analyses can be done for the East CCB using the companion graphs in **Appendix F**.

For all dispersion tests conducted for the low and high flow conditions on the East and West basin, the observed HRT occurred prior to the theoretical HRT for that flow. Any improvements to the basins designed to enhance the plug flow characteristic will benefit both low and high flow performance.

3.2.4 Results of Drogue Observations

As a means to more fully visualize the information contained in the dispersion analysis, the project team also conducted observations of a float, known as a "drogue," as it moved through the CCB channel. The drogues used in this study monitored flowpath at three different depths. A qualitative summary of the drogue observations is given in **Figure 3-12**.

Figure 3-12
Drogue Analysis Schematic Description



The essence of these observations is that when the drogue was placed into the channel just downstream of the outlet from the rapid mix chamber, it found its way to the side walls of the channel's first pass and often stopped, and in some trials the drogue actually reversed direction and moved together near the wall

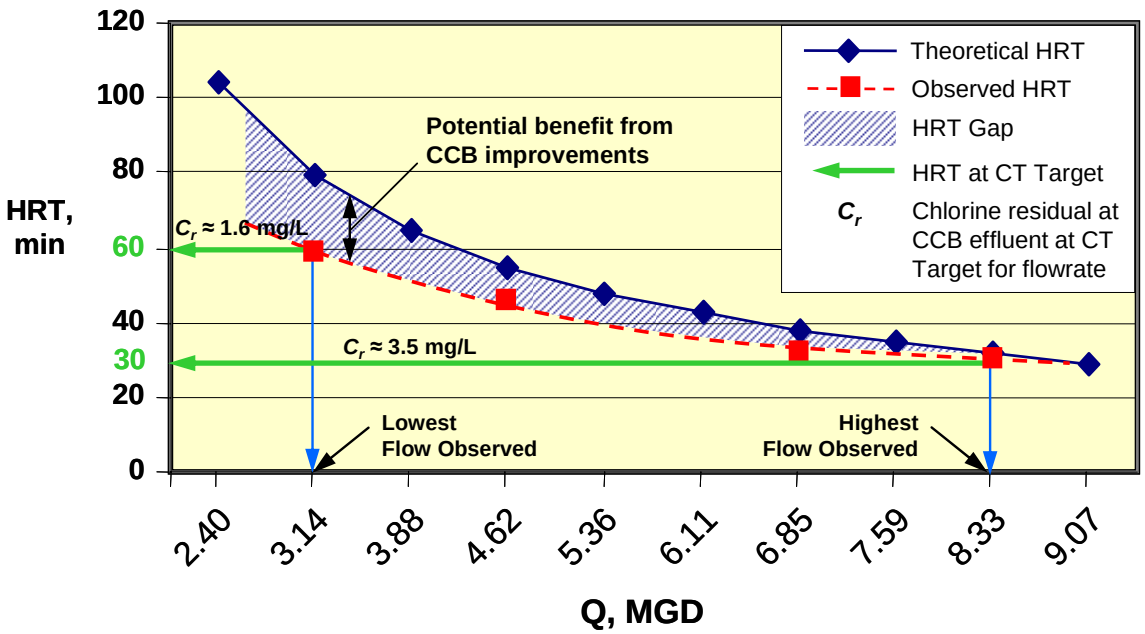
before stopping. In the second and third passes, the drogues tracked the longitudinal flow path reasonably well. These observations confirm the suspicion that the turbulence created by the vertical mixers in the flash mix chambers do result in some back-mixing of the channel flow in the first pass. But beyond the first pass, this problem seems to dissipate (at least as far as surface flow patterns are concerned). It appears that the first "end-turn" of the serpentine channel attenuates the majority of the turbulent energy induced by the mixer. The implication here is that if improvements to the channel to reduce back-mixing conditions are contemplated, the emphasis should be on the first pass in the serpentine flow.

3.2.4.1 Relationship of Channel Hydraulics to Disinfection

The intent of the above field study results was to establish a relationship between the actual CCB contact time that results from the existing system hydraulics to that which the kinetic studies found was necessary to meet the disinfection requirements of the BADCT. To do this, we return to the differences between theoretical and observed HRT and superimpose the target CT.

In **Figure 3-13** the relationship between the theoretical and observed HRT is plotted for the range of flows observed during the tests. As previously pointed out, there is an overall characteristic of short-circuiting in the CCB causing there to be a "gap" between the observed and the theoretical. This gap indicates the degree of improvement necessary to reach optimal performance for any given flow. This gap increases as flows decrease. Therefore, CCB improvements would mostly benefit the system when operating under lower flow conditions. It should be noted that this information does not reflect any additional contact time that may be provided in the 48-inch effluent discharge conduct that conveys the CCB effluent to the point of dechlorination. This additional contact time is likely in the range of 5 minutes.

Figure 3-13
Relationship of Observed to Theoretical HRT to CT



A CT target of 85 mg/L*minutes (Section 3.1.2) for the enhanced system is the minimum predicted by the kinetic model for reliable compliance with the single sample maximum criterion. But this CT projection (85 mg/L*minutes) in the bench-scale was based on samples held in a "batch" mode for each contact time studied. These batches simulate a perfect plug flow condition, and thus equal to the theoretical. Because of this, and other uncertainties in conditions deriving the model, the recommended target CT for the basis of design for improvements is a minimum of 100 mg/L*minutes at maximum flow conditions. Standard procedure for the current operation of the BNRAS disinfection process is a NaOCl dose in the range of 1.2 to 1.5 mg/L. In order to sustain the CT of 100 mg/L*minutes in the enhanced process, a chlorine *residual* concentration at the CCB effluent needs to range from 1.6 to 3.5 mg/L to meet this CT target for the range of flows observed in this test.

These residual concentrations indicate that application dosages of the NaOCl of at least twice, perhaps three times, greater depending on the chlorine demand, than what is currently being applied will be necessary. For the maximum flowrate observed, the observed HRT is approximately 30 minutes, meaning that to reach a CT of 100 mg/L*minutes in the existing system, the effluent chlorine residual concentration must be approximately 3.5 mg/L. In these high flows, the importance of plug flow in the CCB is critical because the amount of exposure time to the residual is reduced. At low flowrates (where the observed HRT is about 60 minutes), a minimum chlorine residual concentration of about 1.6 mg/L is necessary to reach the CT target of 100 mg/L*minutes in the existing system. But at these low flow ranges, the CT is very sensitive to the residual concentration, and the actual dosages required will likely be higher than what might be expected. Therefore, enhancements to the CCB to improve the HRT for these conditions will be beneficial. A more "ideal" HRT reduces the sensitivity of the chlorine residual

concentration in all flow ranges. The BNRAS basis of design flow rates and respective peaking factors are listed in **Table3-2.**

Table 3-2
Design Flow Rates and Peaking Factors for Existing BNRAS Plant

Design Flows	Rates, MGD	Peaking Factors
Minimum Flow	9.0	0.72
Average Annual Flow	12.5	1.00
Maximum Monthly Flow	16.3	1.30
Peak Wet Weather Flow	23.8	1.90

It is important to also note that contact time minimums are typically a factor in the regulatory framework for CT requirements, and the definitions vary. For example, according to USEPA, the "T" in the CT is defined as that time when 10% of a tracer mass reaches the basin outlet, a value the EPA identifies as "t_{10}". In some state regulations, however, the "T" is computed as that time when the peak of the tracer mass passes the outlet, known as the "modal" contact time. From the field dispersion analyses cited in this report (Section 3.2.3), the observed modal time is approximately 90% of the relative theoretical contact time for the range of flows studied.

3.2.5 Conclusions from Mixing and Dispersion Studies

Several conclusions can be drawn from these mixing and dispersion studies of the performance of the existing BNRAS CCB that ultimately relate to BADCT compliance. In terms of mixing behavior for the existing system, these are:

- The WaterChamp™ unit mixer appears capable of providing adequate mixing in the entry chamber where the chlorine is injected.
- The position of the WaterChamp™ unit in the influent entry chamber is less than ideal and should be repositioned to optimize the mixing regime in this chamber.
- The vertical shaft flash mixers create similar mixing regimes in both the East and West basin flash mix chambers.
- The hydraulic time-to-peak behavior of the flash mix chambers is longer than what would be expected from a basis of design; this behavior is accentuated in low flow conditions.
- The hydraulic residence time in the flash mix chambers is significantly longer than the theoretical; the turbulence caused by the mixers appears to result in back-mixing; this behavior is accentuated in low flow conditions.
- The differences in times-to-peak between the East and West flash mix chambers indicate a flow imbalance between the East and West basin.

In terms of dispersion behavior of the existing system, these are:

- Deviations from ideal plug flow are evident under all flow conditions observed; deviations are most significant under low flow conditions.
- At low flow conditions, both short-circuiting and stagnation occur.
- At high flow conditions, performance is closer to ideal plug flow.

- Observed hydraulic residence times in the CCB channels are less than the respective theoretical times for all flow conditions observed; implication is that short-circuiting is occurring, even in low flow conditions.
- Enhancements to the CCB channel are necessary to improve the observed HRT to as near the theoretical as practical. This is especially beneficial for achieving the target CT during all flow conditions.
- Significant deviation from uniform flow conditions are most prevalent in the first pass of the CCB channel; condition appears directly related to back-mixing effects from the large mixers in the upstream flash mix chambers; more uniform flow is observed in second and third passes.

4. Recommendations for Improvement

Improvements to the existing BNRAS chlorination process system are necessary to enhance its performance in order to reliably meet the BADCT criteria for microbial inactivation. The improvements focus on both the mixing system that disperses the injected chlorine into the bulk fluid and in the chlorine contact basin that provide the contact time for microbial exposure to the chlorine residual. The fundamental objective of these improvements is to boost the CT of the system to the range where achieving the 4-out-of-7 days of non-detect for *E.coli* and reliably meeting the single sample maximum criterion of 15 MPN/100 ml. It is recommended that the target CT be a minimum of 100 mg/L*minutes at maximum flow conditions.

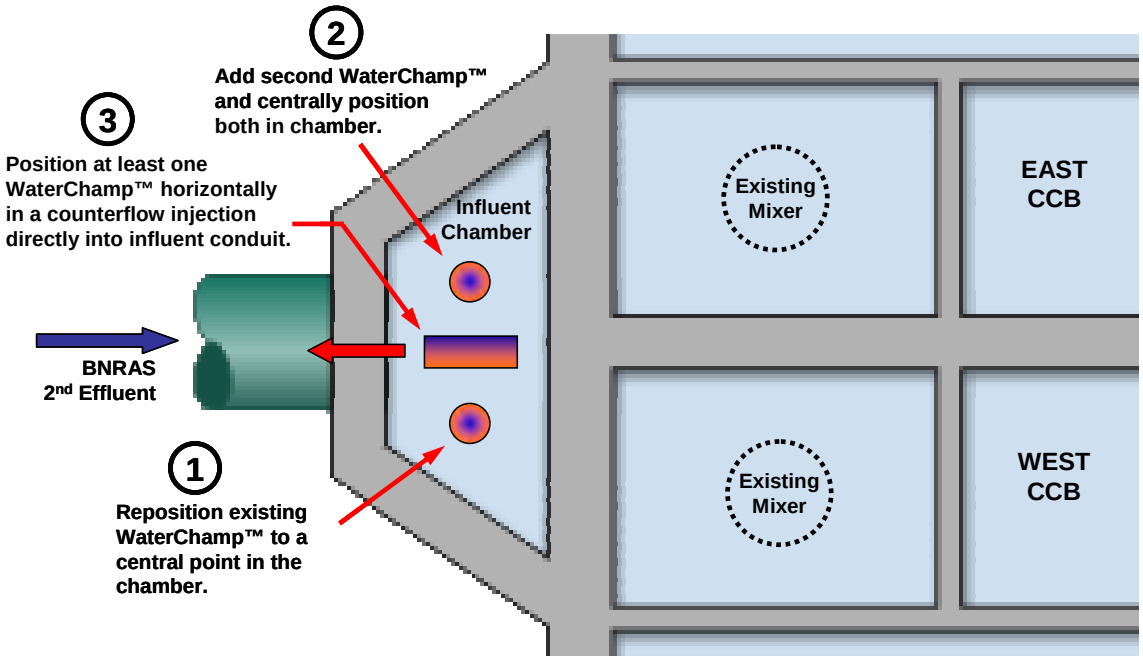
The recommendations described here for improvements to the existing BNRAS chlorination process do not include the installation of effluent filtration prior to disinfection. Therefore, it must be emphasized that reliable compliance with the single sample maximum criterion for *E.coli* depends on, and is highly sensitive to the operational performance of the upstream treatment process, especially during periods of high flows. Consistent performance of the final clarifiers in the existing BNRAS plant (and in new plants to be built in the future as part of the ROMP) to deliver a high quality secondary effluent with respect to total suspended solids will be absolutely essential. It is strongly recommended that a review of standard operating procedures for final clarification be completed to ensure that the performance consistency is being maximized. Additional information on this topic is provided in Section 4.3.

The enhanced chlorination system requires improvements to both the system's capability to deliver higher chlorine dosages, and in the CCB flow hydraulics to minimize short-circuiting, back-mixing, and stagnation zones, and create as close to plug-flow behavior as practical. The improvements to the chlorine delivery system relate to dosage; the improvements to the mixing enhance the uniformity of dispersion of the chlorine into the bulk fluid; the improvements to the channel hydraulics enhance the flow characteristics of the bulk fluid to expose the microbes to the highest possible chlorine residual for the longest possible period of time.

4.1 Mixing Improvement Recommendations

The schematic shown in **Figure 4-1** illustrates three recommendations that should result in improving the uniformity of chlorine dispersion into the BNRAS secondary effluent bulk fluid in the entry chamber of the existing chlorine contact facility.

Figure 4-1
Influent Chamber Mixing Upgrade Recommendations



The three recommendations are as follows:

- Reposition existing WaterChamp™ to a central location within the entry influent chamber. This will improve the uniformity of the dispersion of the injected chlorine throughout the bulk fluid in the influent chamber.
- Purchase a second WaterChamp™ to supplement the existing and place the two centrally within the influent chamber.
- Place one WaterChamp™ in a horizontal position, with the injector facing into the incoming flow from the BNRAS secondary in the center of the chamber to inject the chlorine as a "counterflow" to the incoming flow.

An additional point of consideration:

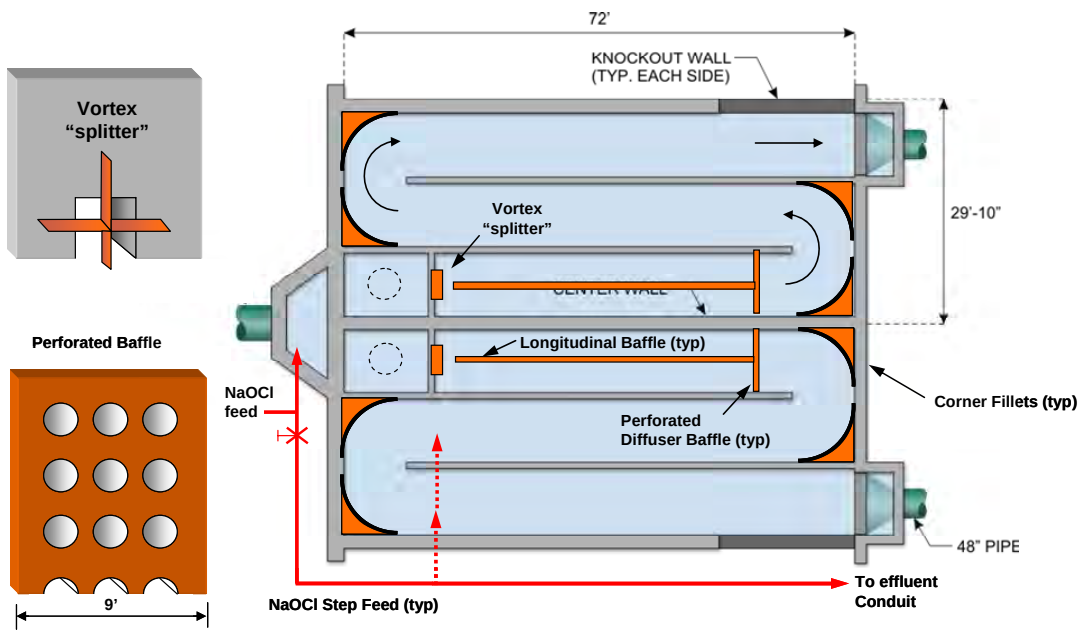
Though not evaluated in this study, consideration of the installation of a "static mixer" unit for chlorine injection in the existing BNRAS secondary effluent 60-inch conduit to replace and/or supplement the injection and mixing of the WaterChamp™ unit(s) may have merit. Because significant head loss will occur through the static mixer, a detailed hydraulic analysis must be done as part of the preliminary design. There currently exists 1.06 feet (+/-) of available hydraulic head under peak wet weather flow conditions between the final clarifier effluent channel and the CCB influent chamber. It is possible that the head loss through a static mixer could be as much as two feet, which for this application would be problematic. Also, a static mixer has the potential to trap debris that may be present in the bulk fluid

passing through it. However, this is not a highly likely scenario since the BNRAS secondary effluent should be relatively free of errant debris. Furthermore, the mixing efficiency of such a mixing unit is a function of both flow rate and water temperature. Specifically, the mixing efficiency decreases with decreasing flow rate and with decreasing water temperature. Therefore, a static mixer does not have the operational flexibility to adjust to adverse conditions such as low flow rates and cold water temperatures. It is for these uncertainties that it is also strongly recommended a pilot-scale study/test be conducted to analyze the efficiency of such a mixing unit to determine its appropriateness and applicability for this enhanced chlorination process.

4.2 Chlorine Contact Channel Improvement Recommendations

Figure 4-2 illustrates the recommendations for improvements to the existing BRNAS chlorine contact basin to improve the hydraulics of the channel flow.

Figure 4-2
Chlorine Contact Basin Upgrade Recommendations



The recommendations are as follows:

- Consider the installation of "rounding" fillets in all corners of the serpentine flow channels; creates more uniform flow around corners and minimizes potential for dead zones where stagnation can occur, especially in a low flow condition.
- Consider the installation of a perforated baffle at the end of the first pass of the serpentine channel to enhance plug flow characteristics (see illustration in FIGURE 4-2). This baffle will increase the head loss across the basin and therefore requires a detailed hydraulic profile analysis as part of its design.

- Consider ceasing operation of the vertical shaft flash mixers; these appear to be creating turbulence in the first pass of the serpentine channel, significantly disrupting plug flow in the first pass.
- If it is found that continued operation of the flash mixers is necessary, then the following features would be appropriate:
  - Consider installation of a "vortex" splitter on the outlet side of the flash mix chamber outlet orifice (see illustration in FIGURE 4-2) to reduce back-mixing caused by the vertical shaft flash mixers.
  - Consider a longitudinal baffle in the middle of the first pass running the full length of the first pass. This will enhance the uniform flow characteristic in the first pass.
- Consider the installation of a "step feed" chlorination line to allow for supplemental chlorination downstream of the initial chlorine injection point. Downstream locations should include beginning of the third pass and in the 48-inch effluent conduit.
- Periodic cleaning of the CCB is imperative for ensuring optimal performance. It is recommended that PCWMD operations and/or maintenance staff take each of the CCBs out of service at least once, preferably twice annually for cleaning. Cleaning should consist of high-pressure washing using water and/or light bleach solution on all walls and floor, orifices and weirs. Following cleaning the CCB should be filled and "shocked" with up to 50 mg/L of chlorine and held for at least 24 hours prior to discharge and return to full operation.

4.3 Recommendations for Additional Studies on Existing BNRAS Disinfection System

The scope of this Phase II study did not allow for consideration of the full range of issues that should be examined for evaluating enhanced chlorination as an effective and reliable disinfection process for meeting the BADCT standards. Therefore, the following are suggestions for additional studies that PCWMD should consider to supplement the information in this report.

- Operational data during the kinetics studies reported herein indicate the pH of the BNRAS secondary effluent is above 7. With enhanced chlorination practice, the pH in the CCB will likely increase slightly after sodium hypochlorite is added at the elevated doses. Slight downward adjustments in the pH (perhaps 0.2 to 0.4 units) would provide significant benefit to the effectiveness of the chlorination process (increases the concentration of HOCl which is more powerful than OCl^-). Such an adjustment would still be well within permit limitations for pH of the final effluent. It is recommended that PCWMD closely monitor the pH in the CCB to determine whether pH adjustment is worth considering as a tool to supplement the enhanced chlorination performance. If the results are favorable for such an adjustment, simple bench-scale (jar test) studies using H_2SO_4 and/or HCl would be warranted to determine if this benefit can be achieved economically. This increase in disinfection efficacy provides PCWMD with an addition margin of protection against primarily the single sample maximum criterion. These tests can be readily conducted in PCWMD laboratory by PCWMD analytical staff. It must be noted, however, that the formation of disinfection by-products remains and issue for consideration (discussed later).

- The enhanced chlorination process requires close monitoring of the correlations between chlorine residual at the end of the contact period. Operationally, this translates to rigorous attention to the initial chlorine dose. It is strongly recommended that PCWMD analytical staff conduct a series of

bench-scale (jar test) studies that correlate chlorine dose to residual as a function of contact time. Such tests will establish chlorine dosage (lower and upper) that will serve as the "boundaries" for planning the operational procedures for the enhanced system. These studies will also serve to provide PCWMD with information necessary to project annual chlorine usage to support budget planning and frequency of chemical deliveries.

- In conjunction with the above bench-scale testing on chlorine dose, it is recommended that PCWMD analytical and operations staff proceed with the originally proposed field tests to analyze the rate of chlorine residual decay in the full-scale BNRAS chlorine contact basin. These residual decay rate studies should be conducted over at least two depths in the channel to ascertain the influence of temperature and light on chlorine breakdown in the upper surface layers of the flow in comparison with the same at depths near the channel floor. These studies should be conducted under both summer and winter months to take into account the difference in chlorine decay rate at different water temperatures.

- The enhanced chlorination process will likely mean operating at higher dosages of chlorine than what has been standard practice at the existing BNRAS facility. Depending on the type and concentration of organics that remain in the treated BNRAS secondary effluent, various disinfection by-products can form as a result of reacting with the chlorine. The presence of these disinfection by-products in the final effluent has ramifications for water quality issues surrounding the water's ultimate reuse. It is therefore strongly recommended that PCWMD conduct a disinfection by-product formation potential (DBPFP) test, which is a series of bench-scale (jar test) studies that analyze the types and concentrations of disinfection by-products that are likely to form as a result of the enhanced chlorine dosages that will be applied. The test should include warm water conditions because this is typically a "worse case" condition (generates the highest DBP formation potential). Furthermore, if it is determined that pH reduction will be useful in enhancing the disinfection efficiency, then the impacts of pH on DBPFP should be investigated since formation of most DBPs is a function of pH. For example, the formation of trihalomethanes generally decreases with decreasing pH while the formation of haloacetic acids generally increases with decreasing pH.

- Due to the potentially higher chlorine dosages that will likely be necessary to support the enhanced chlorination process, it is recommended that PCWMD evaluate the sizes of their existing sodium hypochlorite storage and feed facilities to assess whether the existing facilities are adequate to accommodate this increase in chlorine dosage (these rates could be as much as three times the current dosage rate).

- The enhanced chlorination process will likely also mean operating the dechlorination process at higher doses to ensure compliance with the AZPDES permit for chlorine residual in the final discharge. (Similar to the above statement, it is recommended that PCWMD evaluate the sizes of the existing storage and feed facilities for the sodium bisulfite dechlorination agent to ensure its capacities are adequate to support the requirements of the enhanced chlorination process.) It will also be important to determine if higher doses of the dechlorinating agent pose threat to aquatic toxicity, since this may impact compliance with the Whole Effluent Toxicity (WET) biomonitoring tests. It is therefore strongly recommended that the PCMWD conduct a set of bench-scale (jar test) studies to assess the potential for excessive dechlorination agent

concentrations to create effluent toxicity issues. If the PCMWD plans to consider alternative dechlorination agents, these studies should include assessment of required dose and reaction time, the toxicity properties of the dechlorinated effluent and other potential water quality impacts the alternative dechlorination agents may create.

- One of the most critical operational factors influencing the reliability of performance of the enhanced chlorination process is the control of total suspended solids in the BNRAS secondary effluent. As noted previously, the TSS concentrations during the kinetics analyses were at or below 5 mg/L, signifying excellent performance of the BNRAS final clarifiers. Even at this low level of TSS, the bench-scale kinetic testing conducted in this study exhibits a "tailing" effect, which is at least partially caused by particle shielding. In high flow conditions during a wet weather event or during performance upset events, for example, it is probable that the concentration of TSS in the secondary effluent could be much higher than 5 mg/L. Increases in TSS can jeopardize compliance with the single sample maximum, and, if these conditions persist for consecutive days, it could jeopardize compliance with the 4-day ND requirement. It is imperative that operation of the final clarifiers be monitored continuously.

  Therefore, two recommendations are hereby posed with respect to final clarifier operations. First, it is recommended that PCWMD conduct an exhaustive and critical review of its standard procedures for operating the existing BNRAS final clarifiers under average and peak flow conditions. These procedures should be reviewed within the context of available historical operational data. Correlations of the effluent suspended solids concentrations to flow rate should be established from the record. If the data exists, a correlation between Solids Volume Index (SVI) and effluent suspended solids concentrations should be established. Using these correlations, modifications to the operational procedures should be made, if necessary, to ensure optimal performance of the clarifiers.

  Secondly, it is recommended that PCWMD operations staff develop and utilize a State Point Analysis (SPA) protocol for operating the existing BNRAS final clarifiers. This procedure provides the facility operators a proactive approach to clarifier operation because it integrates the sludge settling characteristics with both the plant flow condition and the rate of sludge removal via the underflow. The SPA provides the operator with performance information in real time, allowing the operator the "see" the performance limits before they are exceeded and make the appropriate process control decisions to keep within the limits. The SPA protocol can be developed and implemented with PCWMD resources and staff.

  Finally, it goes without saying that the performance of the biological treatment process in the existing nitrogen removal treatment process train influences the performance of the final clarification process. Upsets in treatment performance can result in the proliferation of filamentous organisms that can cause poor settling of the biomass in the clarifiers. Poor settling can result in solids carryover to the chlorine contact basin, reducing the effectiveness of the chlorine. Similarly, treatment upsets that result in the inhibition of complete nitrification can pass "high" levels of nitrite or ammonia on to the chlorination system, which again, reduces the effectiveness of the chorine. Therefore, it is highly recommended that an exhaustive and critical review of the existing BNRAS treatment process control procedures be conducted within the

context of process upsets. Modifications should be made to the process control Standard Operating Procedures, as necessary, to ensure optimal performance is consistent.

- It is recommended that PCWMD staff review its current sample locations for effluent *E.coli* and chlorine residual compliance monitoring and reporting for the existing BNRAS facility. It is possible that a more optimal location exists that is more representative of the true BNRAS chlorine disinfection system performance. This also may mean that monitoring stations be established for both the BNRAS plant and the HPO plant along with the final discharge compliance point in order to isolate the differences between the two facilities.

4.4 Basis of Design Recommendations for Enhanced Chlorination Disinfection Systems for Future BNRAS (Bardenpho) Facilities

Results of the studies and analysis discussed in this report provides information for the basis of design that should be applied to the enhanced chlorination process at future wastewater treatment facilities within PCWMD service area jurisdiction. These include:

1. Minimum CT applied under maximum flow conditions should be 100 mg/L*minutes and applied to the inactivation of the target organism: *E.coli*. This value will of course need to be reevaluated if, in the future, the State of Arizona promulgates new disinfection regulations related to microbial inactivations.

2. Chlorine contact basin should be constructed with a length-to-width ratio of no less than 20:1.

3. Chlorine injection and initial mixing should incorporate the recommendations outlined in Section 4.1. The critical element of these is the application of the WaterChamp™ unit as the initial chlorine injection and mixing apparatus. Its position in the influent chamber is critical to the optimization of the initial mixing to achieve uniform distribution of the chlorine throughout the chamber. This can be accomplished by using:

   - Two units, oriented vertically in the chamber and in such manner as to divide the chamber equally into two volumes, or
   - One unit, oriented horizontally in the center of the conduit conveying the secondary effluent flow into the chamber, with the injection being counterflow to the influent flow.

   An advantage of the first option is system redundancy.

4. Chlorine contact basin for the existing BNRAS process should incorporate the recommendations outlined in Section 4.2. The essential elements include:

   - Rounding of the square corners with a constant radius fillet at the end of each of the serpentine passes using materials consistent with the contact basin wall construction materials;
   - Installing a longitudinal baffle wall in the center of the first pass, beginning immediately downstream of the outlet from the mixing chamber, continuing for the length of the first pass and ending at the start of the end fillet;

- Consideration of ceasing the operation of the vertical shaft mixer units because of the degree of back-mixing and disruptions of plug flow that these tend to create.
- If vertical shaft mixers are utilized in the flash mix chamber, consider installing a vortex splitter device on the downstream side of the outlet orifice of the flash mix chamber to reduce back-mixing;
- If hydraulic head permits, install a perforated baffle wall at the downstream end of the first pass to promote uniform flow (particularly necessary if vertical mixers are specified for the flash mix chamber; and
- Providing for step feed of NaOCl to points downstream in the chlorine contact basin (including points in the conduit conveying basin effluent to the dechlorination chamber) as a means to boost chlorine residuals during critical flow conditions.

5. Construct chlorine contact basins for expandability if increases in CT are necessary to comply with future disinfection regulations promulgated by the State of Arizona.

6. Contact time in the chlorine contact basin should be not less than 30 minutes in average daily flow conditions, and not less than 20 minutes in peak flow conditions.

7. Storage and feed facilities for sodium hypochlorite should be sized based on the dose needed to achieve the target CT (100 mg/L*min) at the residence time recommended above. These facilities should be also constructed for expandability if increases in CT are necessary for future disinfection regulations promulgated by the State of Arizona.

8. Surface overflow rate (SOR) for the final clarifier design should not exceed 400 gpd/ft^2 for average flow conditions, and 600 gpd/ft^2 for peak conditions. The driving force behind these recommended values is providing the margin of protection against violation of the single sample maximum criterion for *E.coli*. It is to be noted that this "margin" is intended to provide protection against noncompliance during very small percentage of time in a given year where a severe wet weather event or some unforeseen operational anomaly results in high suspended solids concentrations in the secondary effluent. But, the increased final clarification capacity generated by these target design overflow rate values does have economic consequences. Therefore, PCWMD is strongly encouraged to carefully evaluate the standard operating procedures currently in place for responding to such abnormal conditions. Revisions to these operational strategies to maximize control of solids in the secondary effluent (including approaches such as the State Point Analysis as discussed in Section 4.3 above) can help to reduce amount of added clarifier capacity required, thereby minimizing the economic impacts.

9. An on-line turbidity meter should be considered for monitoring particulate concentrations in the treated secondary effluent prior to the disinfection process. This monitoring system would serve as an on-line "alarming" device to inform operations personnel of changes occurring in the effluent water quality in advance to allow time for corrections and/or adjustments in operational changes.

10. On an annual basis clean and inspect the chlorine contact basins. Basin cleaning removes solids buildup in the system which may under high flow conditions carryover and impact disinfection performance.

APPENDIX H

Conveyance Evaluation Data

Appendix H

Conveyance Evaluation Data

Interceptor Details

H-1 Aviation Corridor to Santa Cruz Interceptor (ACSC)-1

- Both flow rate and water depth are monitored at this site. A fairly good correlation between water depth and flow rate is observed.
- The 1-year daily peak water depth varies from 7 to 18 inches. The 1-year flow rate ranges from about 2 to 9 mgd. The 100-percentile water depth and flow rate are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix). This indicates that the site is affected by wet weather flow quite significantly.
- Two highest water depths and flow rates occurred on August 4 and August 8, 2006. (The peaks happened at different times during the day, further indication that they are caused by wet weather flows.
- Calculated 10-year water depth is about 21 inches, or a water depth to pipe diameter ratio (d/D) of about 0.51, well below the pipe diameter. The calculated 10-year flow rate is about 10.2 mgd, well below the Manning's design capacity determined from the previous study.
- In summary, this site is impacted significantly by wet weather flows. The net wet weather flow corresponding to a 10-year storm event is estimated to be 6.63 mgd (see **Table H-1,** located at the end of the Appendix). The corresponding wet weather peaking factor is 4.00, which is the second highest of the monitored sites. Nevertheless, hydraulic capacity does not appear to be a problem, but needs to be confirmed by hydraulic modeling.

H-2 Aviation Corridor (AV)-1

- This site is somewhat independent of the other parts of the conveyance system. It has both flow rate and water depth data. Correlation between water depth and flow rate is considered fair, although there were periods that an increase in water depth did not correspond to an increase in flow rate. This could be due to either a downstream deficiency or instrument malfunction.
- A review of the data indicated the anomalies were more likely caused by erroneous velocity measurements. Those questionable flow rate data were excluded for further analysis, while water depth data at those days were included in the analysis. Days with questionable flow rate data sets include: July 17 to 22, August 15 and 16, September 19, October 10 to 12, and November 15 (2005), January 15 and 25, March 29 and 30, April 1, June 1 to 5, June 16 and 17 (2006).
- Historical daily peak water depth varies from 6 to about 12 inches. The historical flow rate ranges from about 1 to 3.3 mgd. The 100-percentile water depth and flow rate are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix) indicating a significant wet weather response.
- Two highest water depths and flow rates occurred on July 27 and August 14, 2005.
- Calculated 10-year water depth is about 13 inches, well below the pipe diameter for existing flows. The calculated 10-year flow rate is about 4 mgd, well below the design capacity determined from the previous study.
- In summary, this site is impacted significantly by wet weather flows. The net wet weather flow corresponding to a 10-year storm event is estimated to be 2.48 mgd (see **Table H-1,** located at the end of the Appendix). The peaking factor is 3.80, which is the third highest of the monitored sites. Hydraulic capacity appears to be adequate, but needs confirmation via hydraulic modeling.

H-3 Canada Del Oro (CDO)-1

- Only water depth data are available at this site.
- Results exclude two questionable 1-minute data points which occurred on April 15, 2006. These two data points were probably caused by erroneous measurements.
- The 100-percentile and 90-percentile water depth is about 19 inches and 17 inches, respectively (see **Table H-1,** located at the end of the Appendix). The maximum daily peak water depth occurred on March 5, 2006.
- In summary, this site is affected by wet weather flows, but not as significant as the previous two sites. The calculated 10-year water depth is about 21 inches, which is less than half of the pipe diameter. Hydraulic capacity is therefore not a concern for the current condition but needs to be confirmed by hydraulic modeling.

H-4 CDO-2

- Only water depth data are available at this site.
- The 100-percentile and 90-percentile water depth is about 12 inches and 10 inches, respectively (see **Table H-1,** located at the end of the Appendix). The maximum daily peak water depth occurred on August 6, 2005.
- In summary, this site is affected by wet weather flows. The calculated 10-year water depth is about 14 inches, which is less than half of the pipe diameter. Hydraulic capacity is not a concern for the current condition, but needs to be confirmed by hydraulic modeling.

H-5 CDO-3

- This site is upstream of CDO-2 and only has water depth data.
- The 100-percentile and 90-percentile water depth is about 12 inches and 8 inches, respectively (see **Table H-1,** located at the end of the Appendix).
- Maximum daily peak water depth occurred at the same day as that for site CDO-2, which is August 6, 2005. This indicates that the maximum daily peak water depths for these two sites may be the result of the same storm event.
- In summary, this site is affected by wet weather flows. The calculated 10-year water depth is about 12 inches, which is half of the pipe diameter. Hydraulic capacity is not a concern for the current condition, but needs to be confirmed by hydraulic modeling.

H-6 Campbell Wash (CW)-1

- Only water depth data are available at this site. Note that this is one of the two locations with the smallest pipe diameter of the monitoring sites.
- The 15-minute daily peak water depth varies from 2 to about 3.7 inches. The 100-percentile water depth is considerably higher than the 90-percentile value (see **Table H-1,** located at the end of the Appendix). The maximum water depth occurred on August 23, 2005.

- In summary, this site is affected significantly by wet weather flows. The calculated 10-year water depth is about 3 inches, which is half of the pipe diameter. Hydraulic capacity is not a concern for the current condition.
- Note that the calculated 10-year water depth is less than the historical 100-percentile value. This indicates that the 100-percentile water depth during this one year period may be the response to a storm event with a recurrence interval of longer than 10 years.

H-7 Dove Mountain (Dove)

- Only water depth data are available at this site.
- Results exclude questionable 1-minute data points on the following days: July 13, August 2, 3 and 8, September 10 and 19, October 18 and 22, November 9, December 9 (2005), January 20, February 2 and 19, May 4, 14 and 24, and June 6 (2006).
- Measured water depth either jumped to a very high value in one minute and back to a low value in the next minute, or the measured values fluctuated around zero and very high values during a short period of time. Note that including these abnormal data points will overestimate the water depth. For example, the 100-percentile water depth would be almost 7 inches rather than 3 inches described below.
- The 15-minute daily peak water depth varies from 2 to about 3 inches. The 100-percentile value is not much different than the 90-percentile value (see **Table H-1,** located at the end of the Appendix). The maximum water depth occurred on March 18, 2006.
- In summary, this site is not affected significantly by wet weather flow. The calculated 10-year water depth is about 3.3 inches, well below the pipe diameter. Hydraulic capacity is not a concern for the current condition.

H-8 Green Valley (GV)-1

- This site is somewhat independent of the other parts of the conveyance system. It has both water depth and flow rate data.
- Correlation between water depth and flow rate is considered fair, except during the period from October 15 to 23, 2005. The 1-minute data exhibited many zero flow rates during this period. . This is likely caused by erroneous velocity readings. Flow rate data from October 15 to 23, 2005 were therefore excluded from the analysis.
- The 15-minute daily peak water depth and flow rate varies from about 6 to 11 inches and from about 1 to 3 mgd. The 100-percentile values are somewhat higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix). The maximum water depth and flow rate occurred on February 20, 2006.
- Calculated 10-year water depth is about half of the pipe diameter. The calculated 10-year flow rate is about 3.2 mgd, well below the Manning's design capacity determined from the previous study.
- Net weather flow corresponding to a 10-year storm event is estimated to be 1.52 mgd (see **Table H-1,** located at the end of the Appendix) with a peaking factor of 2.66. In summary, this site is affected by wet weather flow, yet it seems to have adequate capacity to convey it.

H-9 North Rillito Interceptor (NRI)-1

- Both water depth and flow rate data are available at this site. There is a period, from October 5 to October 28, 2005, during which the flow rates are significantly higher than those at other periods. However, the water depths do not exhibit a similar pattern at the same time period. The anomalies are more pronounced when water depths are plotted against flow rates.
- A review of the data seems to indicate these anomalies were likely caused by erroneous velocity measurements. Questionable flow rate data was excluded from this analysis, while water depth data for those days was included.
- Historical daily peak water depth ranges from about 22 to 31 inches. The historical daily peak flow rate varies from about 16 to 31 mgd. The 100-percentile water depth and flow rate are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Highest water depth and flow rate occurred on September 15, 2005.
- Calculated 10-year water depth is about 32 inches, less than the pipe diameter for existing flows. The calculated 10-year flow rate is about 38 mgd, below the design capacity determined from the previous study.
- In summary, this site is impacted significantly by wet weather flows with the net wet weather flow corresponding to a 10-year storm event is estimated to be 11.16 mgd (see **Table H-1,** located at the end of the Appendix). The peaking factor is 2.21. While hydraulic capacity appears to be adequate at the moment, this may not be the case for the entire 25-year planning period.

H-10 NRI-2

- This site has both water depth and flow rate data.
- Correlation between water depth and flow rate is considered fair, except for the data point at the maximum flow rate. It is not clear whether this abnormal data point was real or caused by an erroneous velocity reading.
- Daily peak water depth varies from about 15 to 26 inches. The daily peak flow rate ranges from 10 to 32 mgd. The maximum flow rate occurred on July 6, 2005, as discussed above. The maximum water depth occurred on September 14, 2005.
- The 100-percentile values of water depth and flow rate are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix), indicating significant wet weather impacts.
- Calculated 10-year water depth and flow rate is about 29 inches and 33 mgd, respectively.
- In summary, this site is significantly affected by wet weather flows. The net wet weather flow corresponding to a 10-year storm event is calculated to be 17.97 mgd (see **Table H-1,** located at the end of the Appendix) with a peaking factor of 3.04. Hydraulic capacity appears to be adequate at the moment, but this may not be the case for the entire 25-year planning period.

H-11 NRI-3

- This site has both water depth and flow rate data. Correlation between these daily peak water depths and flow rates is good .

- Daily peak water depth varies from about 10 to 14 inches. Flow rates range from about 6 to 12 mgd.
- Highest water depth and flow rate occurred on August 23 and November 24, 2005 respectively.
- Calculated 10-year water depth is about 15 inches, or a d/D of 0.46. The calculated 10-year flow rate is about 12 mgd, well below the Manning's design capacity reported in previous studies.
- In summary, this site is only slightly affected by wet weather flows. The net wet weather flow corresponding to a 10-year storm event is estimated to be 2.29 mgd (see **Table H-1,** located at the end of the Appendix). The corresponding wet weather peaking factor is 1.74. Hydraulic capacity does not appear to be a problem.

H-12 Northwest Outfall (NWO)-1

- Only depth data were provided for this site. Although a maximum water depth of about 30 inches was found on June 30, 2006, a review of the 1-minute data indicated that this data point is questionable and was therefore excluded from the analysis.
- Daily peak water depth varies from about 21 to 29 inches. The 100-percentile water depth occurred on August 6, 2005.
- Calculated 10-year water depth is about 30 inches, well below the pipe diameter (48-inch).
- In summary, this site is only slightly impacted by wet weather flows. Hydraulic capacity appears to currently be adequate.

H-13 Pontatoc Wash (PONT)-1

- Only water depth data are available at this site. Although a daily peak water depth of about 30 inches was found on May 25, 2005, this data point was excluded in the analysis due to the potential erroneous reading at that day.
- Daily peak water depth varies from about 3 to 5 inches. The 100-percentile water depth is significantly higher than the 90-percentile value (see **Table H-1,** located at the end of the Appendix). The maximum water depth occurred on August 14, 2005. This may have been a backwater condition resulting from capacity limitations of the downstream NRI.
- Calculated 10-year water depth is about 4 inches, significantly less than the pipe diameter (12-inch).
- In summary, while this site appears to be slightly impacted by wet weather flows, this cannot be verified from depth data alone.

H-14 Pantano Interceptor (PTI)-1

- Both water depth and flow rate data were provided for this site.
- Correlation between water depths and flow rates is good, although there are periods that flow rates were relatively low.
- A review of the 1-minute data for those low flow rate periods does not indicate any unusual readings. No data were excluded in this analysis.
- Daily peak water depth varies from about 12 to 16 inches. The historical daily peak flow rate ranges from about 8 t o14 mgd.

- Maximum water depth and flow rate occurred on August 23, 2005. The calculated 10-year water depth is about 17 inches, half of the 36-inch pipe diameter. The calculated 10-year flow rate is about 13 mgd, well below the design capacity determined from the previous study.
- In summary, this site does not appear to be significantly impacted by wet weather flows with a 10-year wet weather flow of about 2.3 mgd and a peaking factor of 1.71 (see **Table H-1,** located at the end of the Appendix).

H-15 PTI-2

- Only water depth data were provided for this site. Two questionable 1-minute water depth readings occurred on August 26, 2005 and are excluded from this analysis.
- Daily peak water depth varies from about 9 to 14 inches.
- Maximum water depth occurred on November 24, 2005.
- Calculated 10-year water depth is about 15 inches, significantly less than the pipe diameter (30-inch).
- In summary, this site is not significantly impacted by wet weather flows and hydraulic capacity appears to be adequate.

H-16 Santa Cruz-East Interceptor (SCE)-1

- Both water depth and flow rate data were provided for this site.
- Water depth data on November 20, 2005 and June 26, 2006 were considered questionable and excluded from the analysis. Flow rate data on the following days are considered questionable and excluded: July 29 and 30, 2005. November 11 to 21, 2005 and June 25, 2006.
- Daily peak water depth varies from 19 to 29 inches. The daily peak flow rate varies from 14 to 44 mgd. The 100-percentile water depth and flow rate are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 28 inches, or a d/D of about 0.36, well below the pipe diameter (78-inch). The calculated 10-year flow rate is about 50 mgd, well below the Manning's design capacity determined from the previous study.
- In summary, this site is significantly affected by wet weather flows. The net wet weather flow corresponding to a 10-year storm event is about 21 mgd (see **Table H-1,** located at the end of the Appendix). The corresponding peaking factor is 2.45. Hydraulic capacity appears to be adequate at the moment, but this may not be the case for the entire 25-year planning period.

H-17 SCE-2

- Both flow rate and water depth data were provided for this site. However, flow rate data are only available for: February 28, 2006 and March 1 to 30, 2006. Therefore, only water depth data were analyzed. Note that water depth data from February 17 to 27, 2006, are not available.
- A review of the 1-minute data for the two maximum daily water depths occurred on August 7 and 9, 2006 indicated that the data for these two days were likely caused by erroneous readings. Data for these two days are excluded from the analysis.

- Remaining data exhibited a water depth from about 8 to 19 inches. The 100-percentile value is significantly higher than the 90-percentile value (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 17 inches, or a d/D of about 0.6. Note that the calculated 10-year value is less than two of the maximum daily water depth values observed in this one-year period. These two water depths may be a response to storm events with recurrence intervals greater than 10 years, or may have been caused by downstream deficiencies.
- In summary, this site is appears to be significantly impacted by wet weather flows. A comparison of the 10-year water depth and pipe diameter indicates that hydraulic capacity is adequate for current flows.

H-18 Santa Cruz Interceptor (SCI)-1

- Both water depth and flow rate data were provided for this site. Data on July 24 and 25, 2005 are considered questionable and were excluded. Data on July 27 and 28, 2005 were not available. The remaining data indicated a fairly good correlation between water depths and flow rates.
- Daily peak water depth varies from about 11 to 19 inches. The historical flow rate varies from about 4 to 8 mgd. The 100-percentile values of water depth and flow rate are significantly greater than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth and flow rate are about 17 inches and 7.3 mgd, respectively. These values are well below the pipe diameter (30-inch) and the Manning's design capacity determined from the previous study.
- In summary, this site is significantly impacted by wet weather flows. The net weather flow due to a 10-year storm event is estimated to be about 2.78 mgd, with a peaking factor of 2.26 (see **Table H-1,** located at the end of the Appendix). Hydraulic capacity is not considered to be a problem but needs confirmation via hydraulic modeling.

H-19 Southeast Interceptor (SEI)-1

- Only water depth data are available at this site.
- Historical water depth varies from about 19 to 28 inches. The 100-percentile water depth is significantly higher than the 90-percentile value (See **Table H-1** at the end of Appendix E).
- Calculated 10-year water depth is about 28 inches, or a d/D of about 0.5.
- In summary, this site is affected by wet weather flows but hydraulic capacity is not a problem.

H-20 SEI-2

- Only water depth data are available at this site.
- Maximum daily peak water depth occurred on August 23, 2005. It has a value of about 35 inches, which is significantly higher than all other observed values at this site. Furthermore, this value is very close to the pipe diameter, which is 36 inches. A review of the 1-minute data indicates that the observation may be real. This peak value was included in the historical percentile value. The second maximum water depth occurred on July 23, 2005.
- In summary, the water depth at this site varies from 10 to 35 inches. It is impacted by wet weather flows significantly. The calculated 10-year water depth is about 19 inches or a d/D of 0.52 (see

H-21 SEI-3

- Only water depth data are available at this site. Some high water depth readings were questionable and excluded in this analysis. Days with these questionable readings include: the whole month of July, August 1, 19 and 26, September 2, 14, and 15 to 30, October 1, 24 and 26, November 15, 18 and 26, December 16 to 29 (2005), January 21, February 1 to 21, March 6, April 14, May 14, 22 and 24, June 6, 14 to 19 and 30 (2006).
- Daily peak water depths, after excluding the above abnormal data points, vary from about 9 to 17 inches. The 100-percentile value is significantly higher than the 90-percentile value (See **Table H-1** at the end of Appendix E).
- Calculated 10-year water depth is about 16 inches, or a d/D of about 0.53.
- In summary, this site is impacted by wet weather flows quite significantly. Hydraulic capacity appears to be adequate for the current condition but needs confirmation via hydraulic modeling.

H-22 South Rillito Interceptor-Central (SRC)-1

- Both water depth and flow rate data are available at this site. Correlation between water depth and flow rate is good, except for 4 daily peak data points. These abnormal data points occurred on August 24 to 27, 2005, which include the two highest daily peak flow rates.
- A review of the 1-minute data points for these 4 days indicated that they are probably due to erroneous velocity measurements. Flow rate data for these 4 days were excluded for further analysis, while water depth data at those days were included in the analysis.
- Historical daily peak water depth varies from about 19 to 25 inches. The historical daily peak flow rate varies from about 14 to 26 mgd. The 100-percentile water depth and flow rate are significantly greater than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 26 inches, which is well below the pipe diameter. The calculated 10-year flow rate is about 29 mgd, which is higher than the Manning's design capacity determined from previous study. Note that the capacity is 11.8 mgd, which is even less than the lowest flow rate (14 mgd) observed in this year. This indicated that the design capacity from the previous study is probably not accurate.
- In summary, this site is impacted by wet weather flows. The calculated 10-year net wet weather flow is 12.36 mgd, with a peaking factor of 2.47 (see **Table H-1,** located at the end of the Appendix). The 10-year calculated water depth is only about half of the pipe diameter, an indication that hydraulic capacity is not a concern. The 10-year calculated flow rate should be compared with hydraulic modeling results to confirm whether the existing hydraulic capacity is adequate.

H-23 South Rillito Interceptor – West (SRW)-1

- This site has both water depth and flow rate data, with a fairly good correlation.

- Historical daily peak water depth varies from about 8 to 15 inches. The historical daily peak flow rate varies from about 2 to 4 mgd. The 100-percentile values are somewhat higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 15 inches, or a d/D of 0.51. The calculated 10-year flow rate is about 4.2 mgd, below the Manning's design capacity determined from the previous study.
- In summary, this site is affected by wet weather flows. The calculated 10-year net wet weather flow is 1.81 mgd, with a peaking factor of 2.45 (see **Table H-1,** located at the end of the Appendix). Hydraulic capacity does not appear to be a problem, but requires confirmation via hydraulic modeling.

H-24 South Rillito Interceptor-West, North Line (SRWN)-1

- This site only has water depth data.
- Historical daily peak water depth varies from about 8 to 19 inches. The 100-percentile value is somewhat higher than the 90-percentile value (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 18 inches, or a d/D of 0.3.
- In summary, this site is slightly impacted by wet weather flows, but hydraulic capacity appears to be adequate.

H-25 South Rillito Interceptor-West, South Line (SRWS)-1

- Only water depth data are available at this site, with the daily peak values varying from about 12 to 19 inches.
- The 100-percentile water depth is significantly greater than the 90-percentile value (see **Table H-1,** located at the end of the Appendix), indicating a considerable impact of wet weather flows.
- Calculated 10-year water depth is about 21 inches or a d/D of 0.77.
- In summary, this site is impacted by wet weather flows, but hydraulic capacity appears to be adequate for the current condition based on the calculated 10-year water depth and pipe diameter.

H-26 Southwest Interceptor (SWI)-1

- Both water depth and flow rate data are available at this site. A good correlation between water depth and flow rate is observed, except for the day with the highest water depth and flow rate.
- Highest daily peak water depth and flow rate occurred on August 23, 2005. A review of the 1-minute data on that day indicated that backwater, caused by downstream deficiency, might occur.
- Historical daily peak water depth varies from about 4 to 30 inches. The historical daily peak flow rate ranges from about 2 to 10 mgd. The 100-percentile values of water depth and flow rates are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated water depth is about 11 inches, or a d/D of 0.35. The calculated 10-year flow rate is about 9 mgd, well below the Manning's design capacity determined from the previous study.
- In summary, this site is impacted by wet weather flows. The calculated 10-year net wet weather flow is 2.13 mgd, with a peaking factor of 1.87 (see **Table H-1,** located at the end of the Appendix). Backwater, caused by downstream deficiency, might happen during the one-year

period. Hydraulic capacity at this site appears to be adequate for the current condition but needs confirmation via hydraulic modeling.

H-27 Tucson Boulevard Diversion (TUCDIV)

- Both water depth and flow rate data are available at this site. Note that this site is unique because the amount of flow through this pipe depends on how it is operated. Water depth and flow rate shown at this site may not be a direct response of wet weather flows in this area.
- Some water depth and flow rate data are questionable and excluded in the analysis. After excluding those questionable data points, a fairly good correlation between water depth and flow rate is observed.
- Historical daily peak water depth varies from about 2 to 32 inches. The historical daily peak flow rate varies from about 1 to 12 mgd. The 100-percentile values are significantly higher than the 90-percentile values (see **Table H-1,** located at the end of the Appendix).
- Calculated 10-year water depth is about 23 inches, or a d/D of 0.70. The calculated 10-year flow rate is about 15 mgd, well below the Manning's design capacity from the previous study (see **Table H-1,** located at the end of the Appendix).
- In summary, this site may be impacted by wet weather flows. However, the impact is complicated by the way this site is operated and may not be a direct result of the wet weather flows in this area. Nevertheless, the calculated 10-year net wet weather flow is 11.79 mgd, with a peaking factor of 6.67 (see **Table H-1,** located at the end of the Appendix). Note that this is the highest peaking factor among all the monitoring sites. However, it may not be a real peaking factor as mentioned previously. Whether hydraulic capacity is adequate is related to future operation.

Table H-1
Historical and Calculated Flow Rates and Water Depths

Site	Flow Rate, mgd					Design Capacity(2), mgd	Wet Weather Flow(3)	PF(4)	Water Depth/Pipe Diameter					Pipe Diameter (inch)
	Historical(1)				Calculated				Historical(1)				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
ACSC-1	2.69	3.56	4.60	8.77	10.19	19.2	6.63	4.00	0.22	0.26	0.29	0.42	0.51	42
AV-1	1.10	1.45	1.87	3.28	3.93	9.1	2.48	3.80	0.30	0.34	0.38	0.53	0.57	24
CDO-1	-	-	-	-	-	94.8	-	-	0.29	0.32	0.36	0.39	0.43	48
CDO-2	-	-	-	-	-	31.1	-	-	0.24	0.25	0.28	0.33	0.38	36
CDO-3	-	-	-	-	-	-	-	-	0.27	0.31	0.33	0.48	0.49	24
CW-1	-	-	-	-	-	-	-	-	0.19	0.20	0.21	0.31	0.25	12
Dove Mtn	-	-	-	-	-	-	-	-	0.16	0.17	0.20	0.21	0.22	15
GV-1	1.26	1.69	2.34	2.82	3.21	-	1.52	2.66	0.34	0.39	0.46	0.51	0.50	21
NRI-1	16.96	19.40	25.54	30.82	30.56	38.3	11.16	2.21	0.54	0.56	0.66	0.74	0.76	42
NRI-2	12.82	15.32	20.04	32.40	33.29	-	17.97	3.04	0.45	0.50	0.56	0.68	0.73	39
NRI-3	8.19	9.49	10.10	11.93	11.78	20.1	2.29	1.74	0.33	0.36	0.37	0.41	0.46	33
NWO-1	-	-	-	-	-	28.7	-	-	0.48	0.52	0.55	0.60	0.63	48
PONT-1	-	-	-	-	-	16.18	-	-	0.27	0.31	0.33	0.44	0.35	12
PTI-1	9.37	10.57	11.66	14.44	12.87	29.8	2.30	1.71	0.36	0.38	0.40	0.44	0.46	36

(1) Based on data recorded from July 1, 2005 to June 30, 2006
(2) From previous study: 2006 Metropolitan Area Facility Plan Update. Included here for reference only
(3) Wet weather flow, estimated as the difference between the calculated 10-year flow and historical 50-percentile flow
(4) PF: Peaking factor, estimated as 1.4 x (calculated 10-year flow/ historical 50-percentile flow)
ACSC = Aviation Corridor to Santa Crus Interceptor; AV = Aviation Corridor; CDO = Canada Del Oro; CW = Campbell Wash; Dove Mtn = Dove Mountain; GV = Green Valley; NRI = North Rillito Interceptor; NOW = Northwest Outfall; PONT = Pontatoc Wash; PTI = Pantano Interceptor

Table H-1 (continued)
Historical and Calculated Flow Rates and Water Depths

Site	Flow Rate, mgd					Design Capacity[2], mgd	Wet Weather Flow[3]	PF[4]	Water Depth/Pipe Diameter					Pipe Diameter (inch)
	Historical[1]				Calculated				Historical[1]				Calculated	
	10%	50%	90%	100%	10-year				10%	50%	90%	100%	10-year	
PTI-2	-	-	-	-	-	13.5	-	-	0.35	0.38	0.41	0.45	0.48	30
SCE-1	25.23	28.33	34.05	44.32	49.52	148.1	21.19	2.45	0.28	0.30	0.31	0.37	0.36	78
SCE-2	-	-	-	-	-	7.8	-	-	0.30	0.38	0.42	0.62	0.58	30
SCI-1	4.19	4.51	4.97	8.34	7.29	12.1	2.78	2.26	0.38	0.40	0.42	0.62	0.57	30
SEI-1	-	-	-	-	-	92.8	-	-	0.36	0.37	0.38	0.46	0.47	60
SEI-2	-	-	-	-	-	-	-	-	0.30	0.31	0.33	0.98	0.52	36
SEI-3	-	-	-	-	-	21.4	-	-	0.33	0.36	0.39	0.57	0.53	30
SRC-1	14.93	16.17	18.03	26.26	28.53	11.8	12.36	2.47	0.35	0.37	0.38	0.45	0.48	54
SRW-1	2.22	2.42	2.69	3.90	4.23	7.8	1.81	2.45	0.30	0.32	0.33	0.51	0.51	30
SRWN-1	-	-	-	-	-	127.9	-	-	0.20	0.24	0.25	0.28	0.28	66
SRWS-1	-	-	-	-	-	9.7	-	-	0.48	0.50	0.53	0.71	0.77	27
SWI-1	5.48	6.39	7.10	9.46	8.52	43.9	2.13	1.87	0.28	0.31	0.33	0.89	0.35	33
TUCDIV	1.37	3.13	7.61	11.98	14.92	30.2	11.79	6.67	0.20	0.30	0.40	0.96	0.70	33

(1) Based on data recorded from July 1, 2005 to June 30, 2006
(2) From previous study: 2006 Metropolitan Area Facility Plan Update. Included here for reference only
(3) Wet weather flow, estimated as the difference between the calculated 10-year flow and historical 50-percentile flow
(4) PF: Peaking factor, estimated as 1.4 x (calculated 10-year flow/ historical 50-percentile flow)
SCE = Santa Cruz-East Interceptor; SEI = Southeast Interceptor; SRC = South Rillito Interceptor-Central;
SRW = South Rillito Interceptor-West; SRWN = South Rillito Interceptor-West, North Line; SRWS = South Rillito Interceptor-West, South Line;
SWI = Southwest Interceptor; TUCDIV = Tucson Boulevard Diversion

Appendix H

Conveyance Evaluation Data

Flow and Depth Figures for :

ACSC
AV
CDO
CW
Dove
GV
NRI
NOW
Pont
PTI
SCE
SCI
SEI
SRC
SRW
SRWN
SRWS
SWI-1
TUCDIV

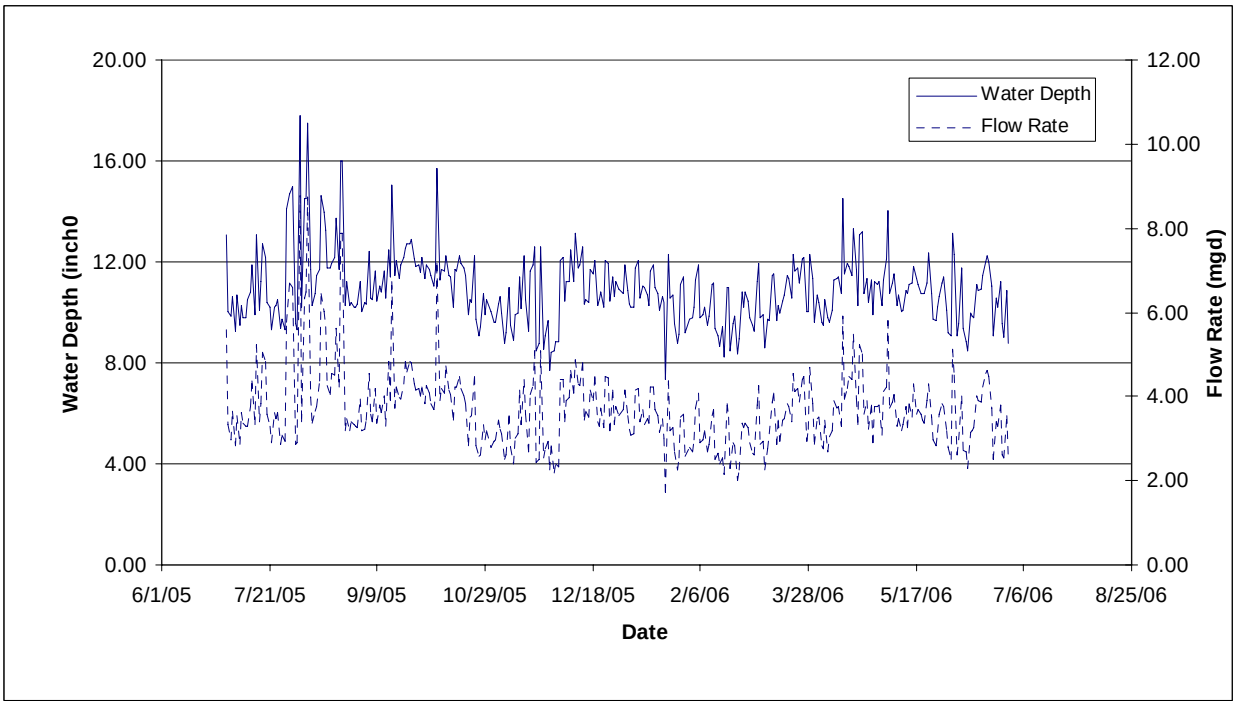


Figure ACSC-1 Daily Peak Water Depths and Flow Rates (site: ACSC-1).

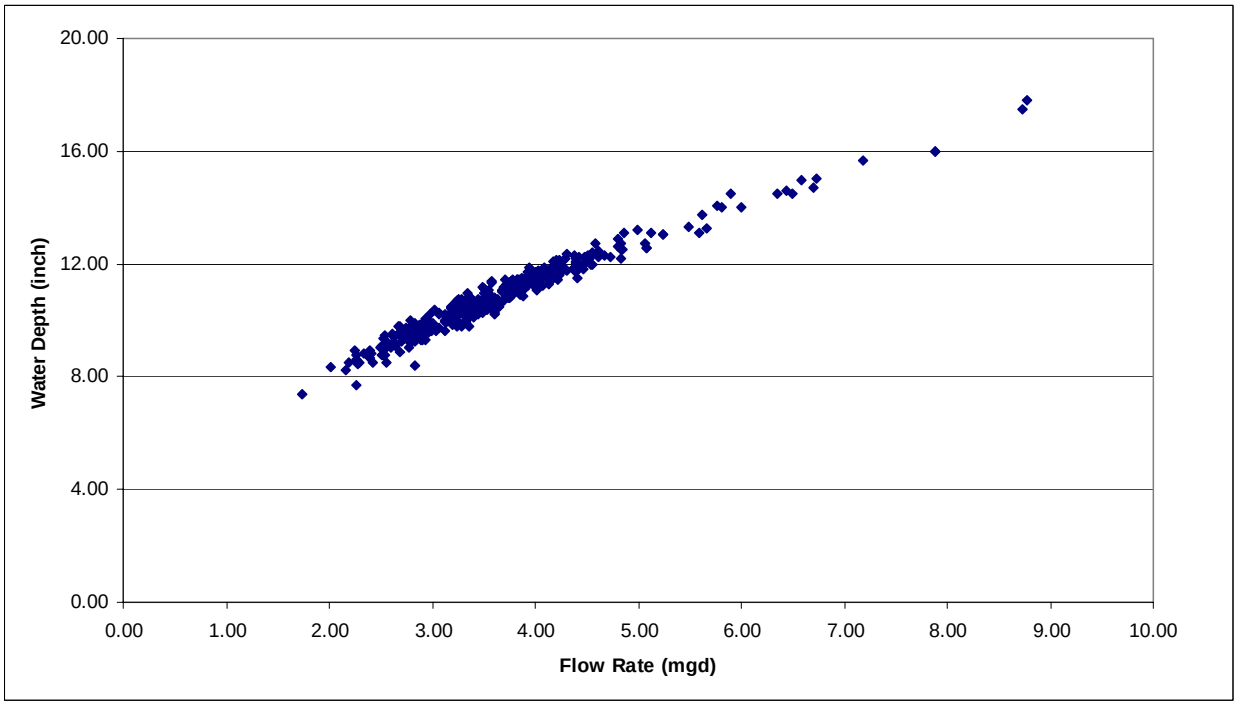


Figure ACSC-2 Correlation between Daily Peak Water Depths and Flow Rates (site ACSC-1)

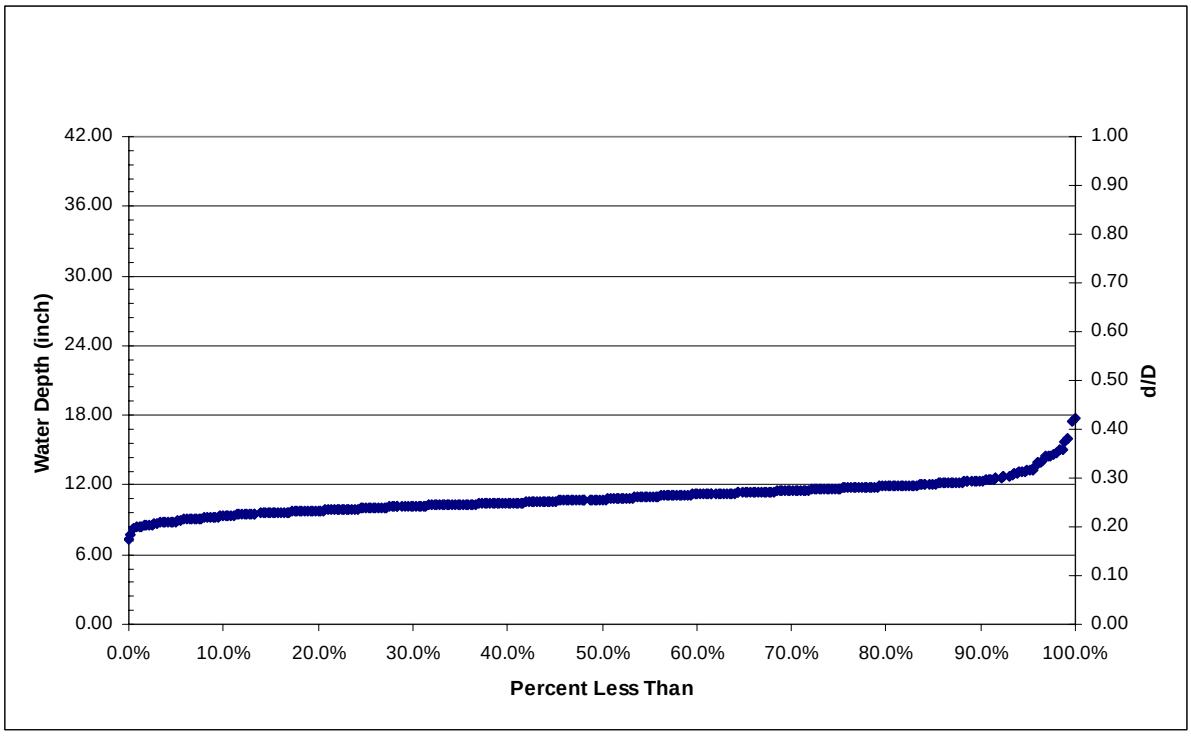


Figure ACSC-3 Historical Percentile Values of Water Depth (site: ACSC-1)

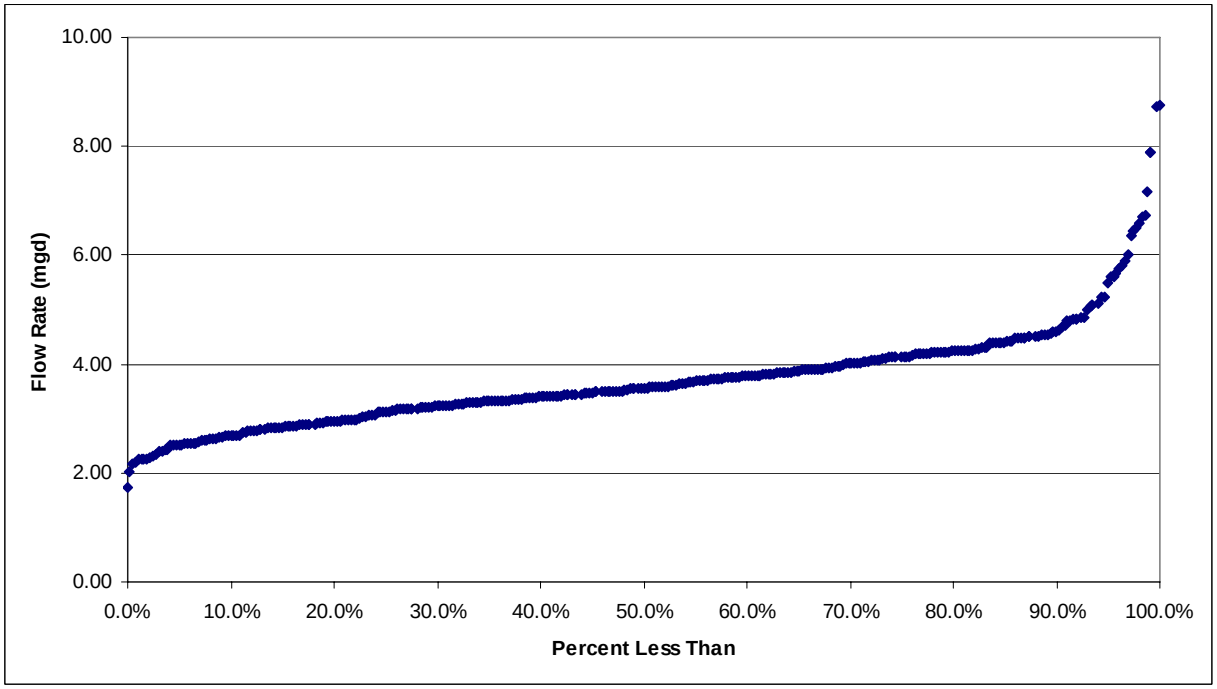


Figure ACSC-4 Historical Percentile Values of Flow Rate (site: ACSC-1)

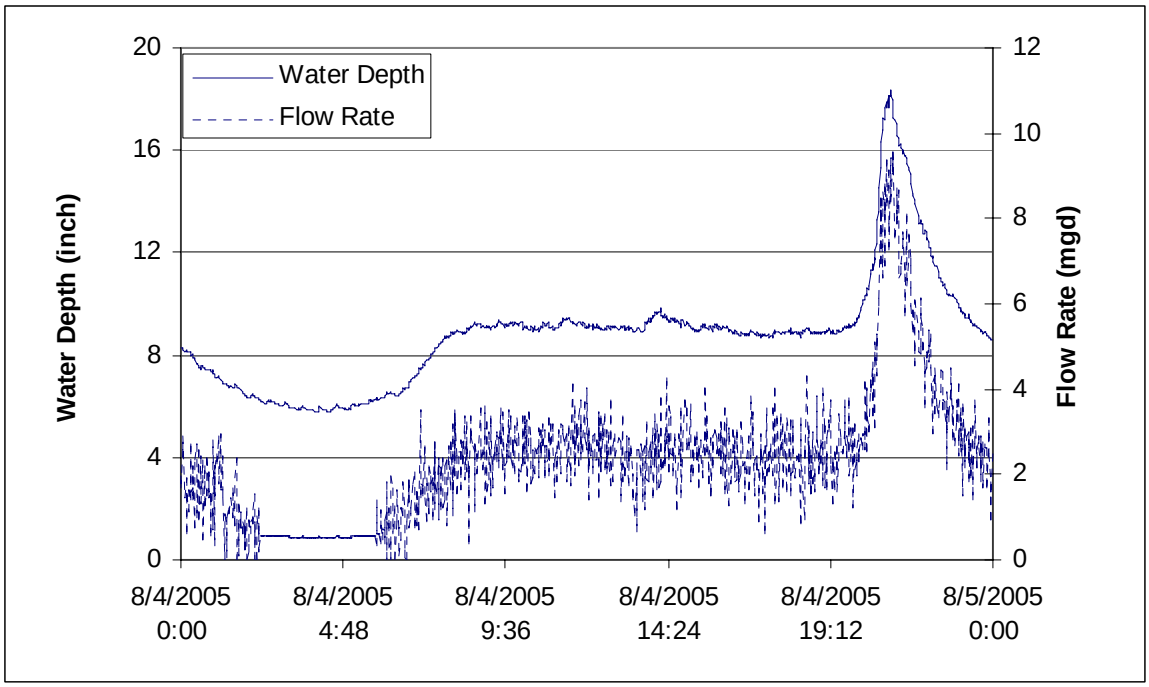


Figure ACSC-5 One-minute Data Points with the Maximum Water Depth and Flow Rate (site: ACSC-1)

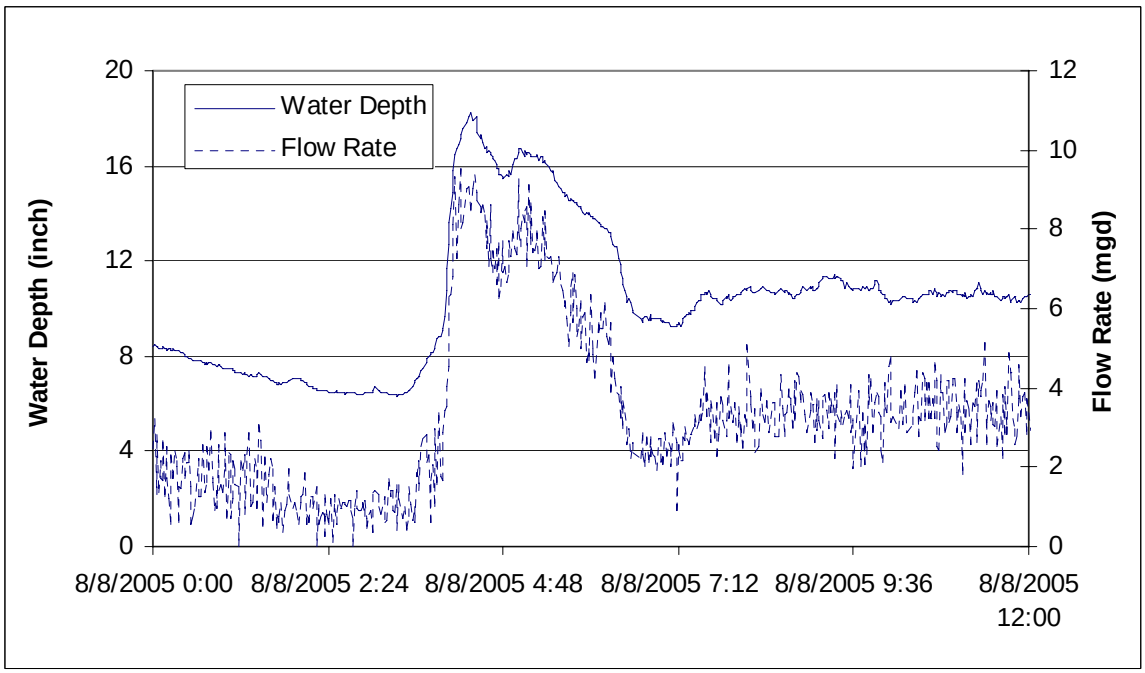


Figure ACSC-6 One-minute Data Points with the Second Highest Water Depth and flow Rate (site: ACSC-1)

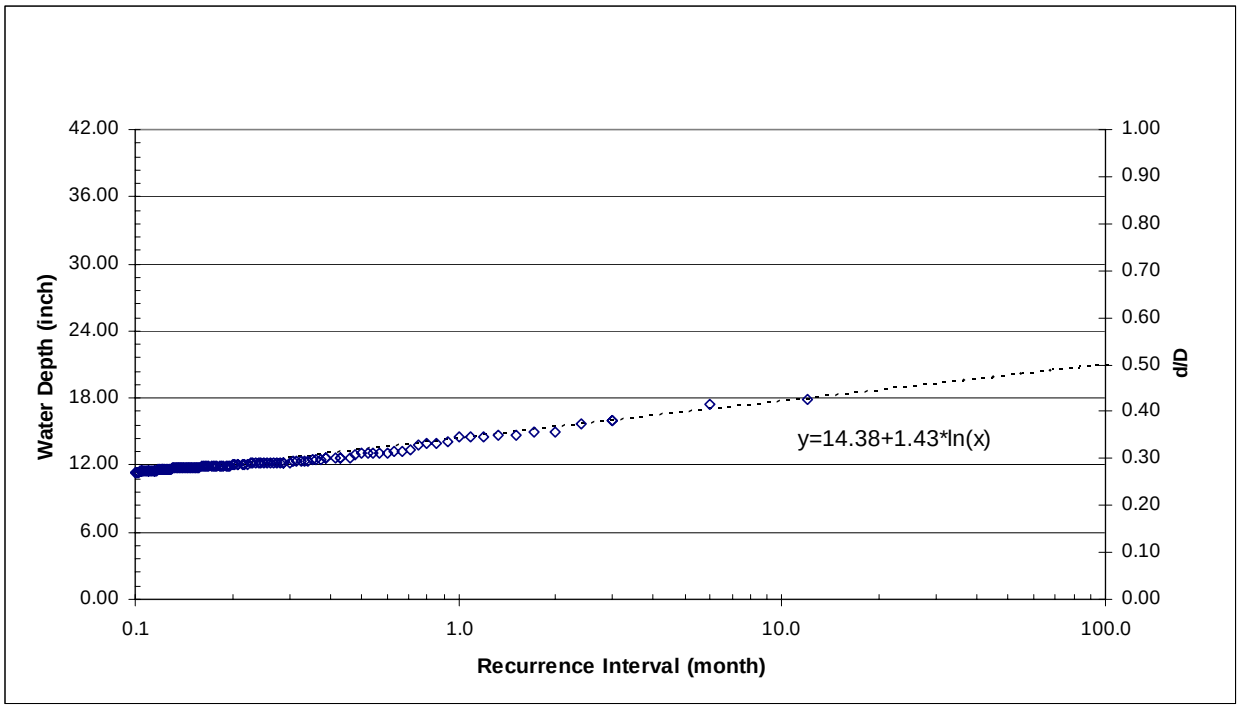


Figure ACSC-7 Water Depths at Different Recurrence Intervals (site: ACSC-1).

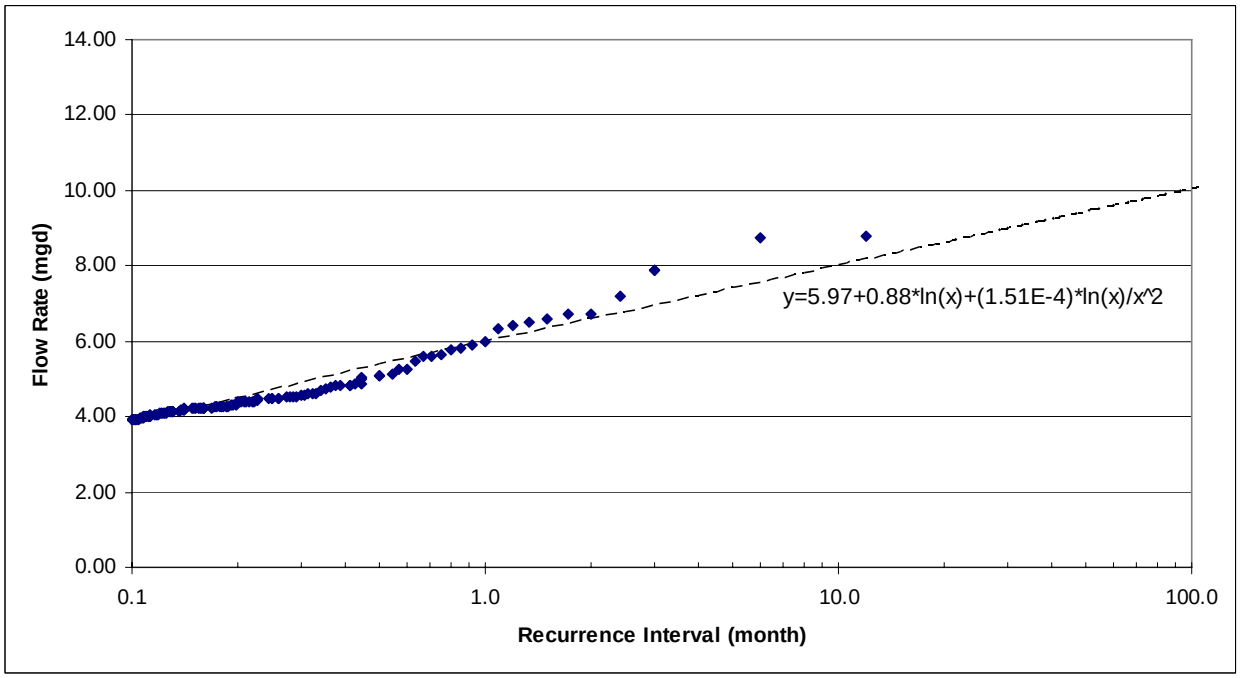


Figure ACSC-8 Flow Rates at Different Recurrence Intervals ((site: ACSC-1)

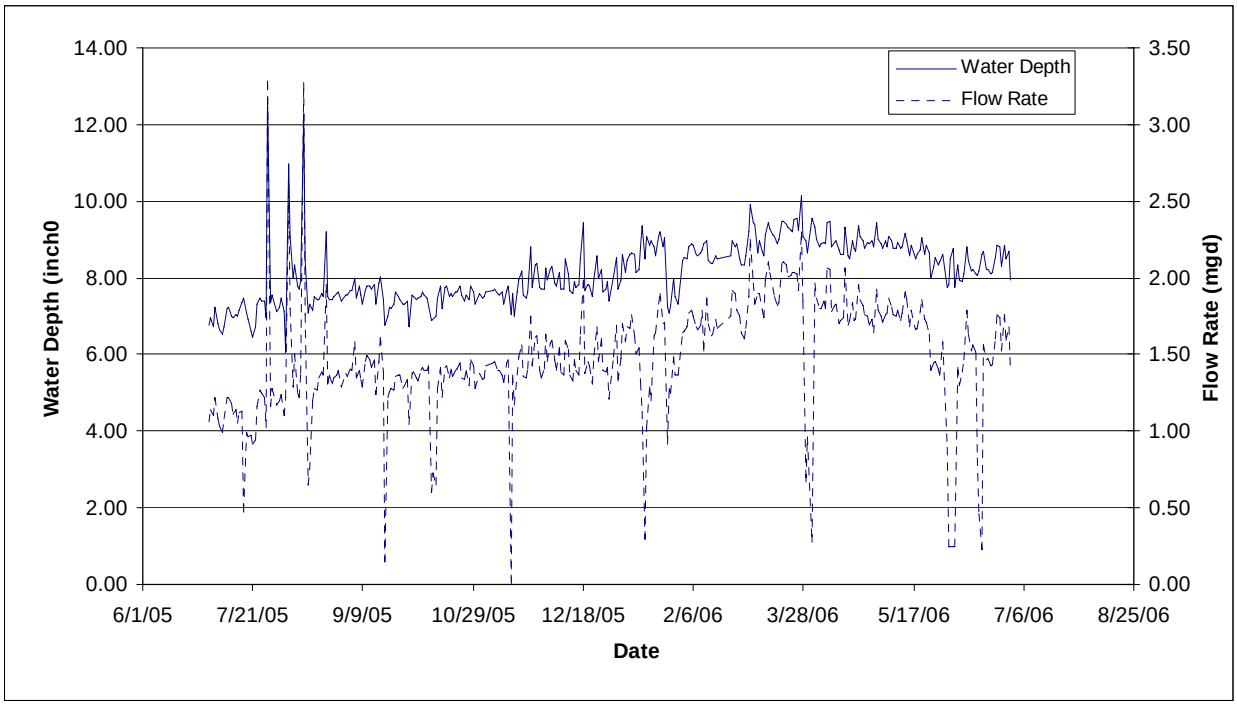


Figure AV-1 Daily Peak Water Depths and Flow Rates (site: AV-1).

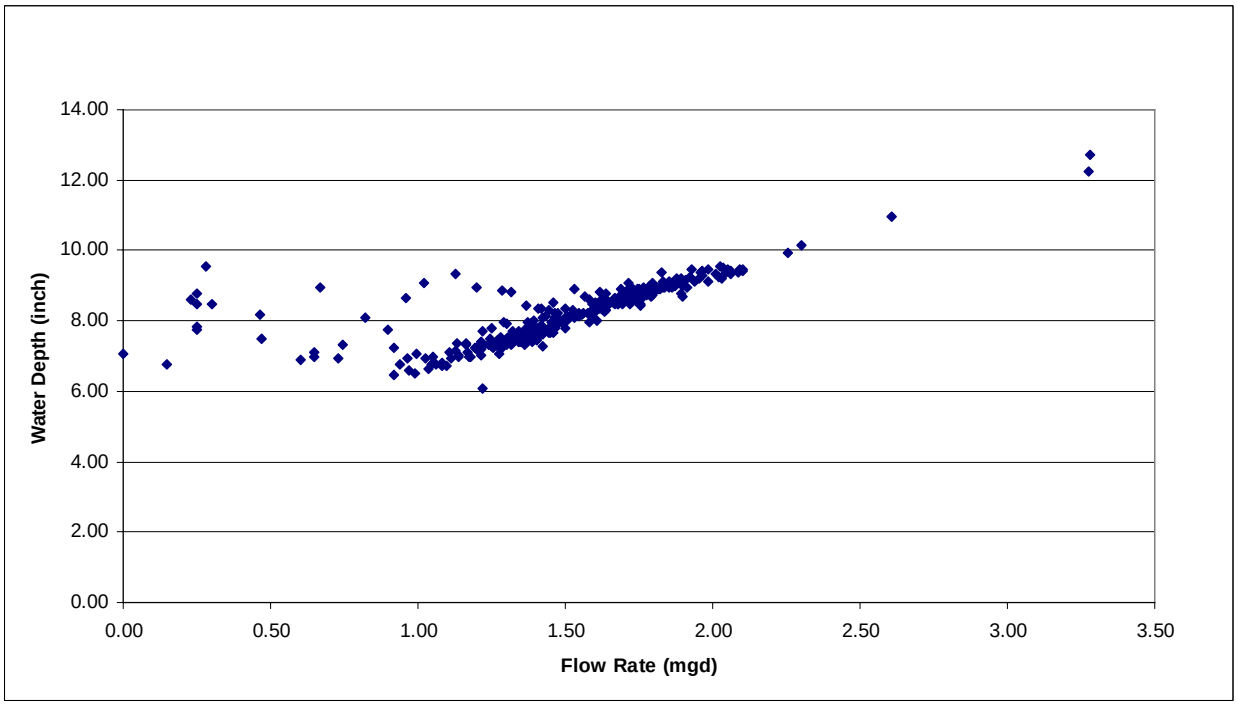


Figure AV-2 Correlation between Daily Peak Water Depths and Flow Rates (site: AV-1)

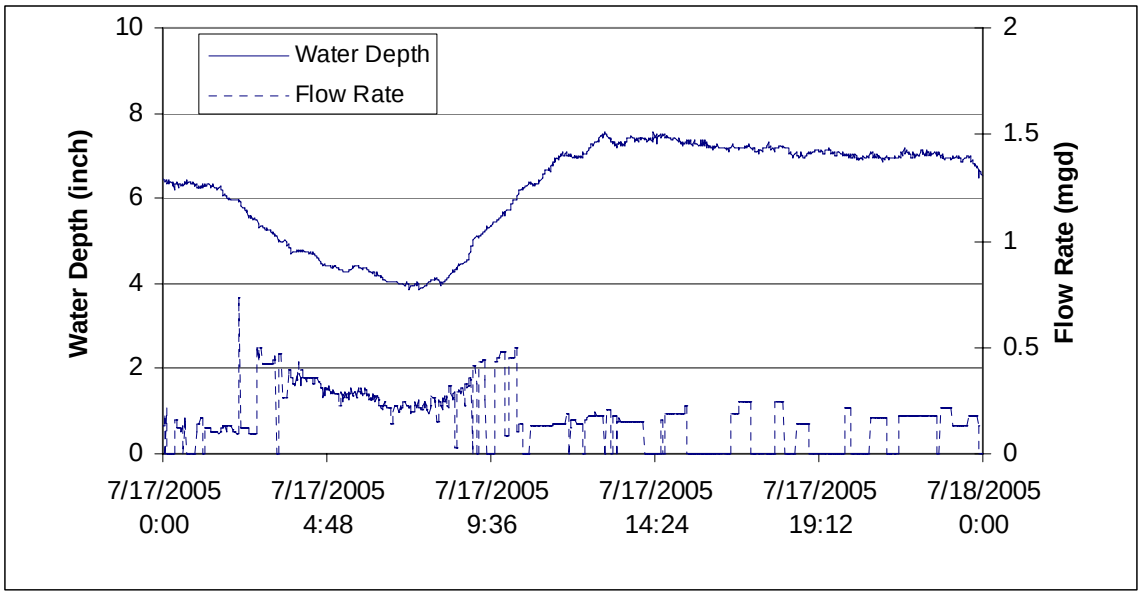


Figure AV-3 One Example of Questionable Data Points (site: AV-1)

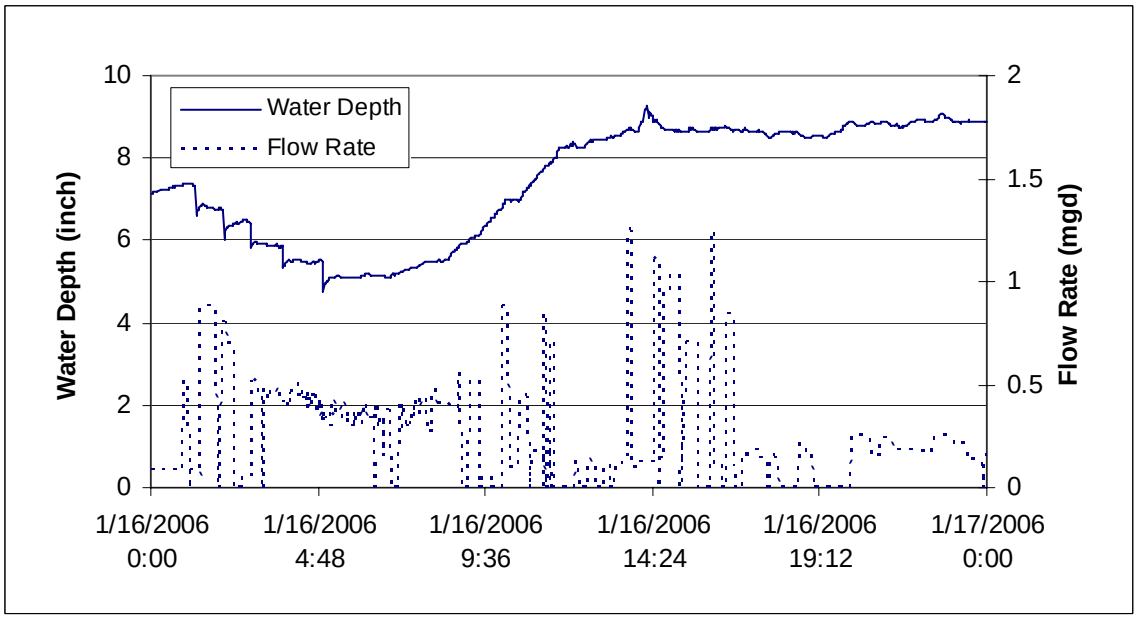


Figure AV-4 Another Example of Questionable Data Points (site: AV-1)

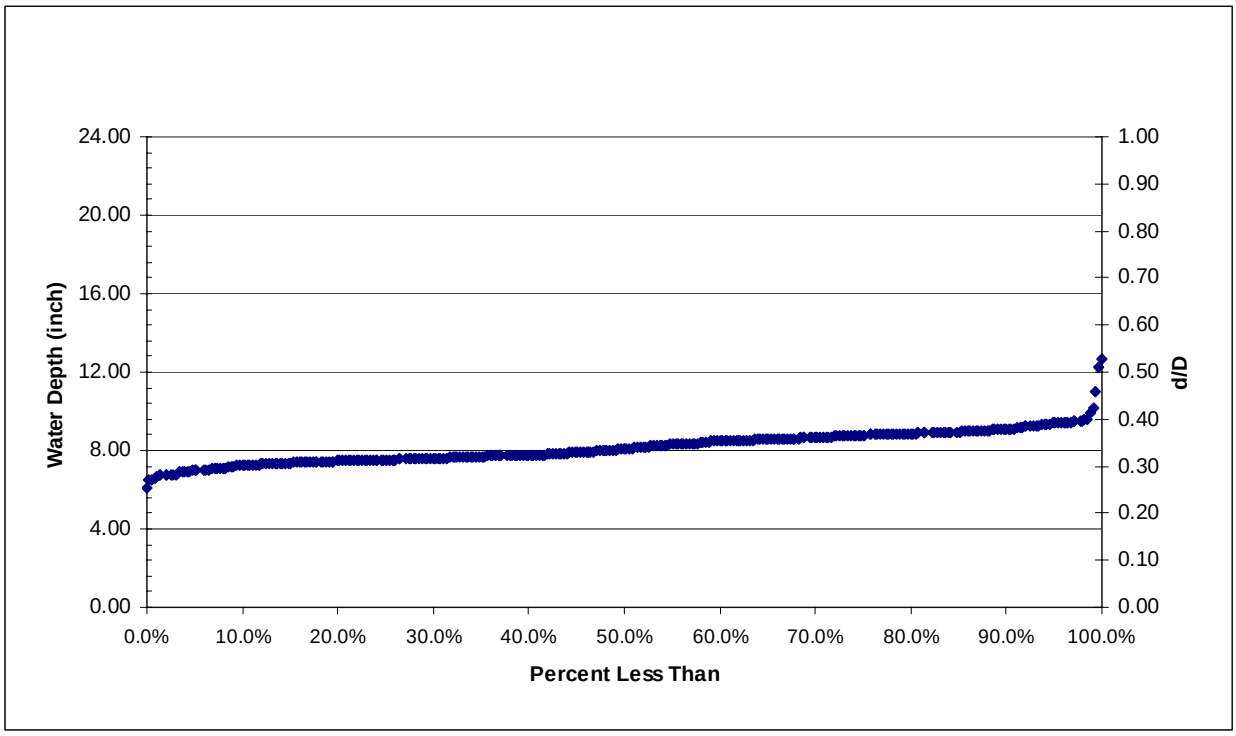


Figure AV-5 Historical Percentile Values of Water Depth (site: AV-1)

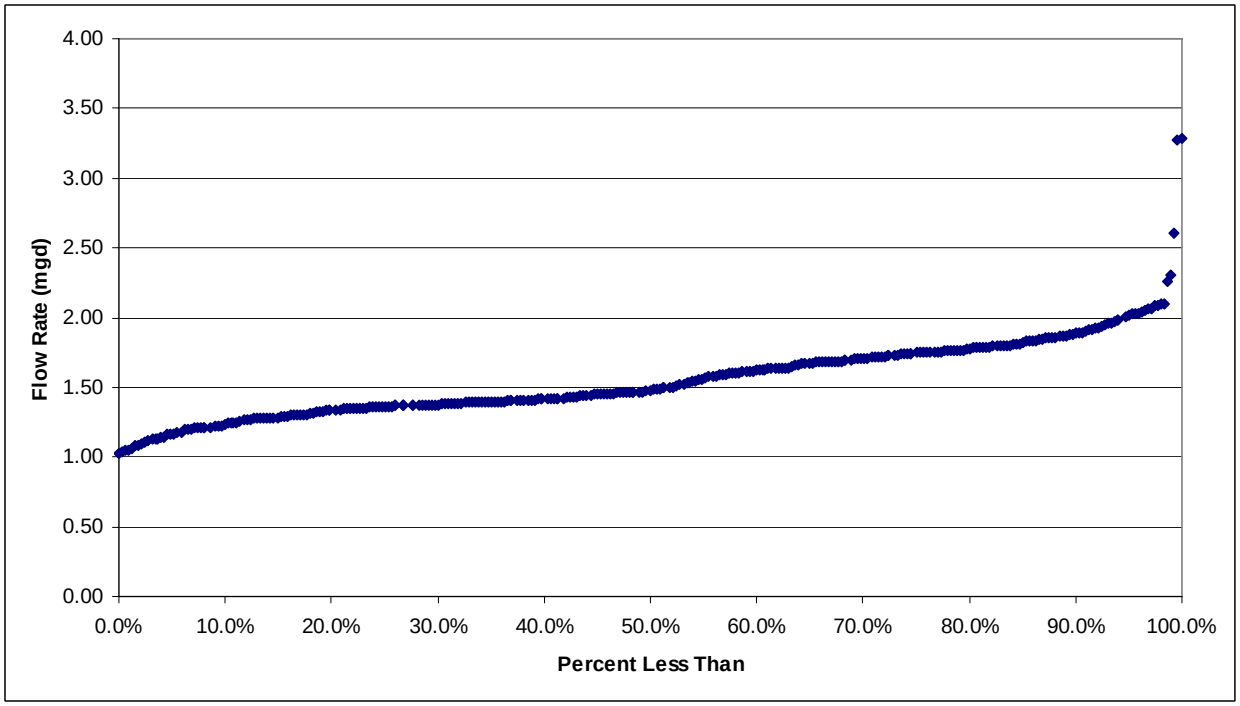


Figure AV-6 Historical Percentile Values of Flow Rates (site: AV-1)

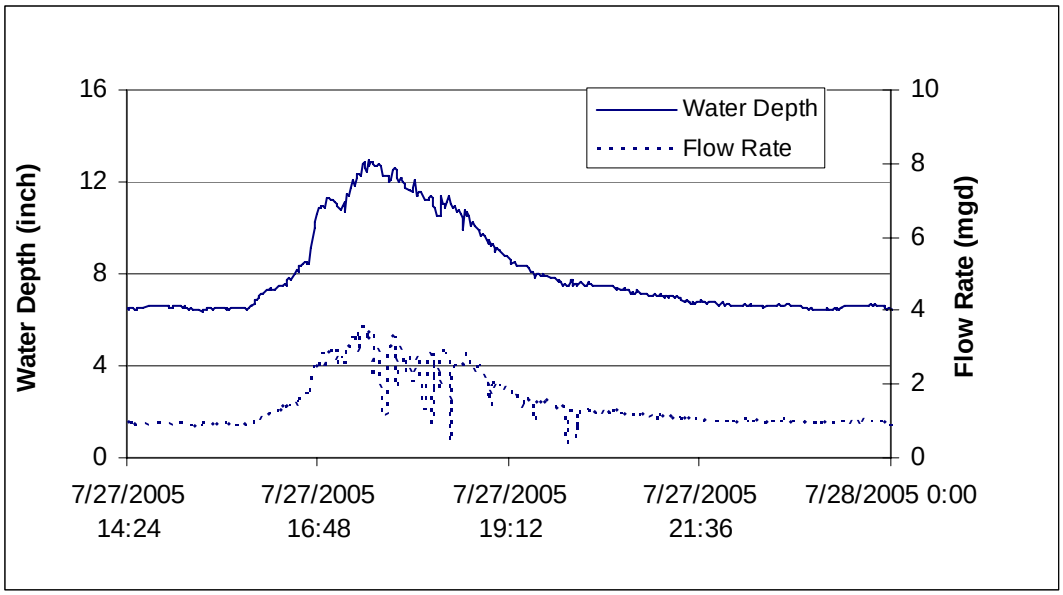


Figure AV-7 One-minute Data Points with the Maximum Water Depth and Flow Rate (site: AV-1)

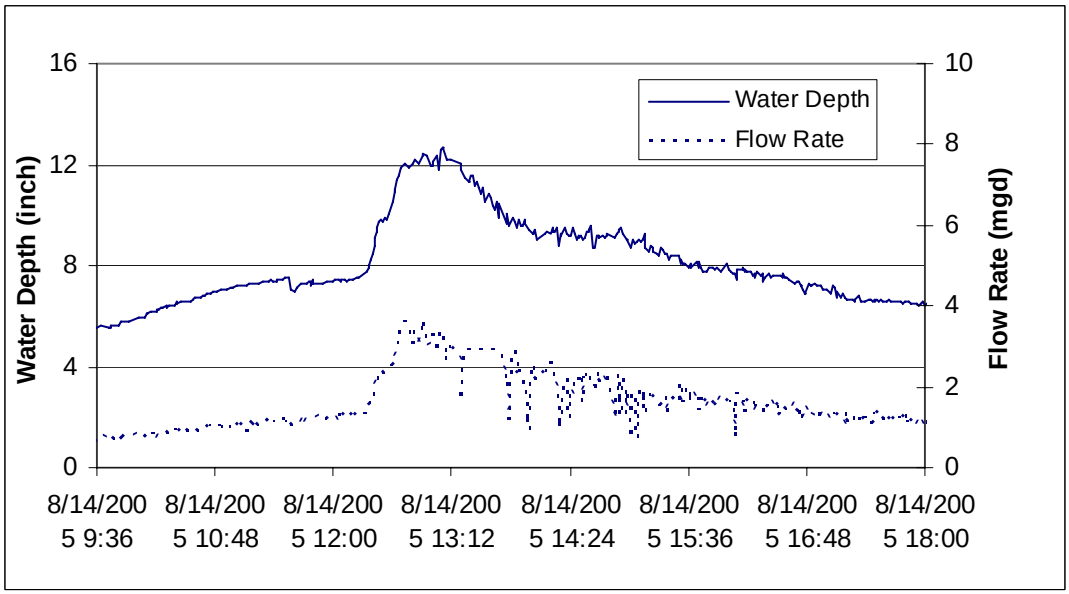


Figure AV-8 One-minute Data Points with the Second Maximum Water Depth and Flow Rate (site: AV-1)

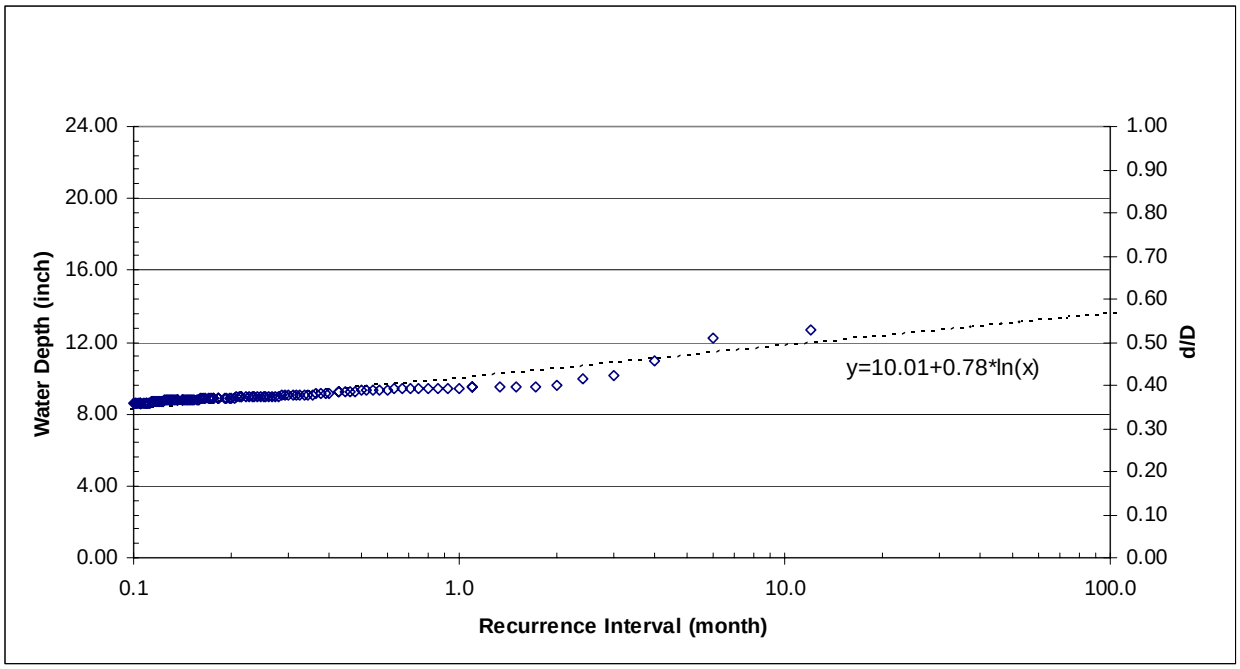


Figure AV-9 Water Depths at Different Recurrence Intervals (site: AV-1)

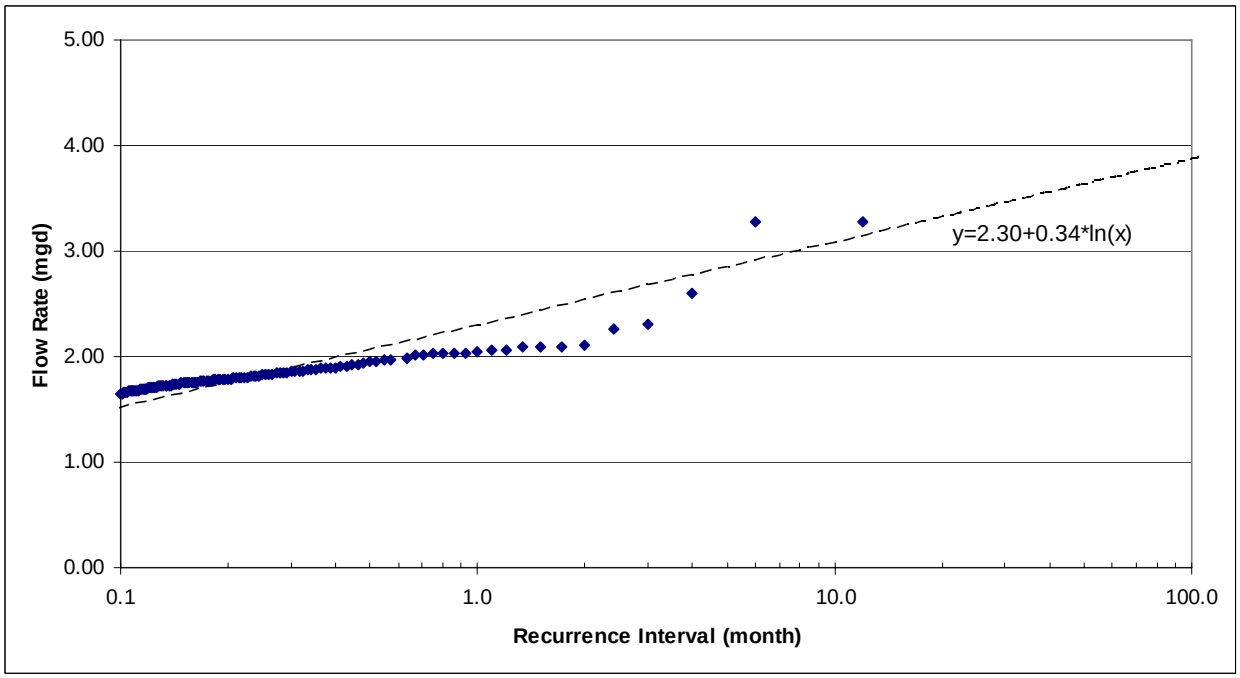


Figure AV-10 Flow Rates at Different Recurrence Intervals (site: AV-1)

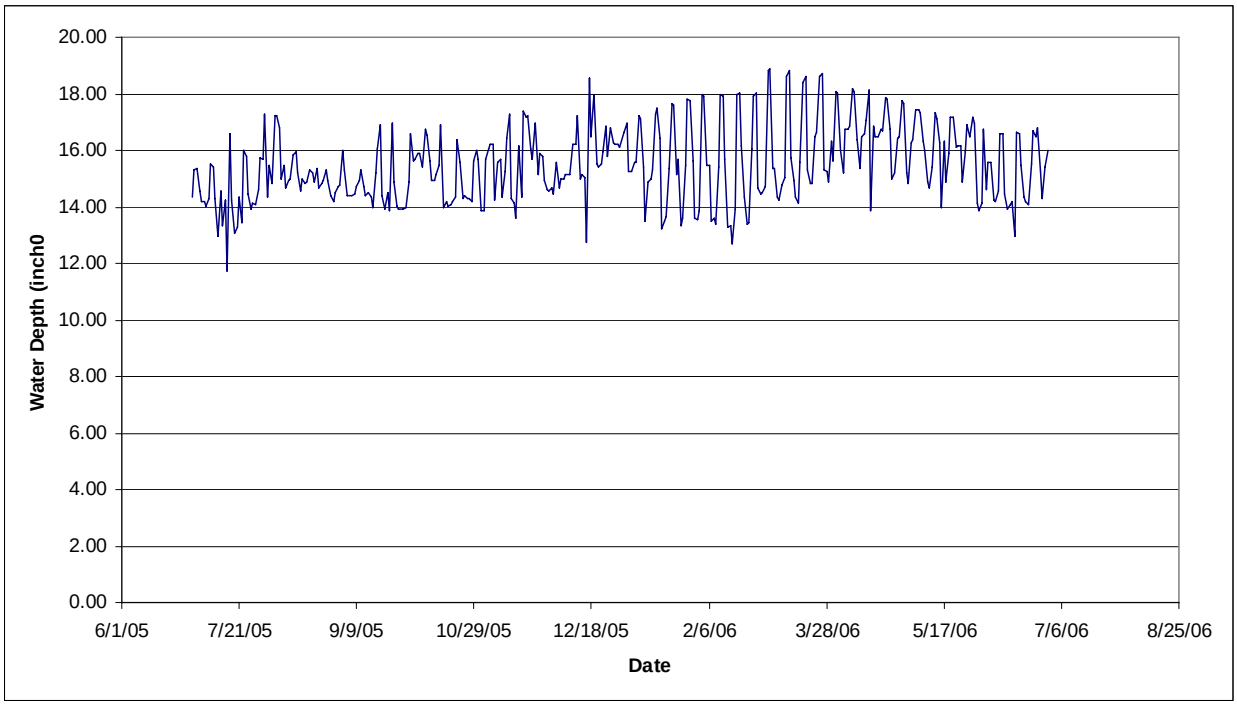


Figure CDO-1-1 Daily Peak Water Depths (site: CDO-1)

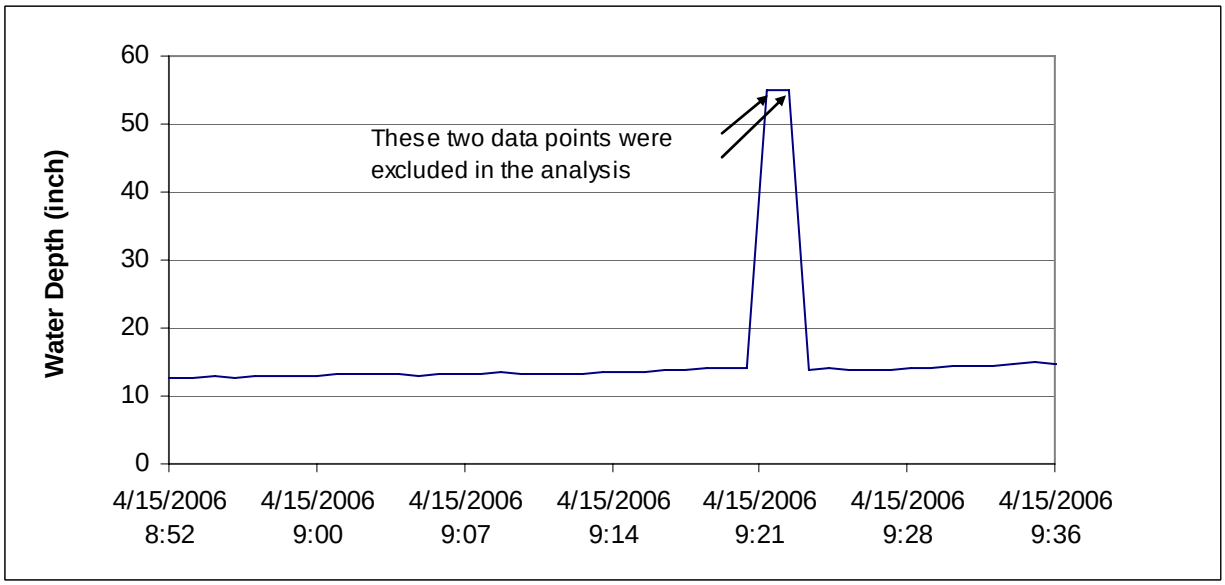


Figure CDO-1-2 Two Questionable One-minute Data Points Excluded in the Analysis (site: CDO-1)

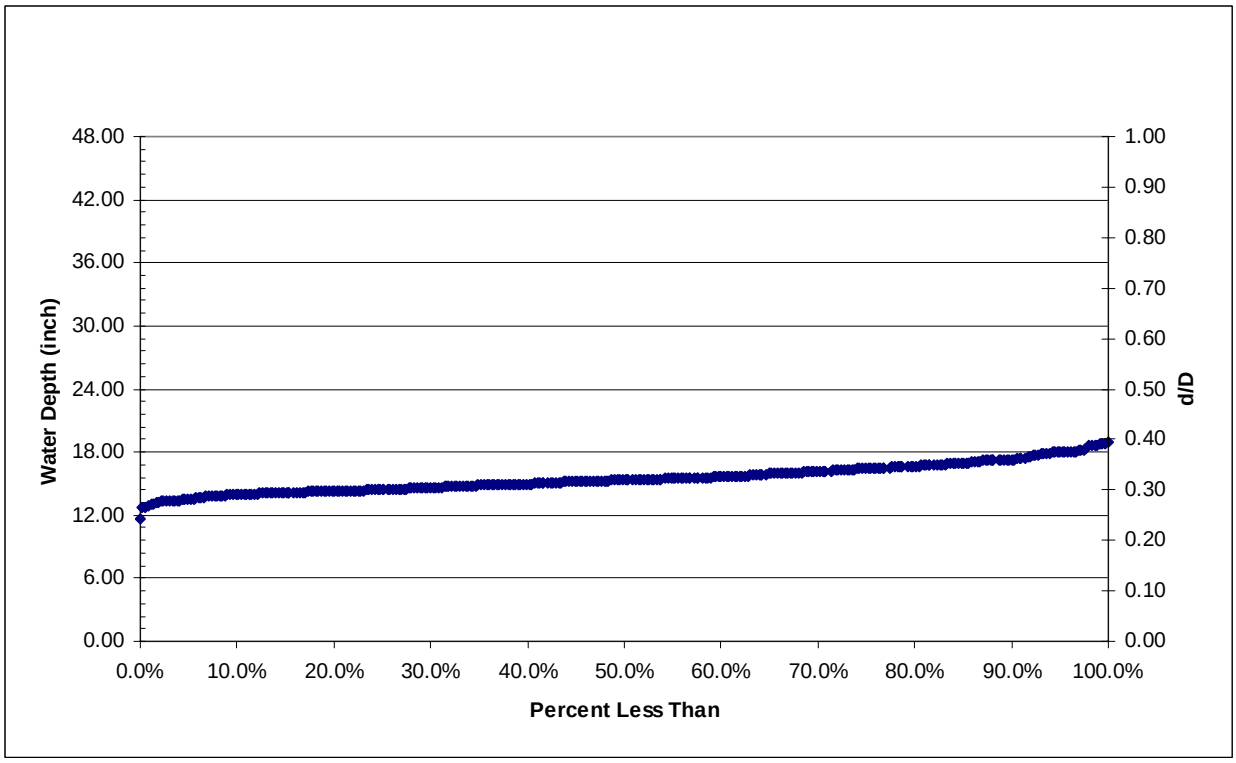


Figure CDO-1-3 Historical Percentile Values of Water Depth (site: CDO-1)

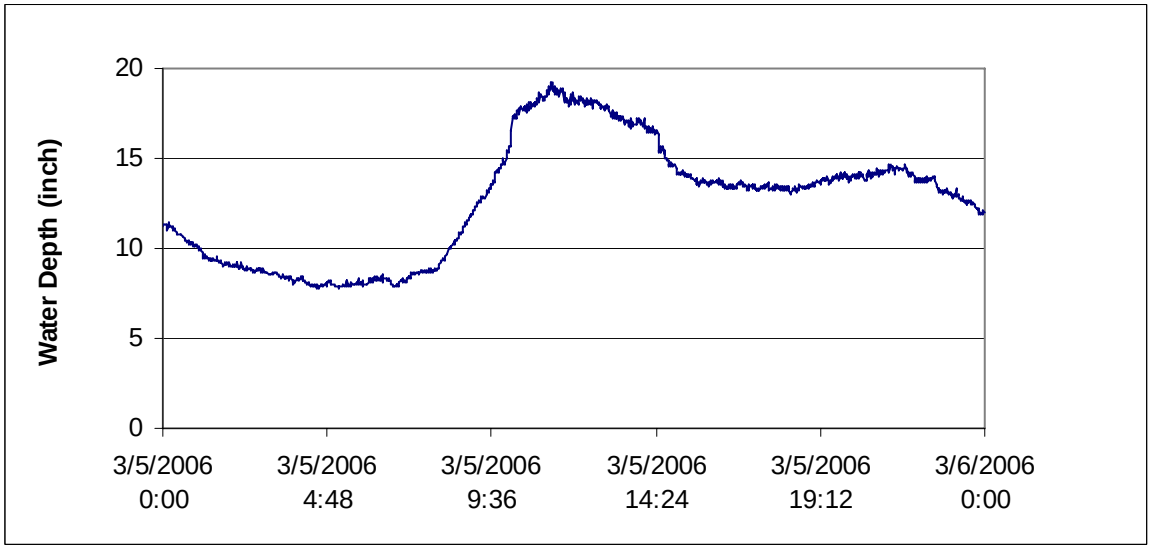


Figure CDO-1-4 One-minute Data Points with the Maximum Water Depth (site: CDO-1)

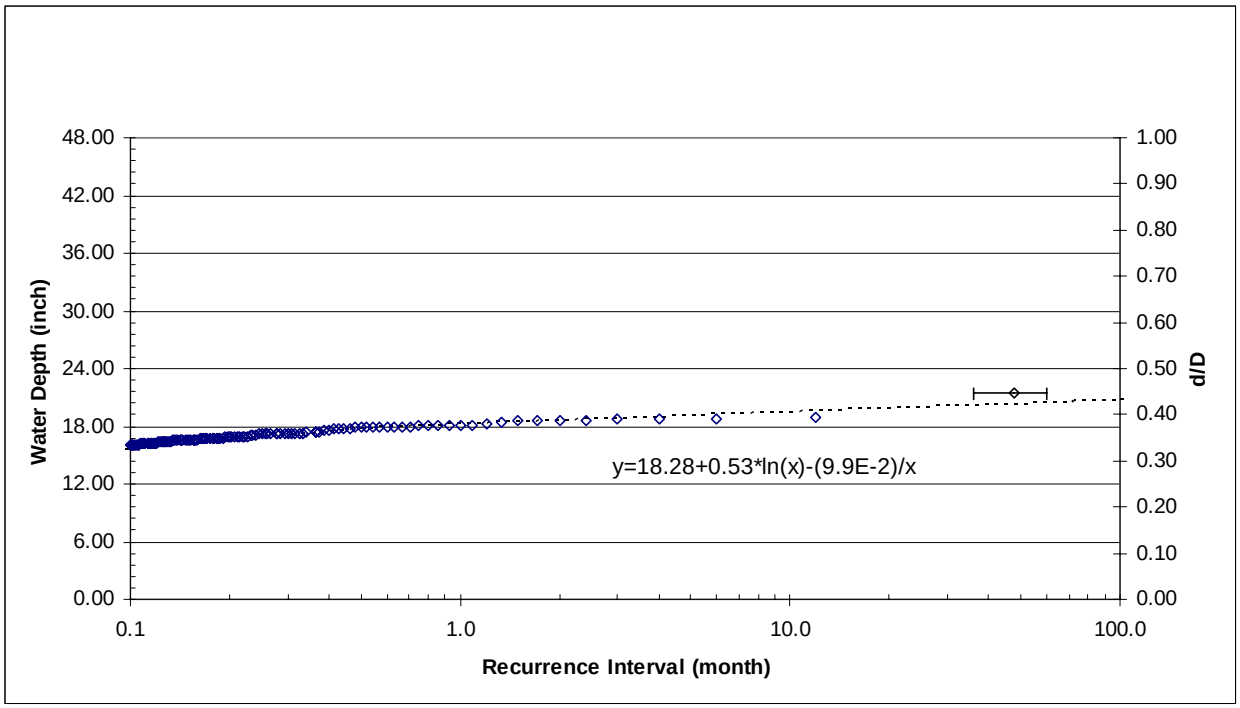


Figure CDO-1-5 Water Depths at Different Recurrence Intervals (site: AV-1)

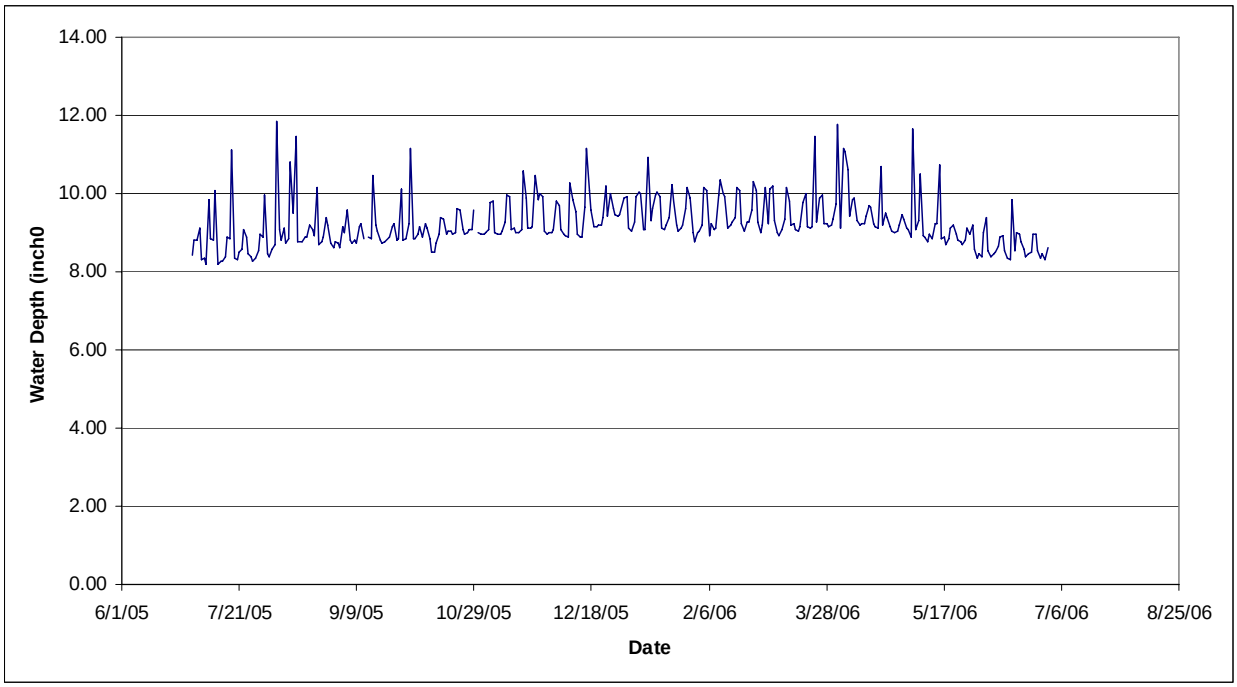


Figure CDO-2-1 Daily Peak Water Depths (site: CDO-2)

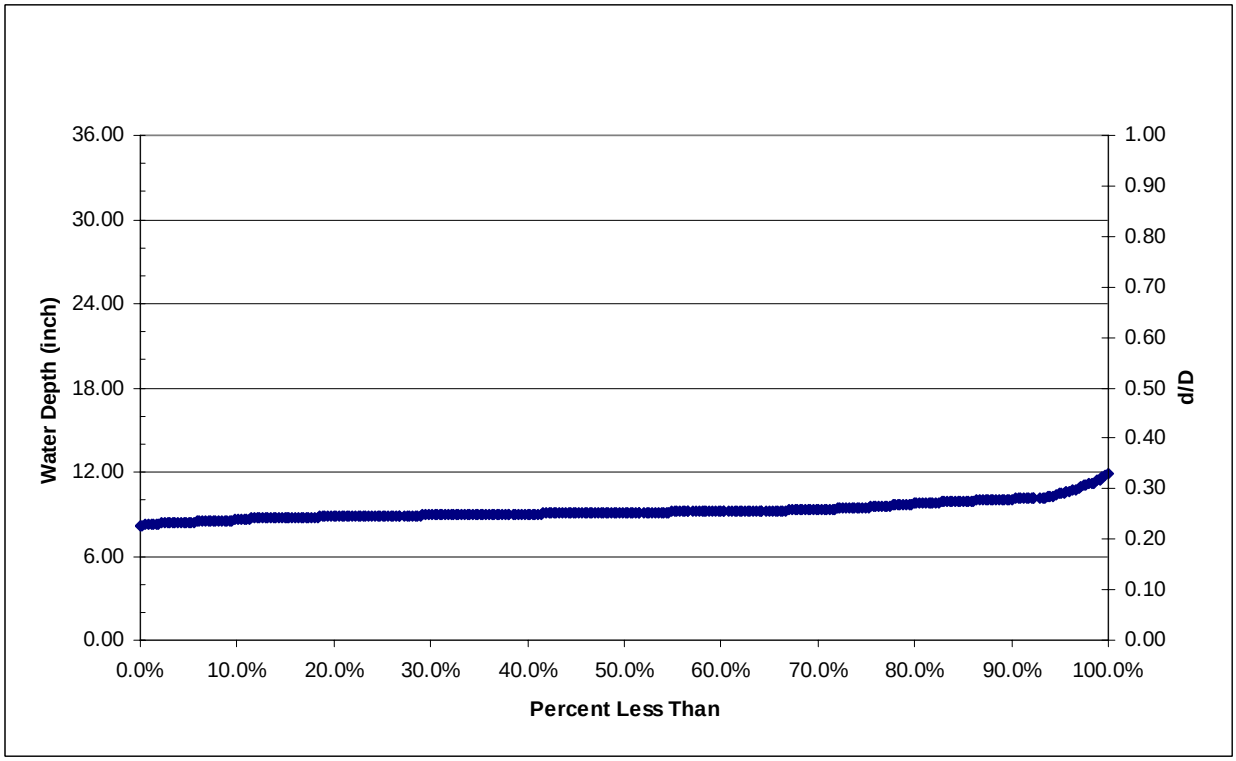


Figure CDO-2-2 Historical Percentile Values of Water Depth (site: CDO-2)

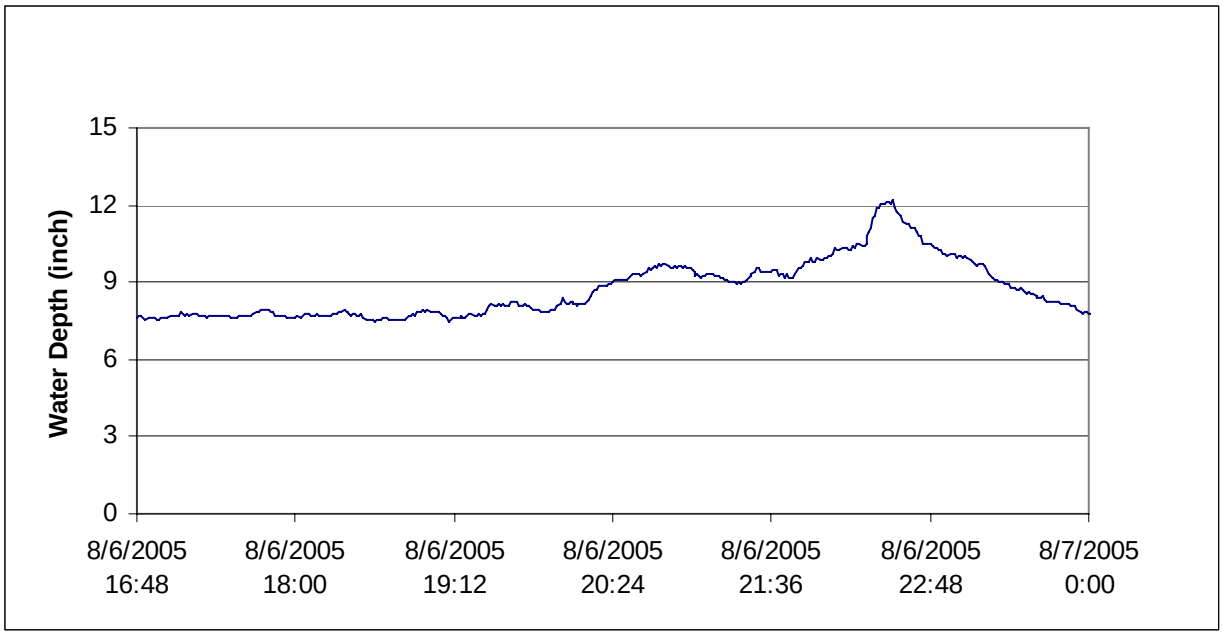


Figure CDO-2-3 One-minute Data Points with the Maximum Water Depth (site: CDO-2)

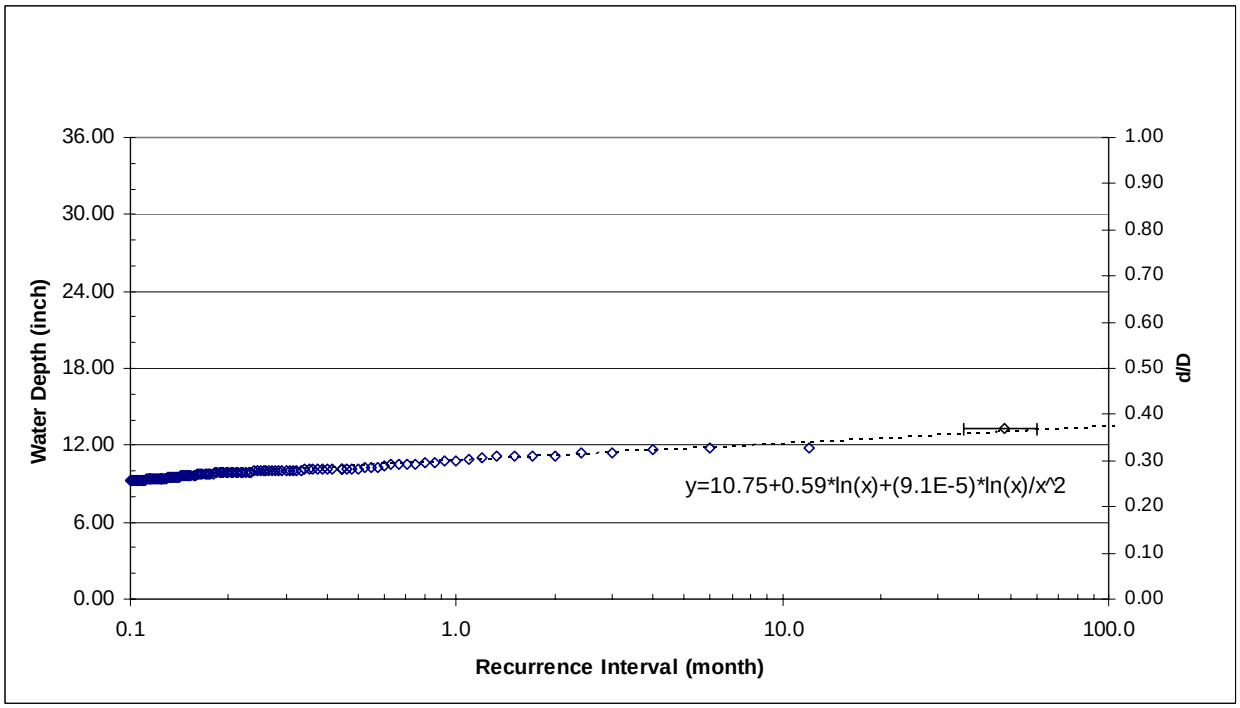


Figure CDO-2-4 Water Depths at Different Recurrence Intervals (site: CDO-2)

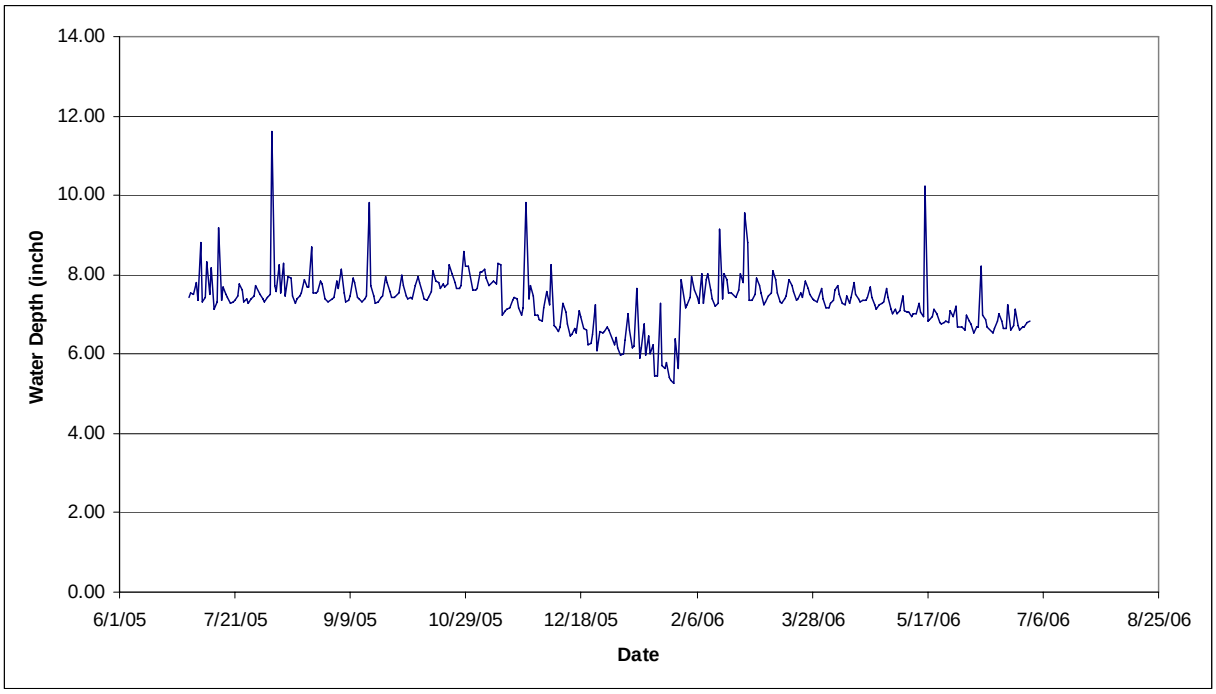


Figure CDO-3-1 Daily Peak Water Depths (site: CDO-3)

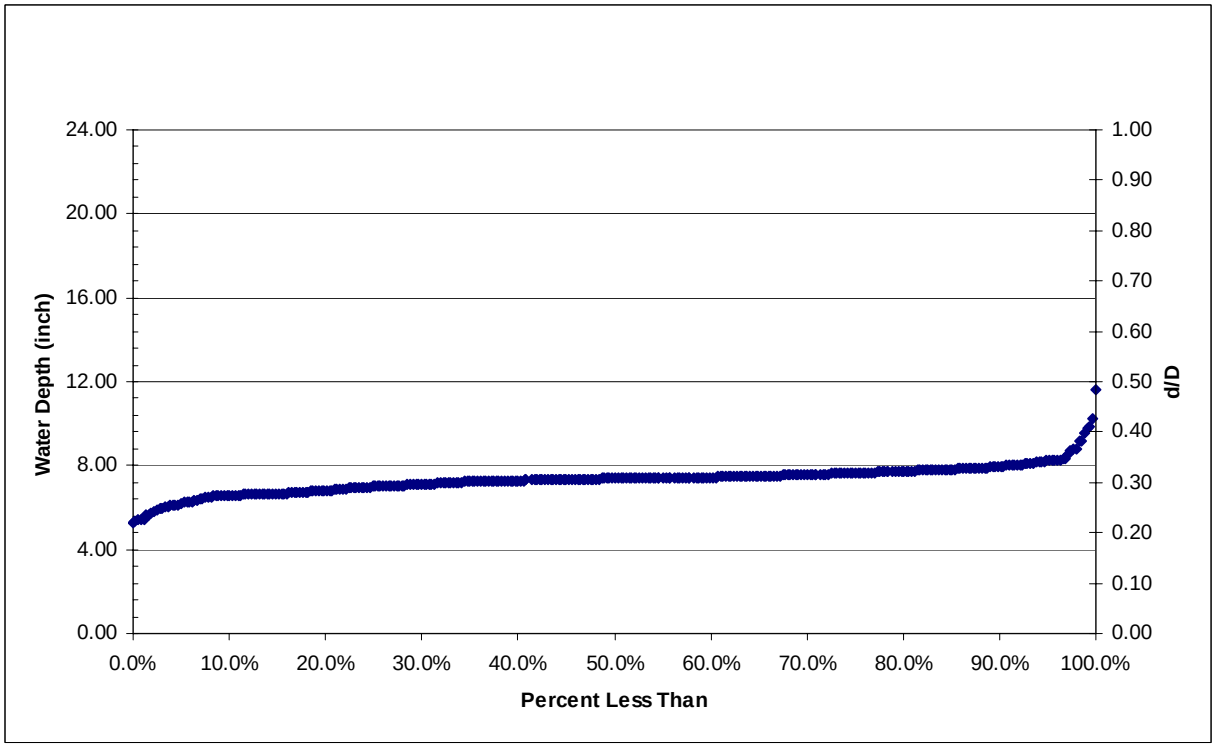


Figure CDO-3-2 Historical Percentile Values of Water Depth (site: CDO-3)

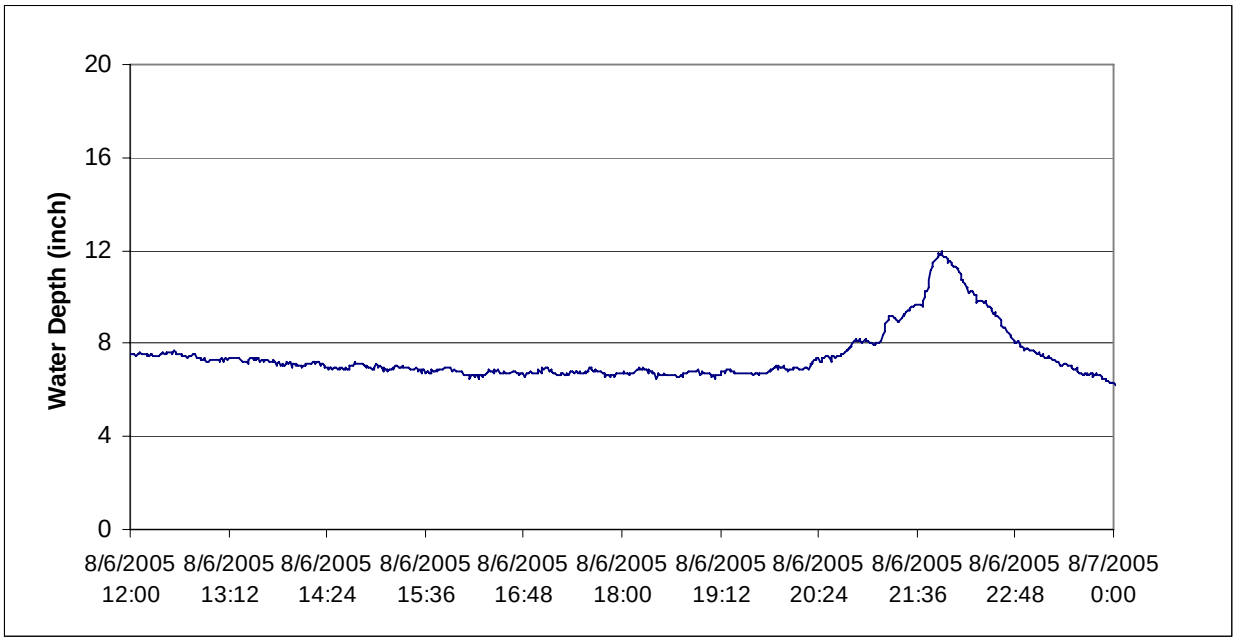


Figure CDO-3-3 One-minute Data Points with the Maximum Water Depth (site: CDO-3)

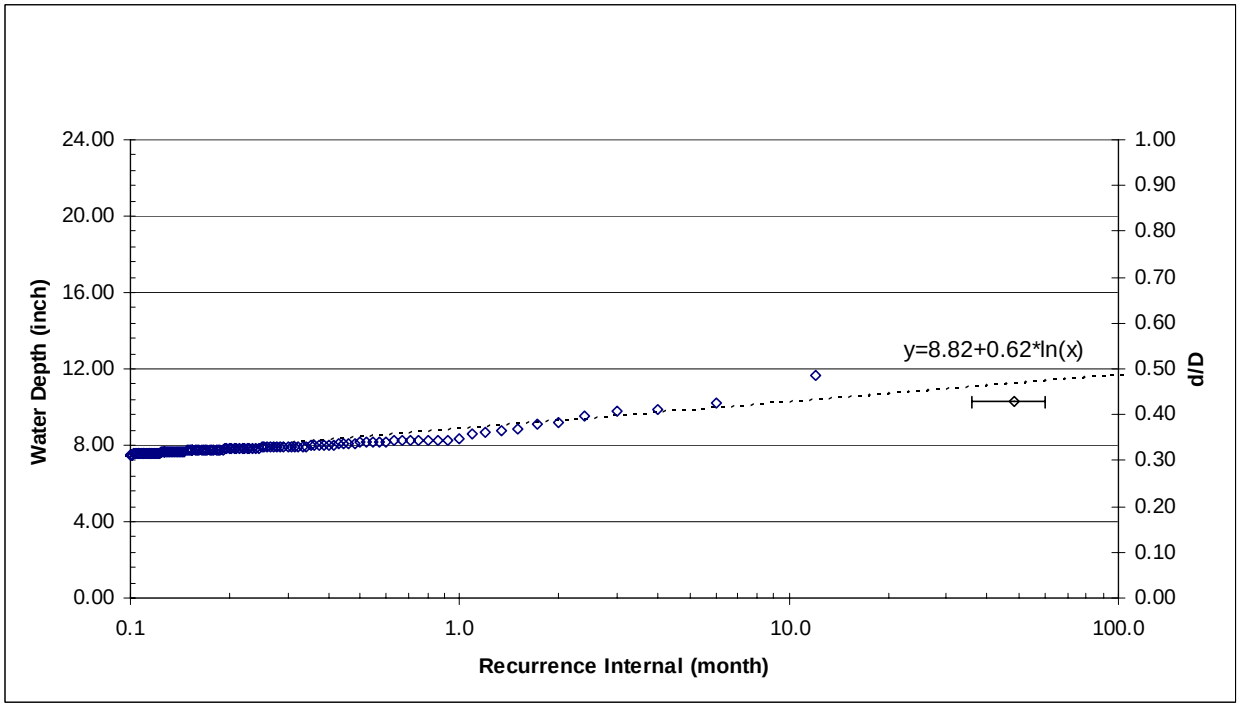


Figure CDO-3-4 Water Depths at Different Recurrence Intervals (site: CDO-3)

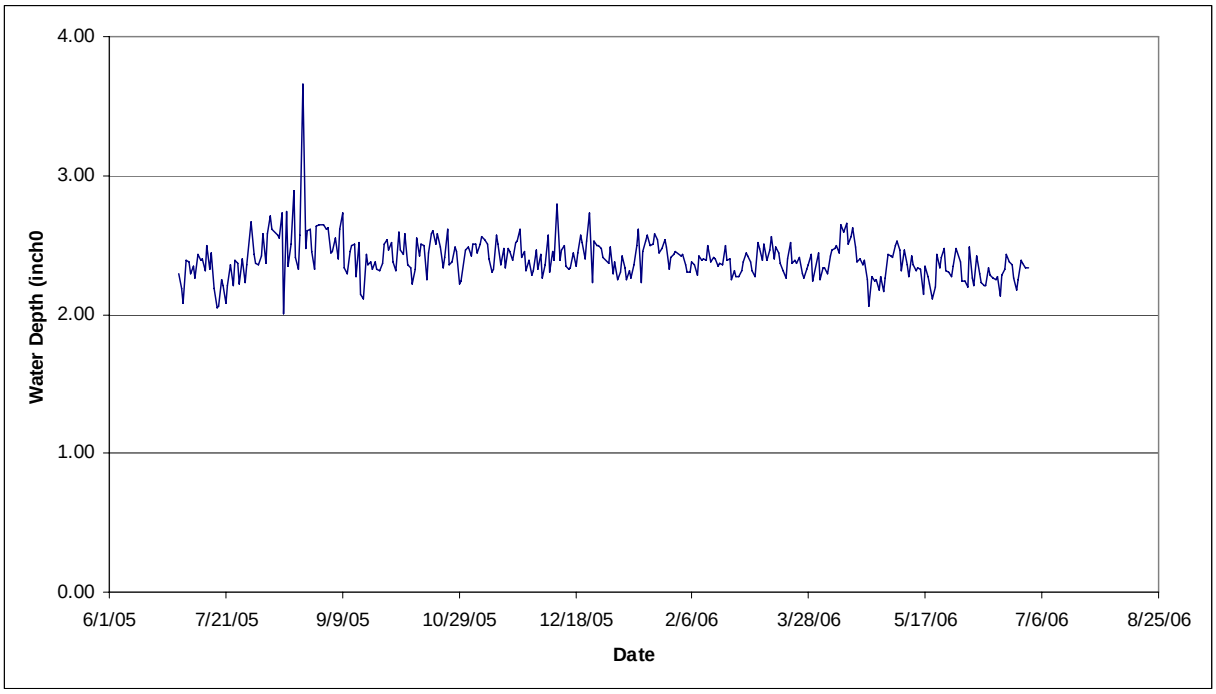


Figure CW-1-1 Daily Peak Water Depths (site: CW-1)

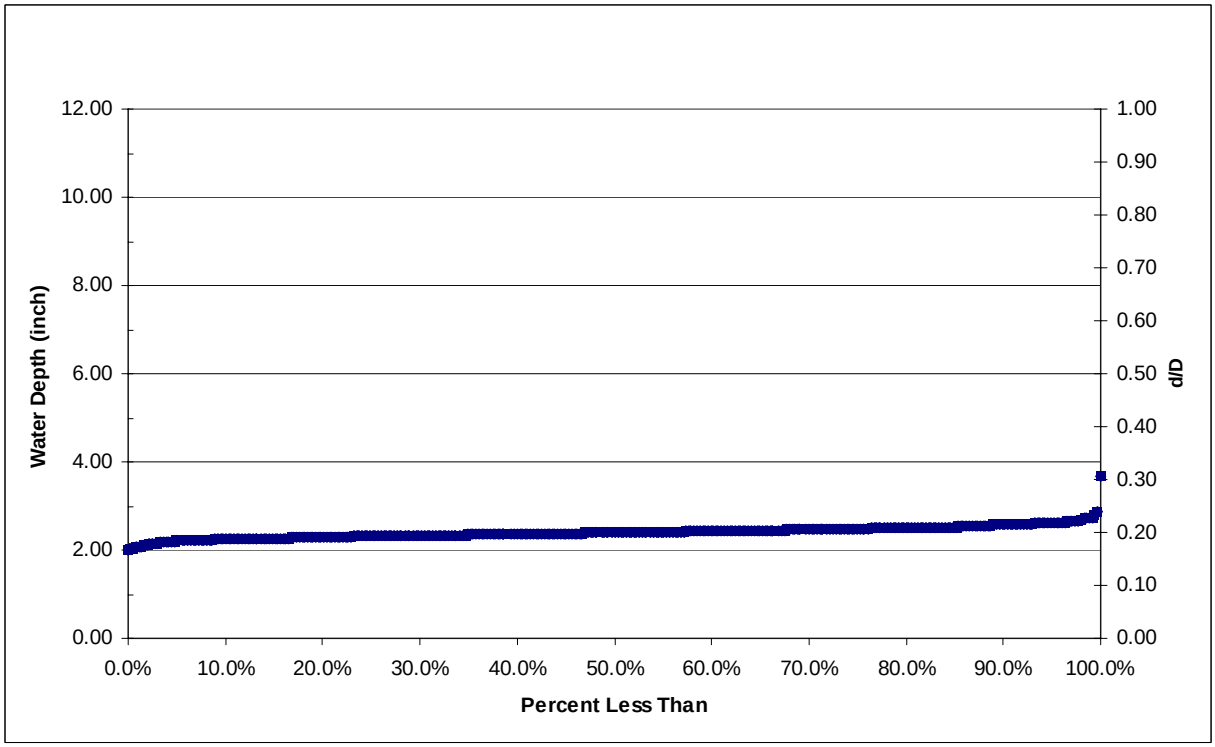


Figure CW-1-2 Historical Percentile Values of Water Depth (site: CW-1)

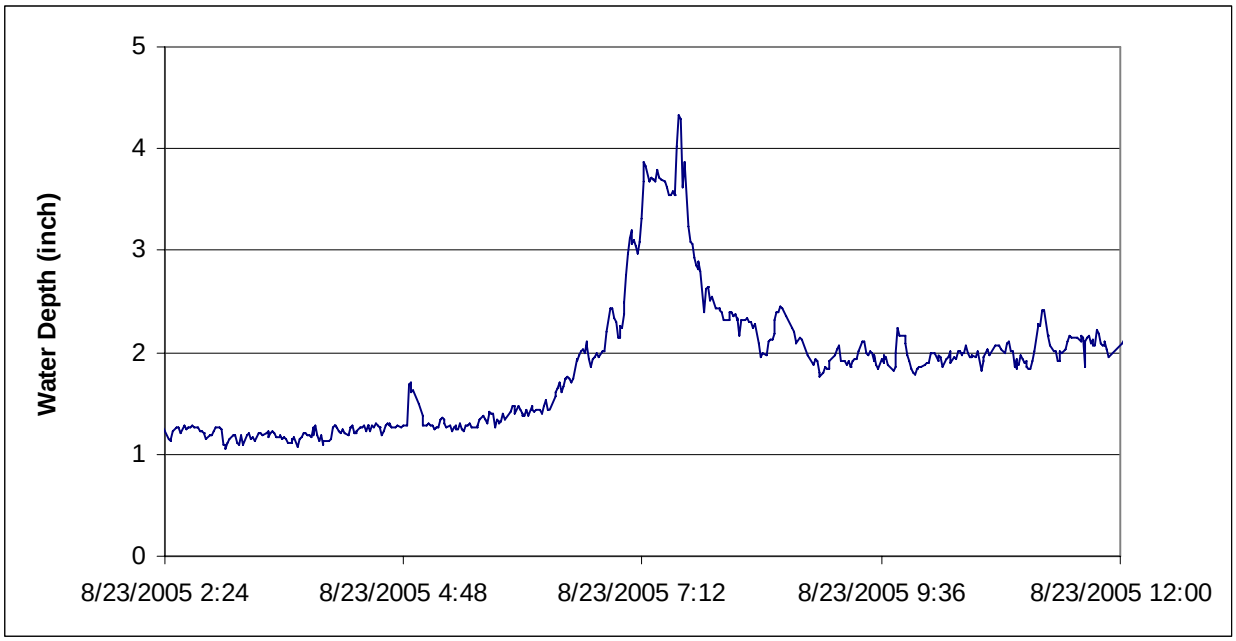


Figure CW-1-3 One-minute Data Points with the Maximum Water Depth (site: CW-1)

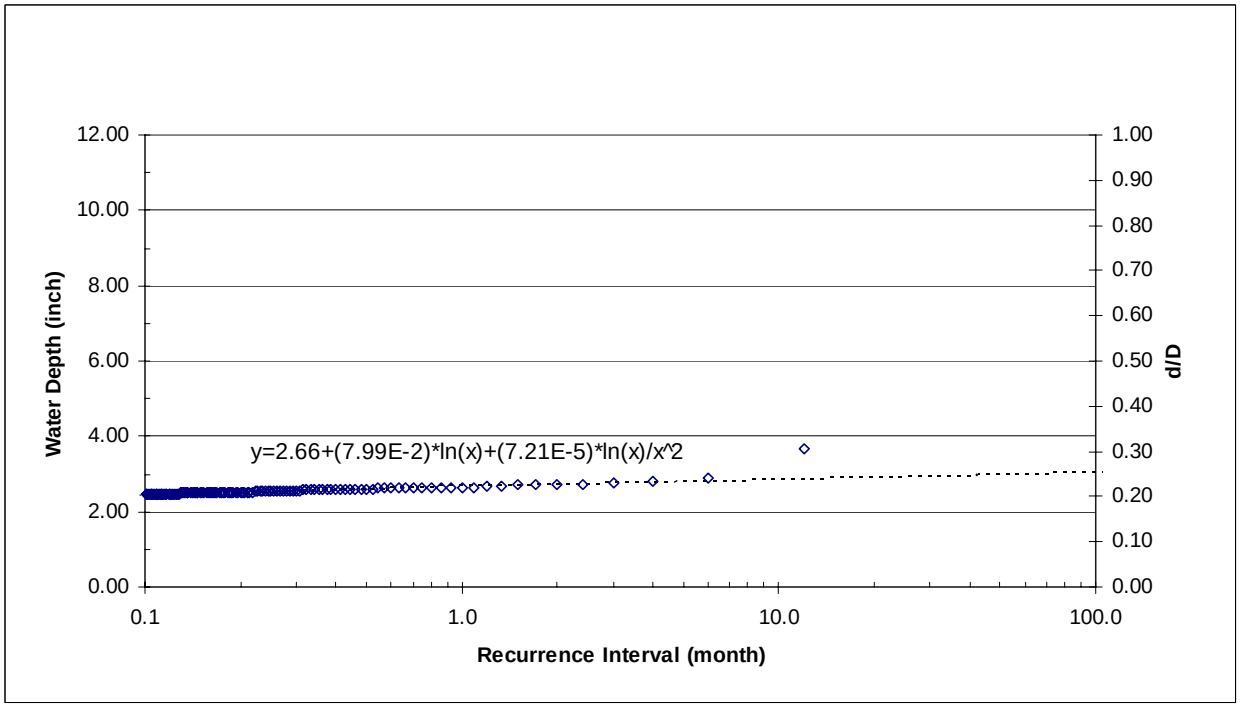


Figure CW-1-4 Water Depths at Different Recurrence Intervals (site: CW-1)

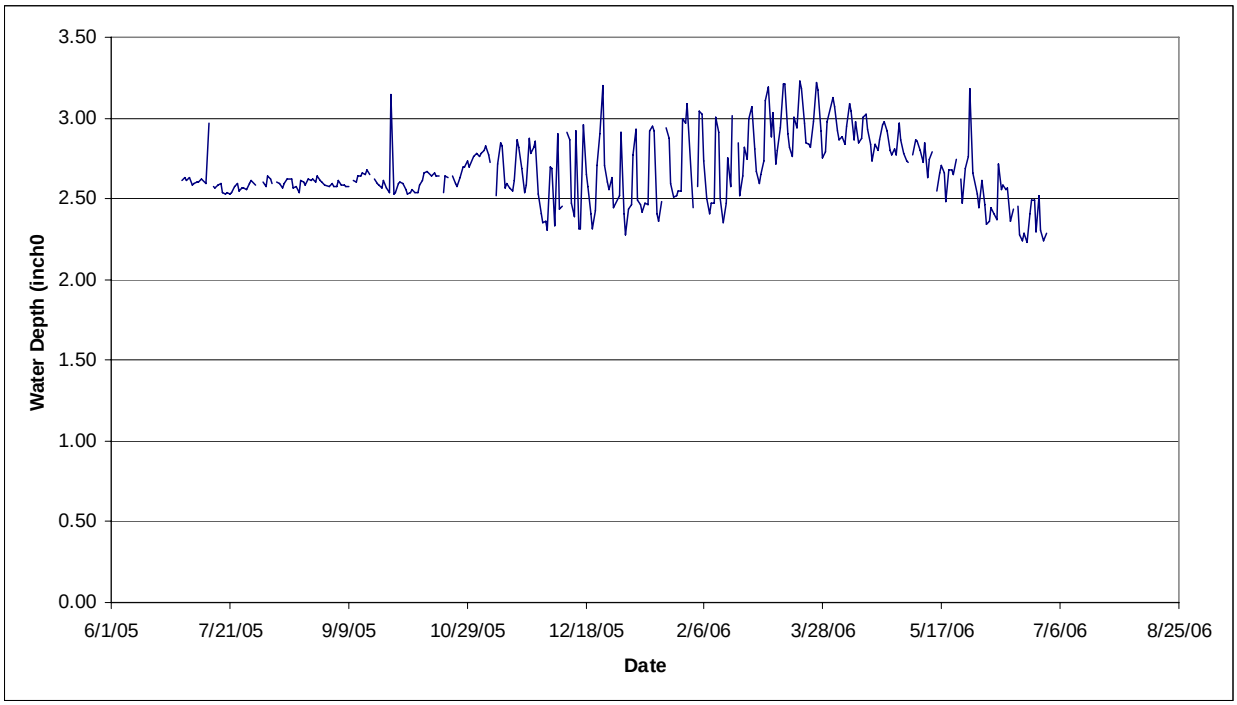


Figure Dove-1 Daily Peak Water Depths (site: Dove Mtn)

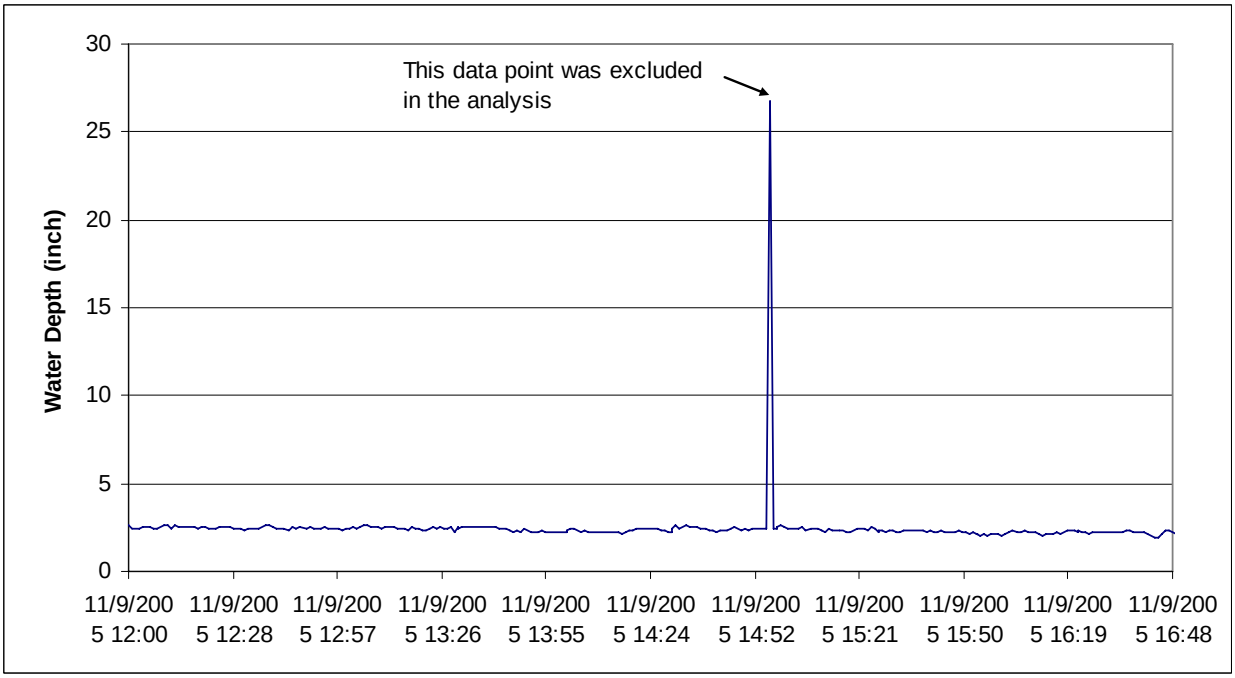


Figure Dove-2 One Example of Questionable 1-minute Data Point (site: Dove Mtn)

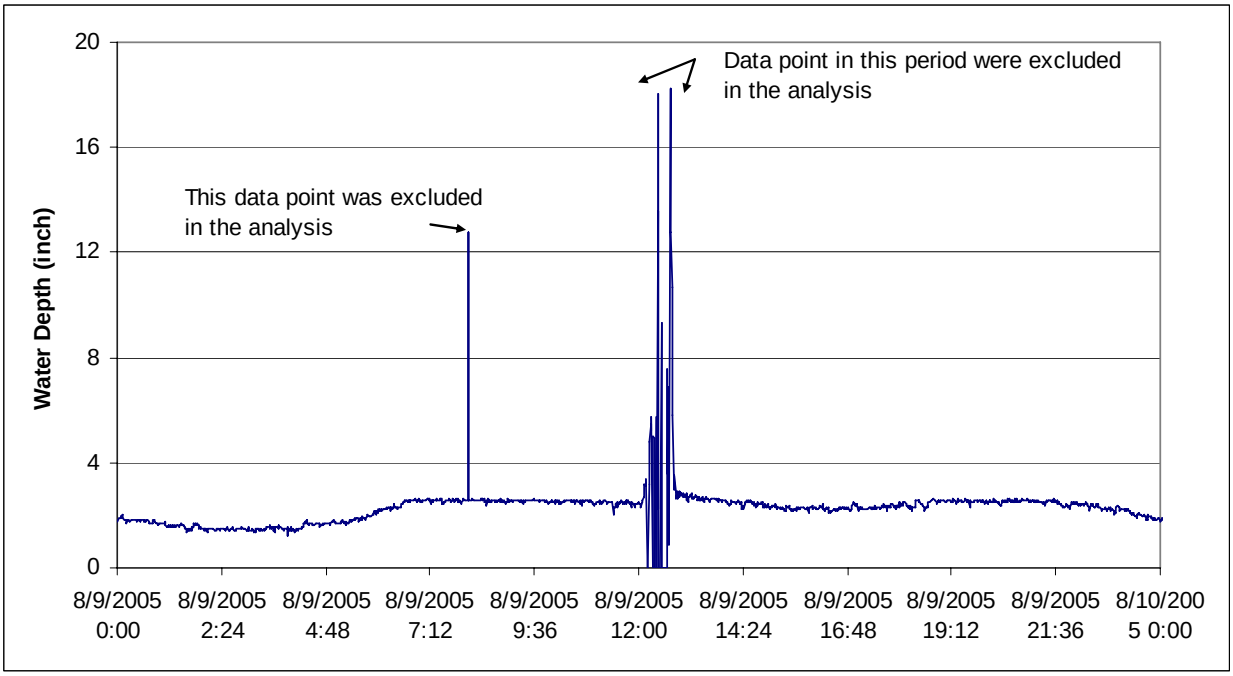


Figure Dove-3 Another Example of Questionable 1-minute Data Points (site: Dove Mtn)

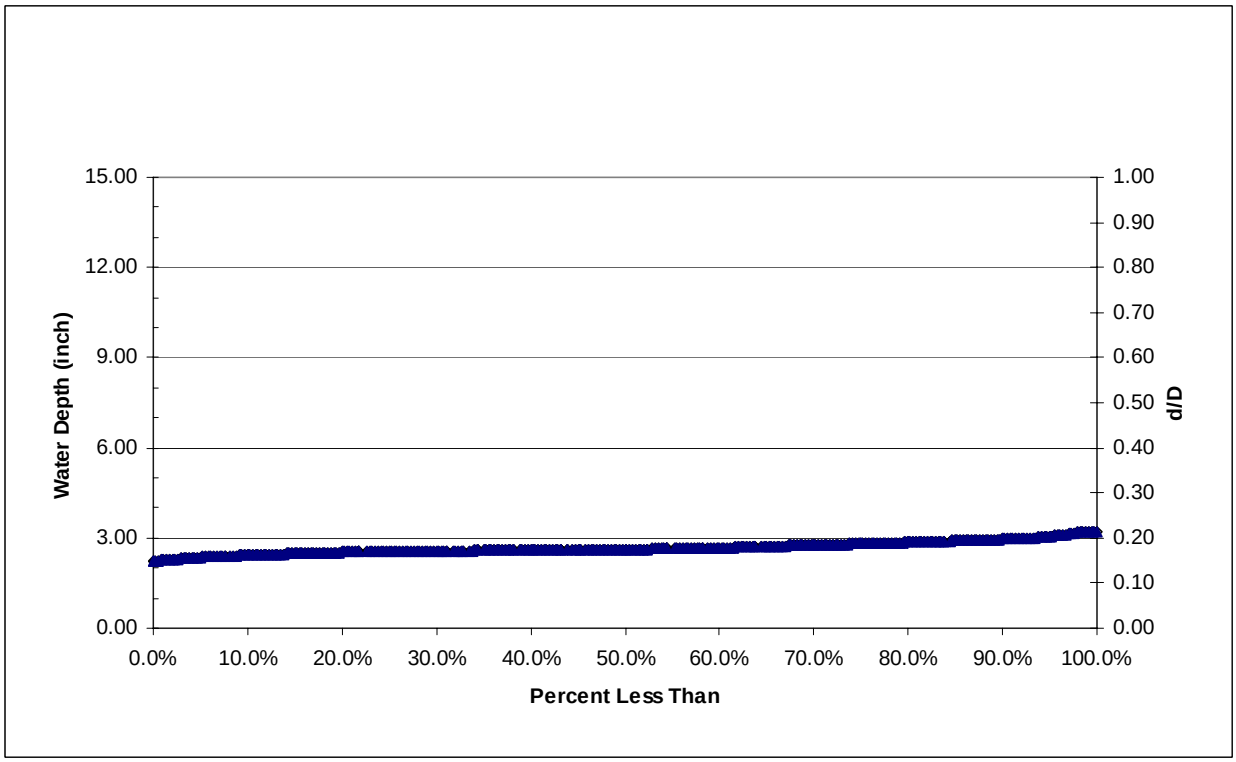


Figure Dove-4 Historical Percentile Values of Water Depth (site: Dove Mtn)

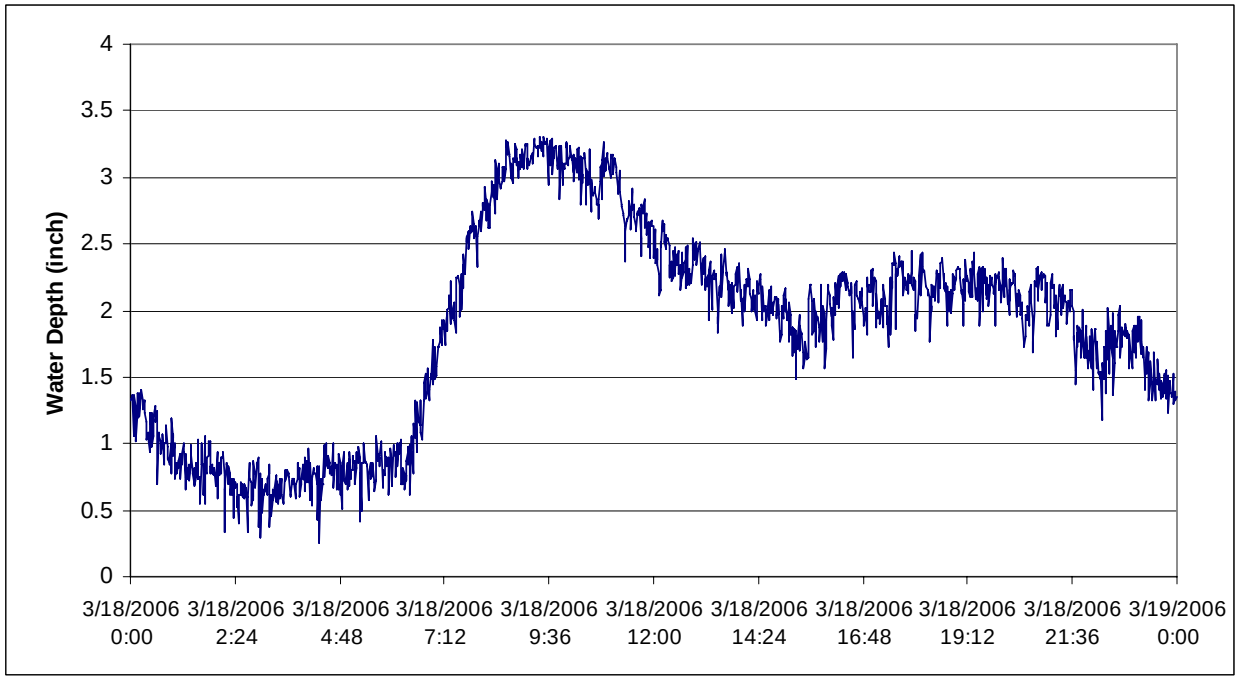


Figure Dove-5 One-minute Data Points with the Maximum Water Depth (site: Dove Mtn)

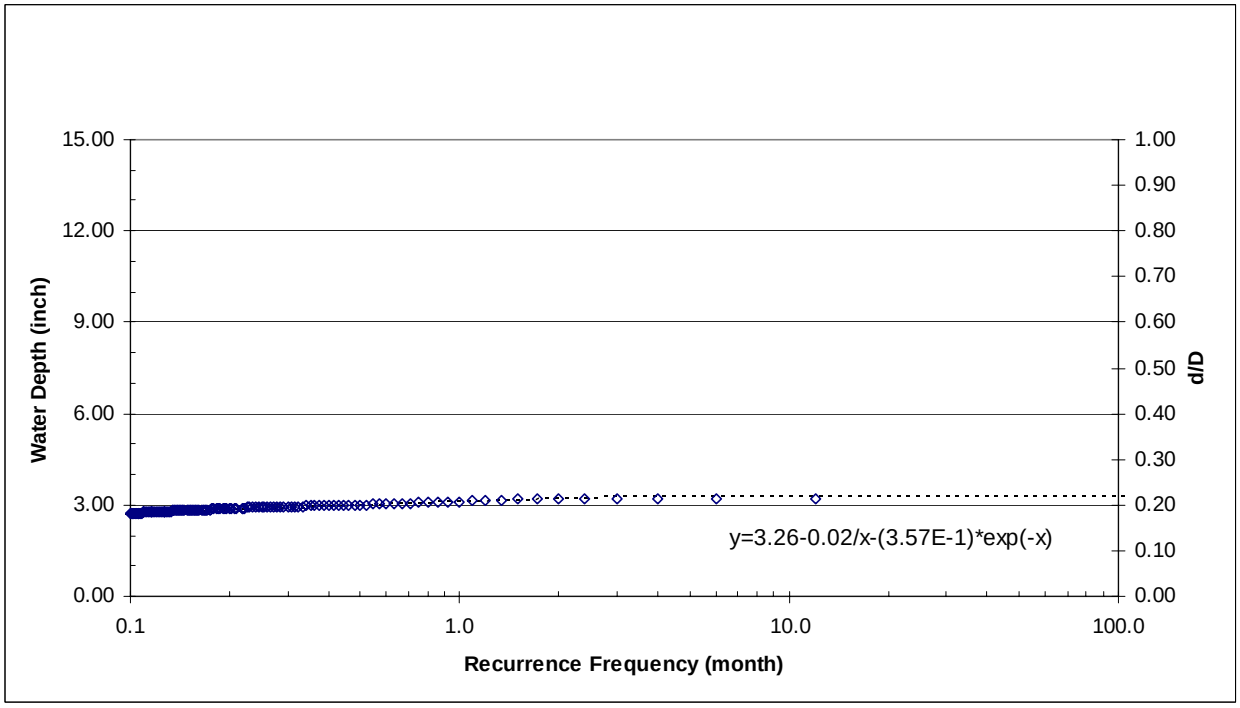


Figure Dove-6 Water Depths at Different Recurrence Intervals (site: Dove Mtn)

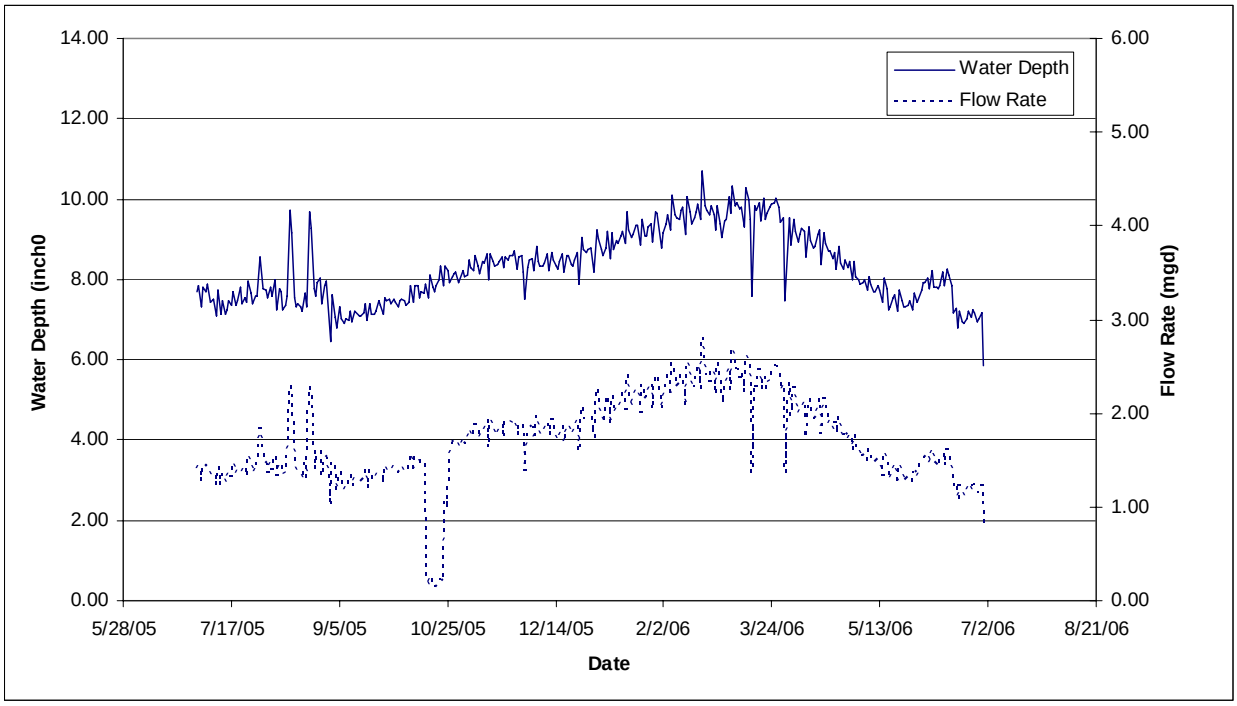


Figure GV-1-1 Daily Peak Water Depths and Flow Rates (site: GV-1)

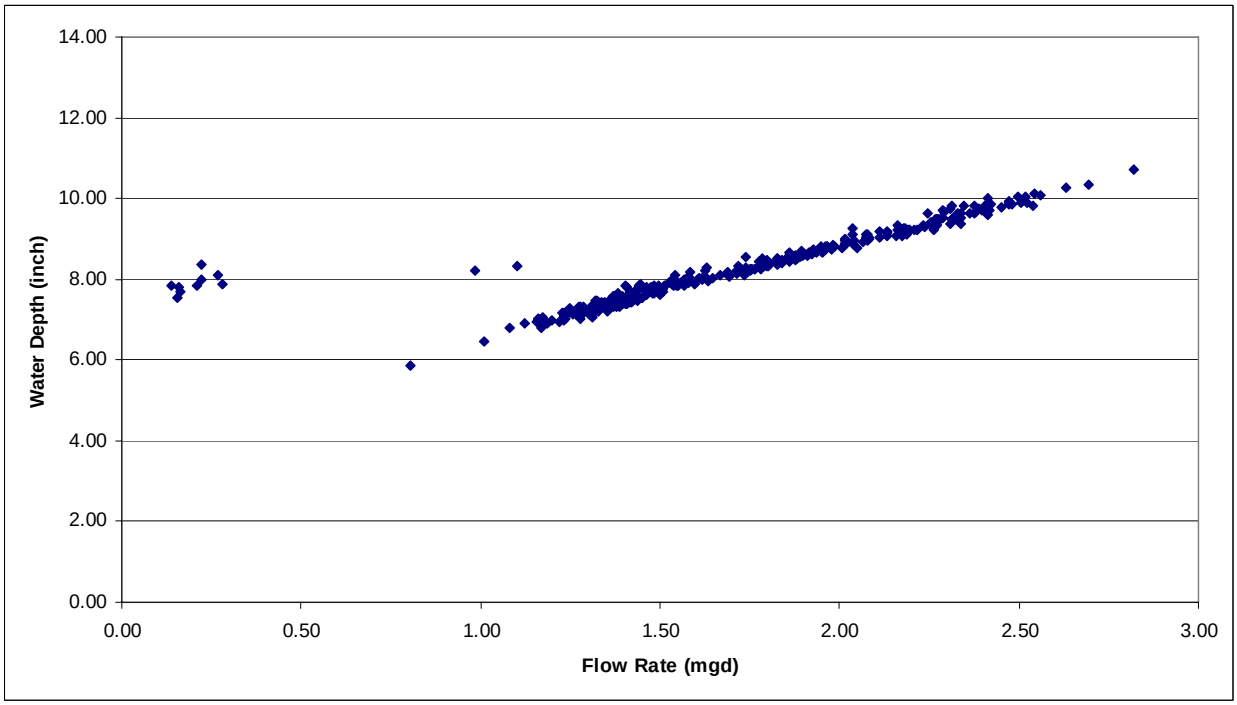


Figure GV-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: GV-1)

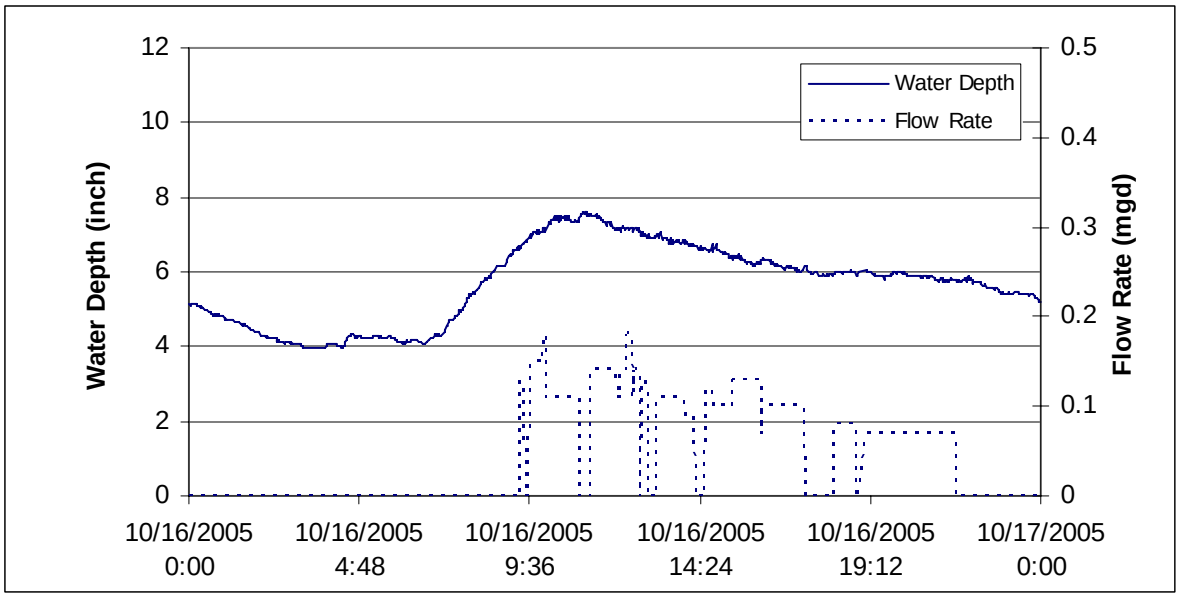


Figure GV-1-3 An example of Questionable 1-minute Data Points (site: GV-1)

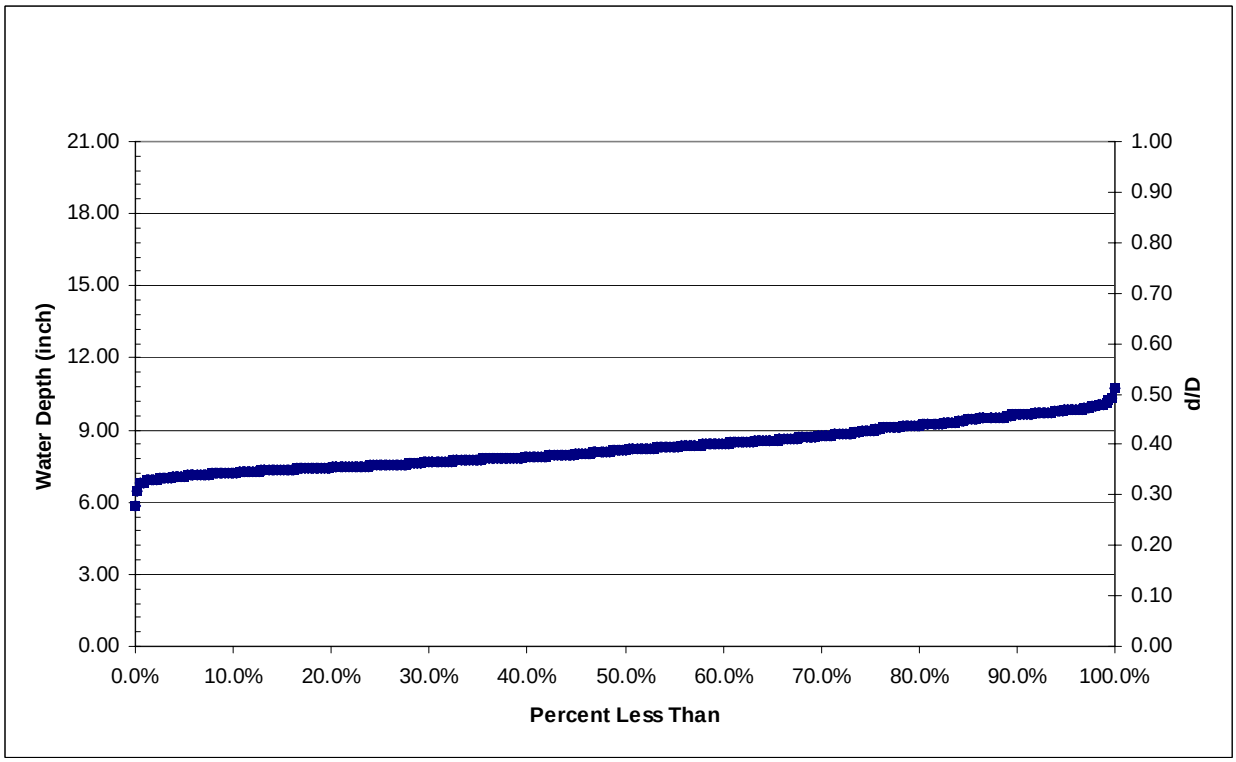


Figure GV-1-4 Historical Percentile Values of Water Depth (site: GV-1)

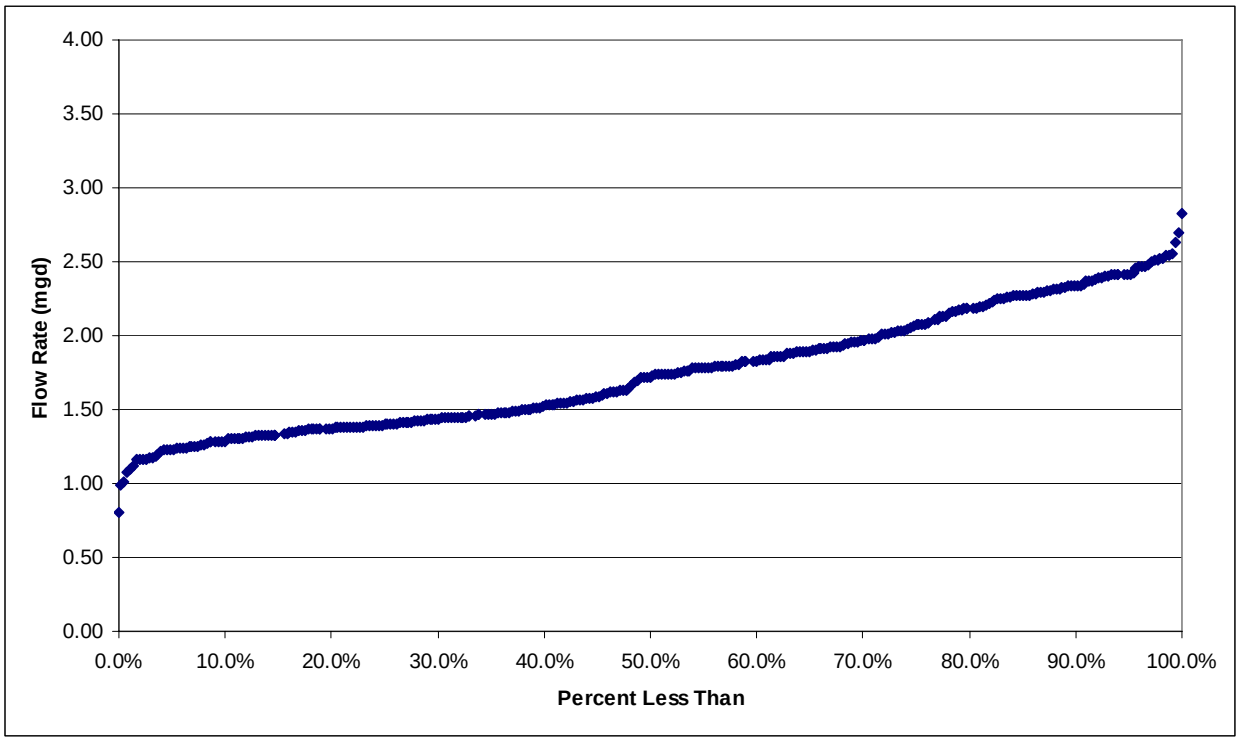


Figure GV-1-5 Historical Percentile Values of Flow Rates (site: GV-1)

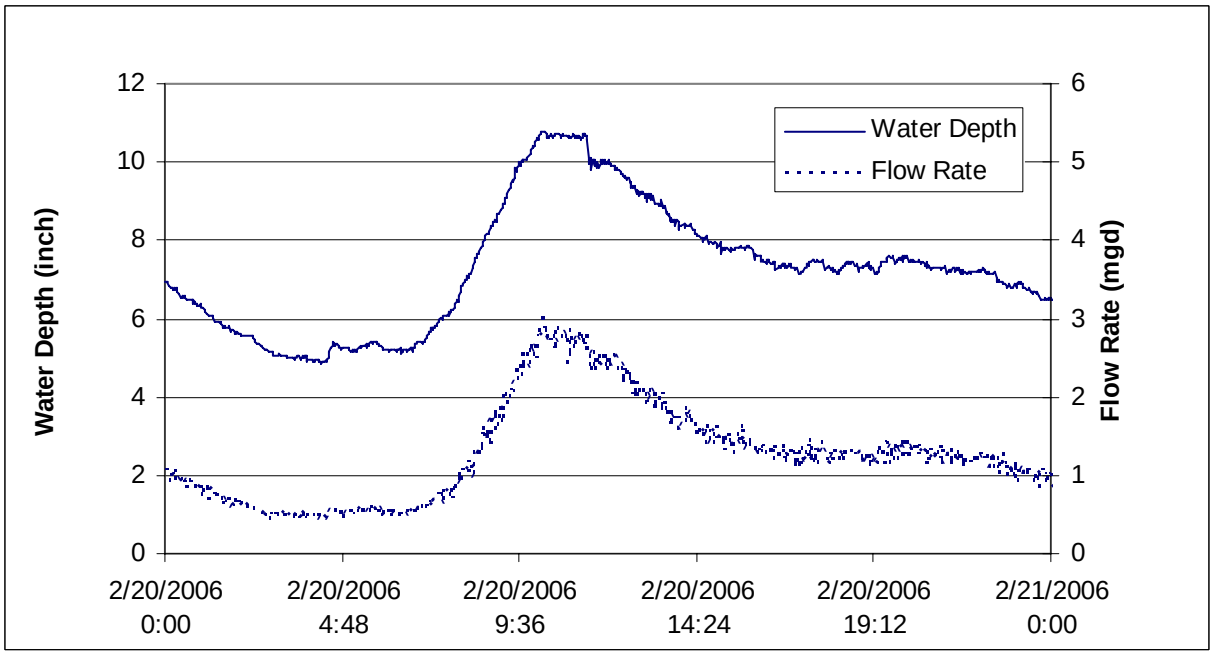


Figure GV-1-6 One-minute Data Points with the Maximum Water Depth and Flow Rate (site: GV-1).

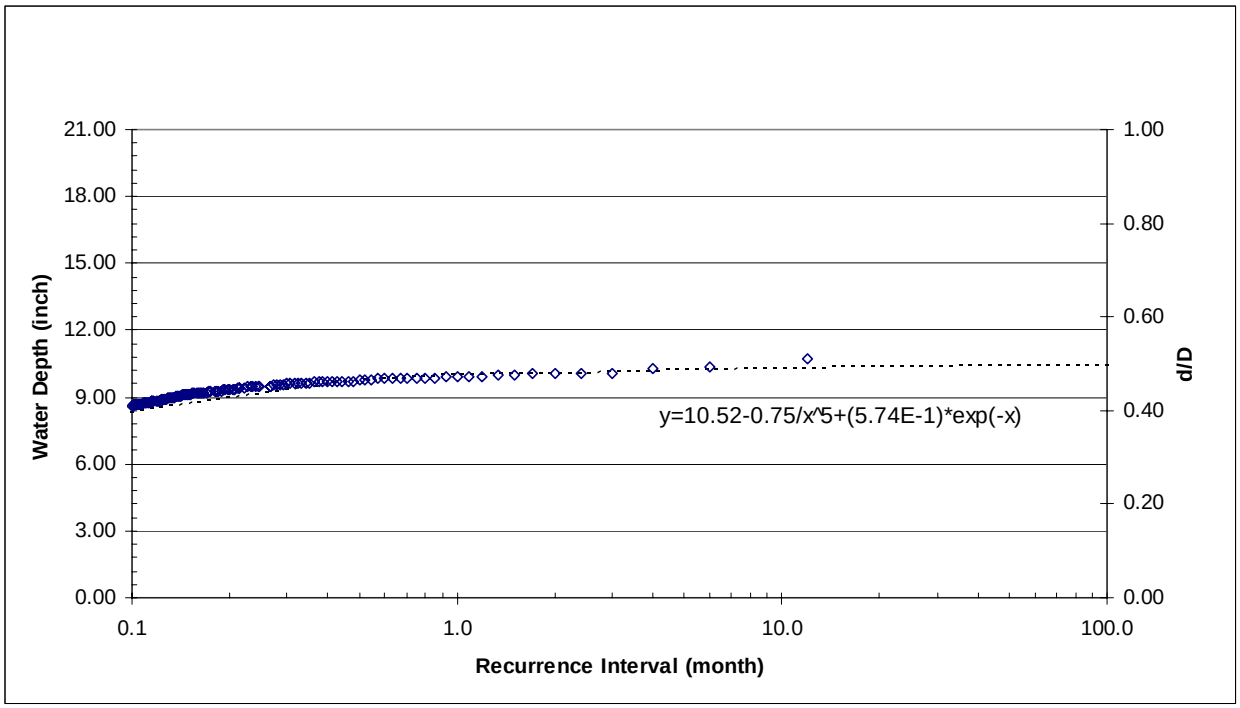


Figure GV-1-7 Water Depths at Different Recurrence Intervals (site: GV-1)

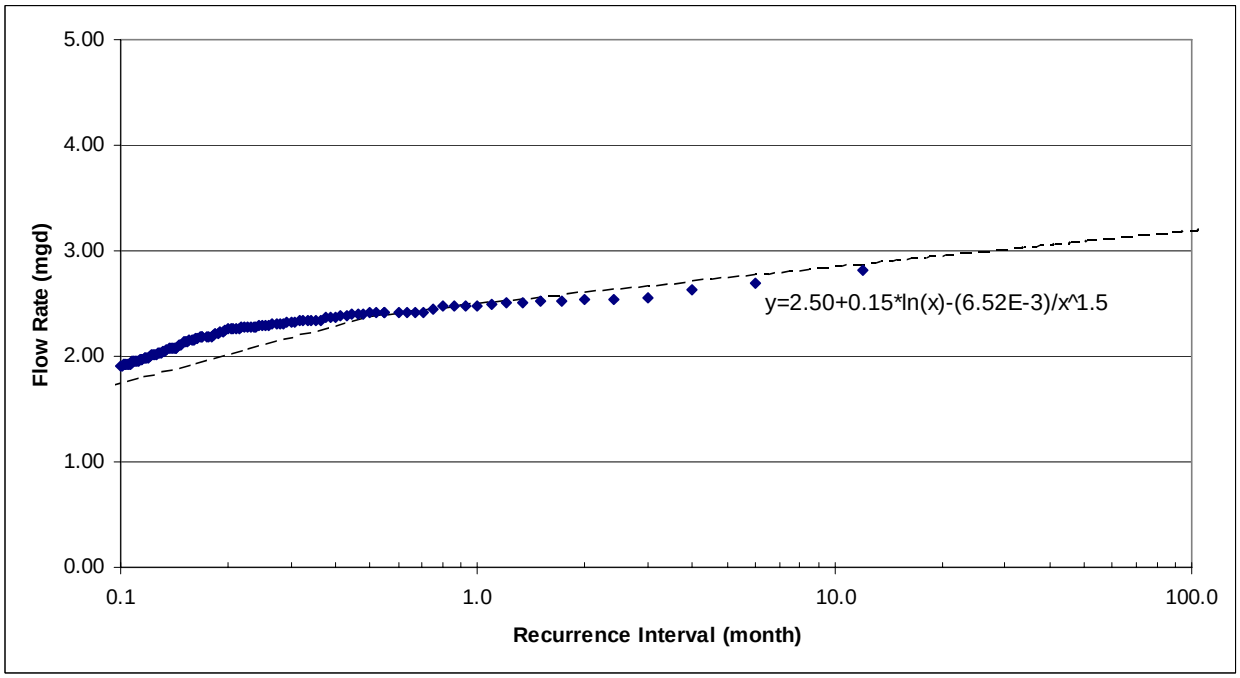


Figure GV-1-8 Flow Rates at Different Recurrence Intervals (site: GV-1)

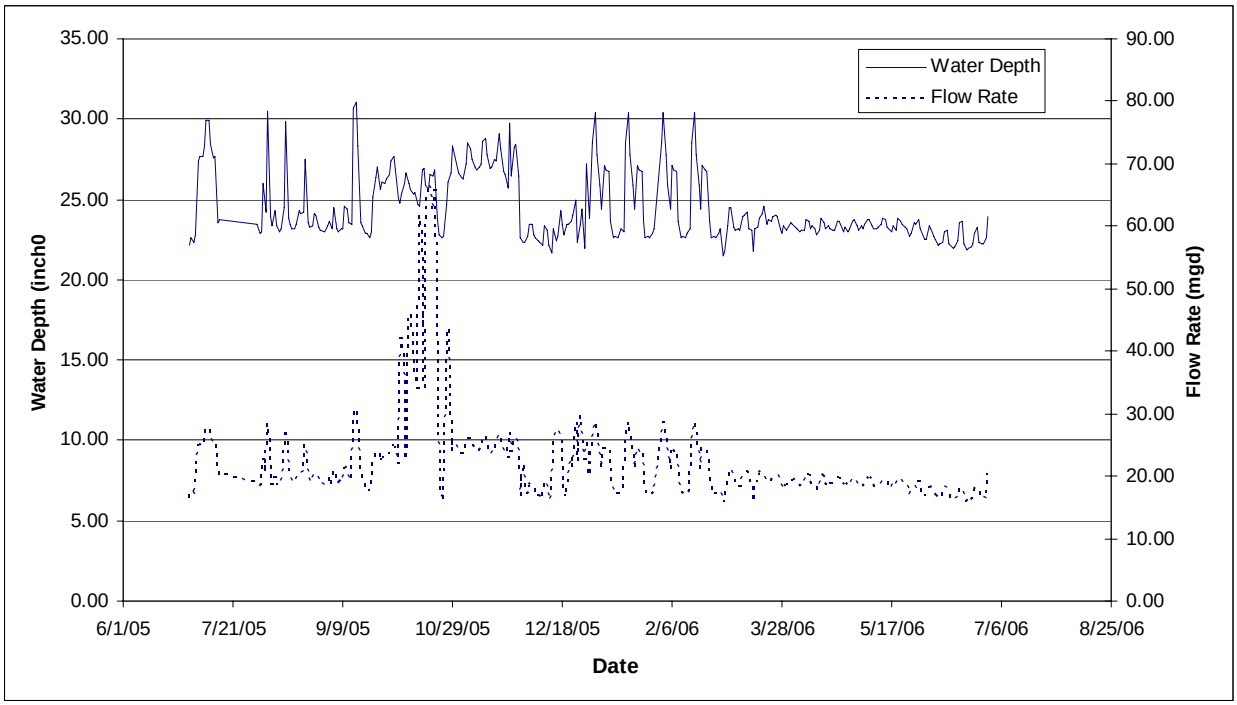


Figure NRI-1-1 Daily Peak Water Depths and Flow Rates (site: NRI-1).

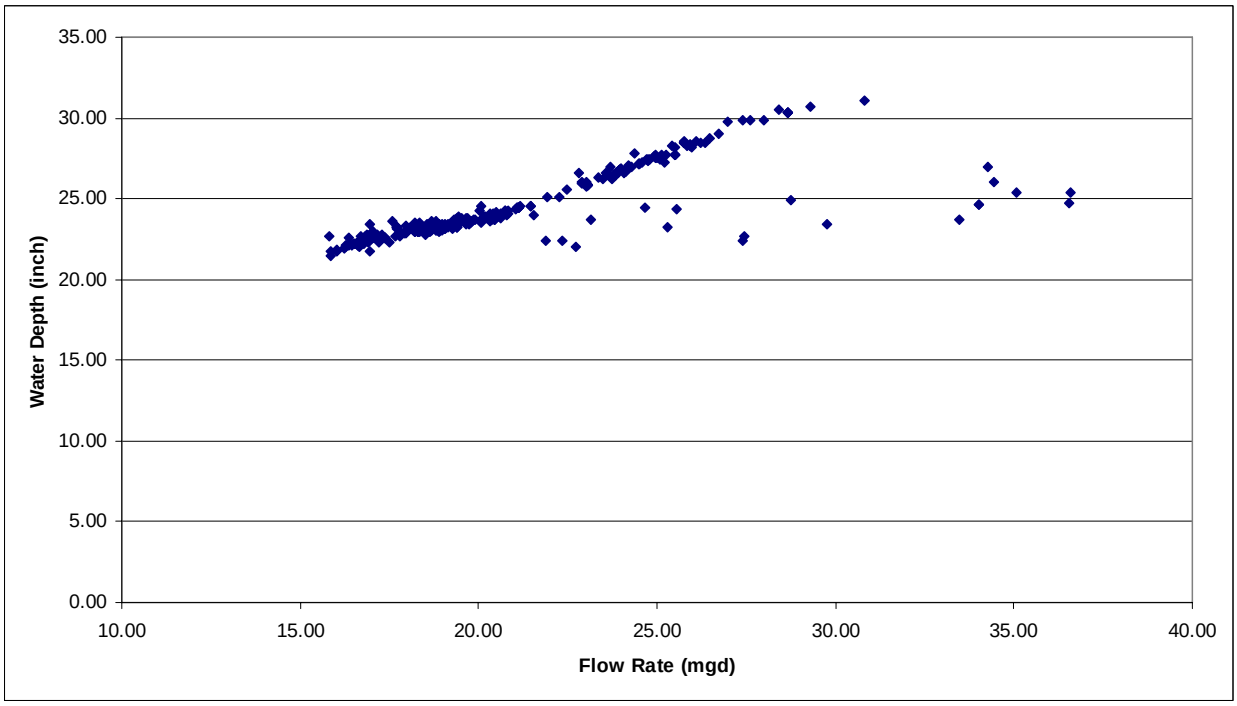


Figure NRI-1-2 Correlation between Water Depths and Flow Rates (site: NRI-1).

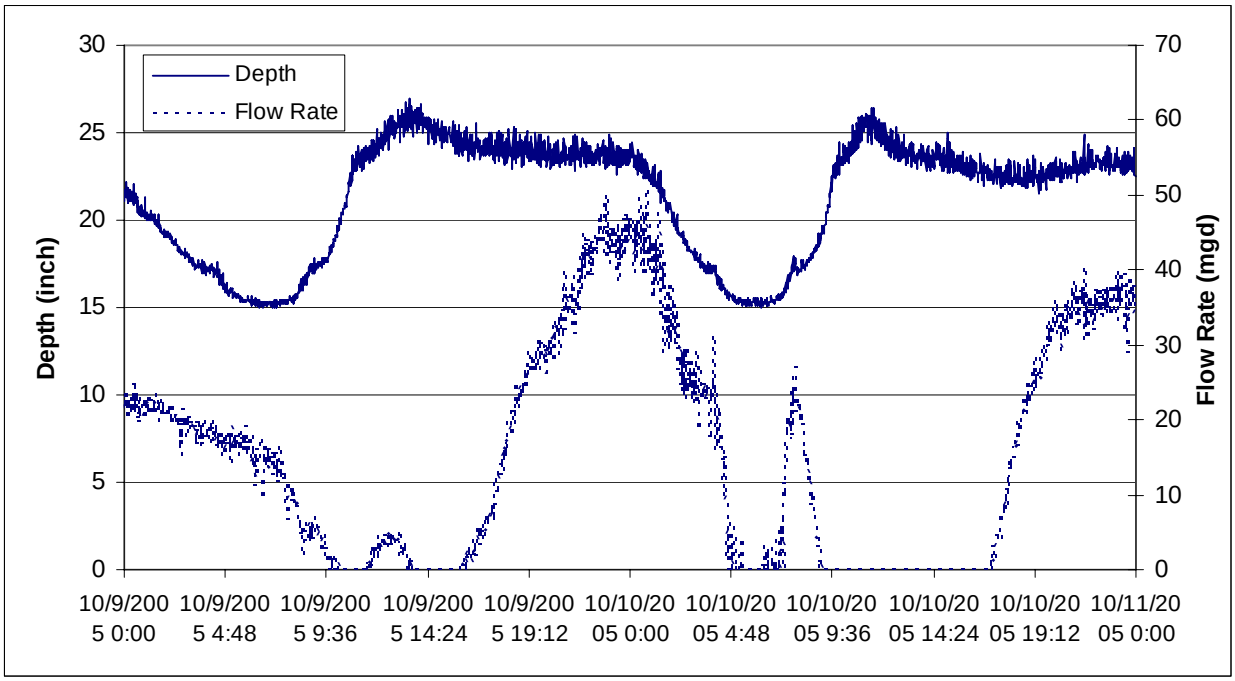


Figure NRI-1-3 An Example of Questionable Data Points (site: NRI-1)

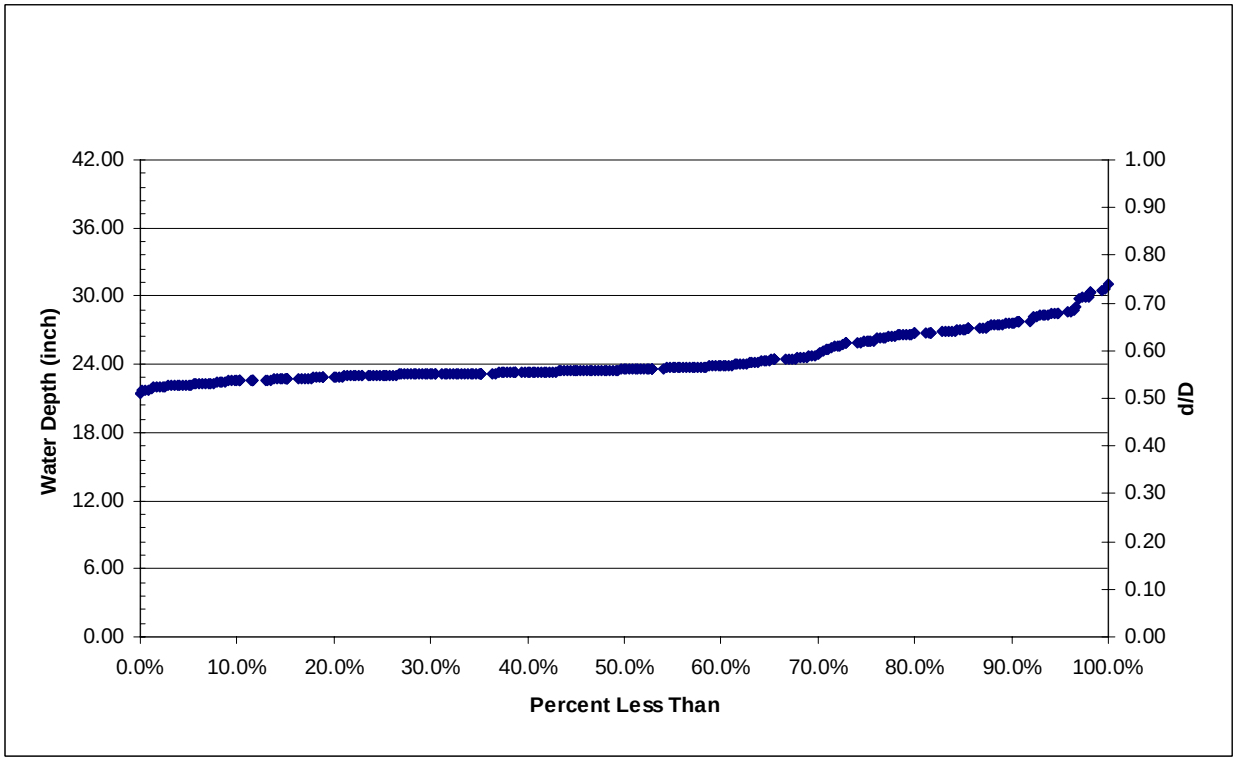


Figure NRI-1-4 Historical Percentile Values of Water Depth (site: NRI-1)

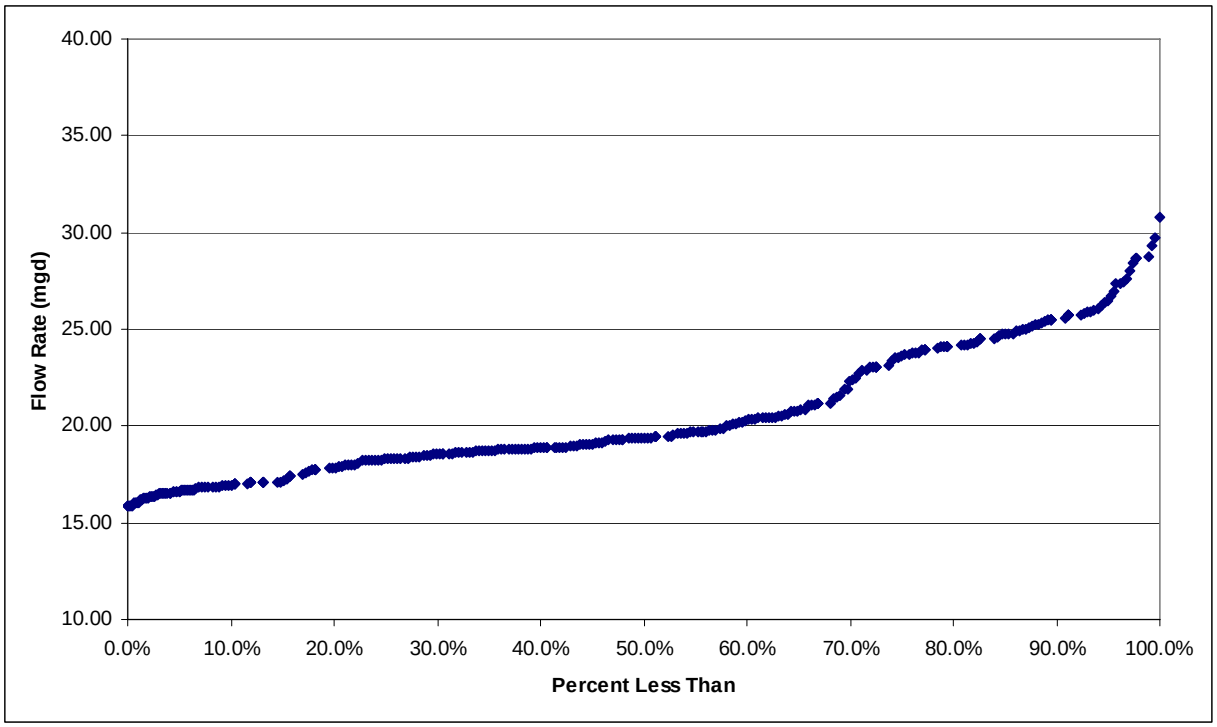


Figure NRI-1-5 Historical Percentile Values of Flow Rate (site: NRI-1)

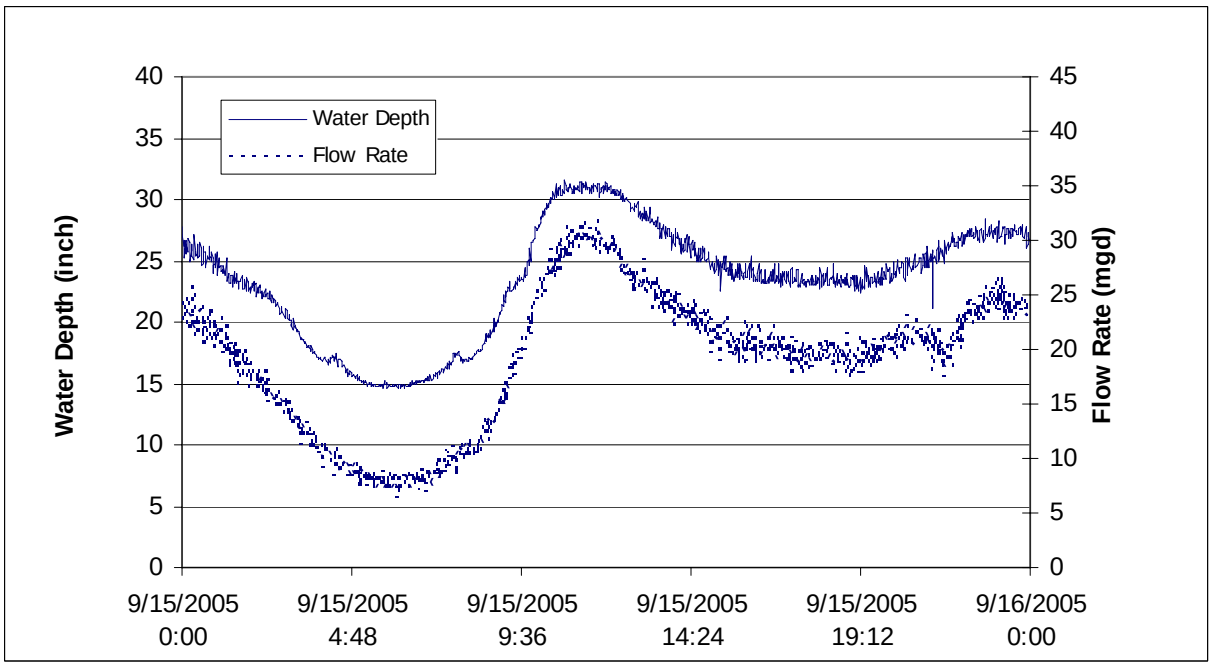


Figure NRI-1-6 One-minute Data Points with the Maximum Flow Rate and Water Depth (site: NRI-1).

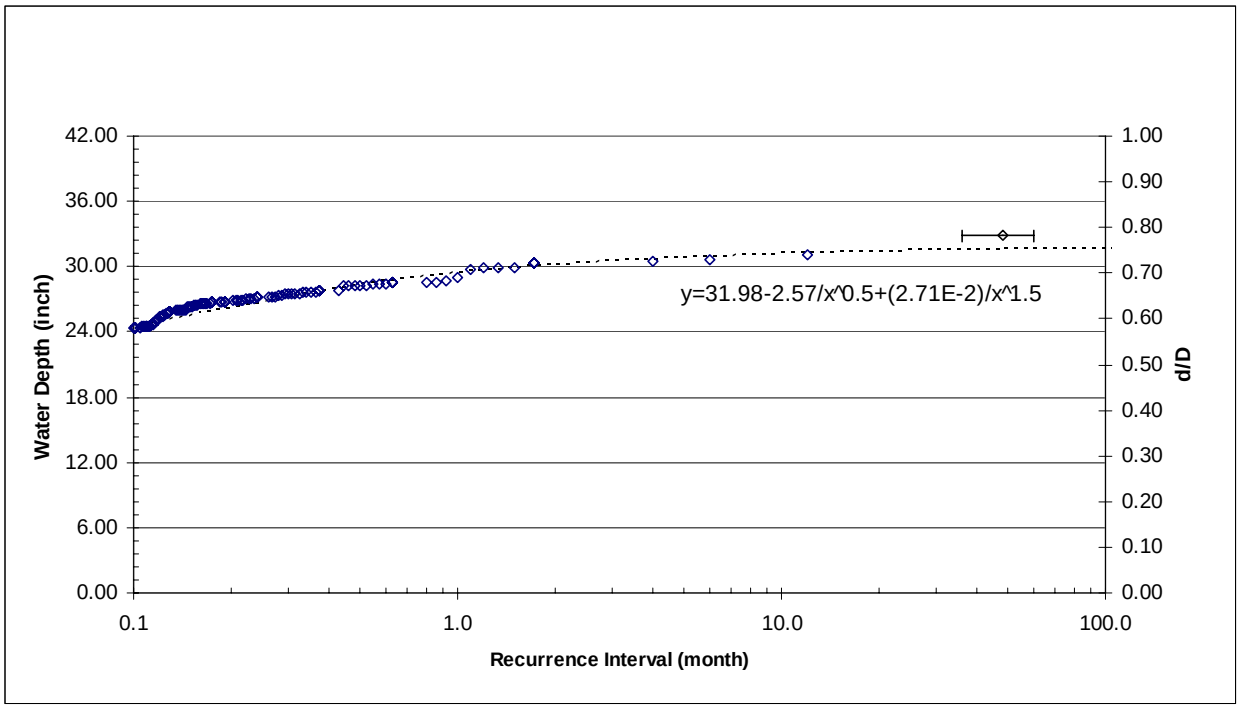


Figure NRI-1-7 Water Depths at Different Recurrence Intervals (site: NRI-1).

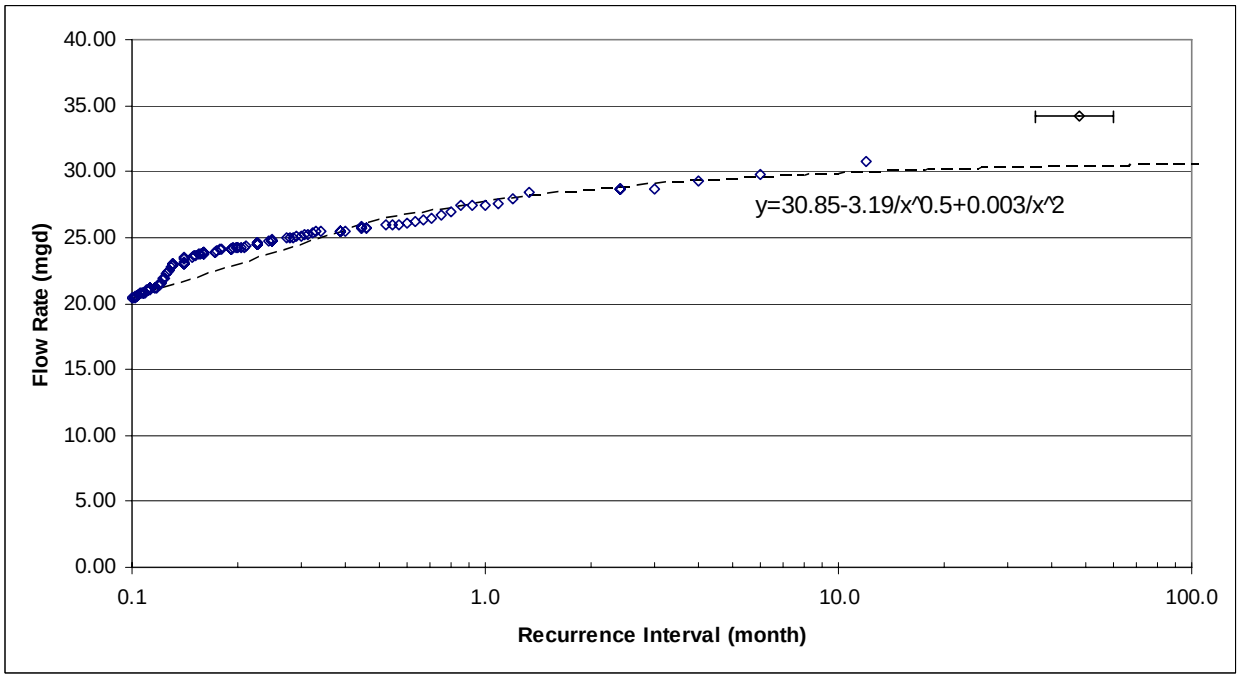


Figure NRI-1-8 Flow Rates at Different Recurrence Intervals (site: NRI-1).

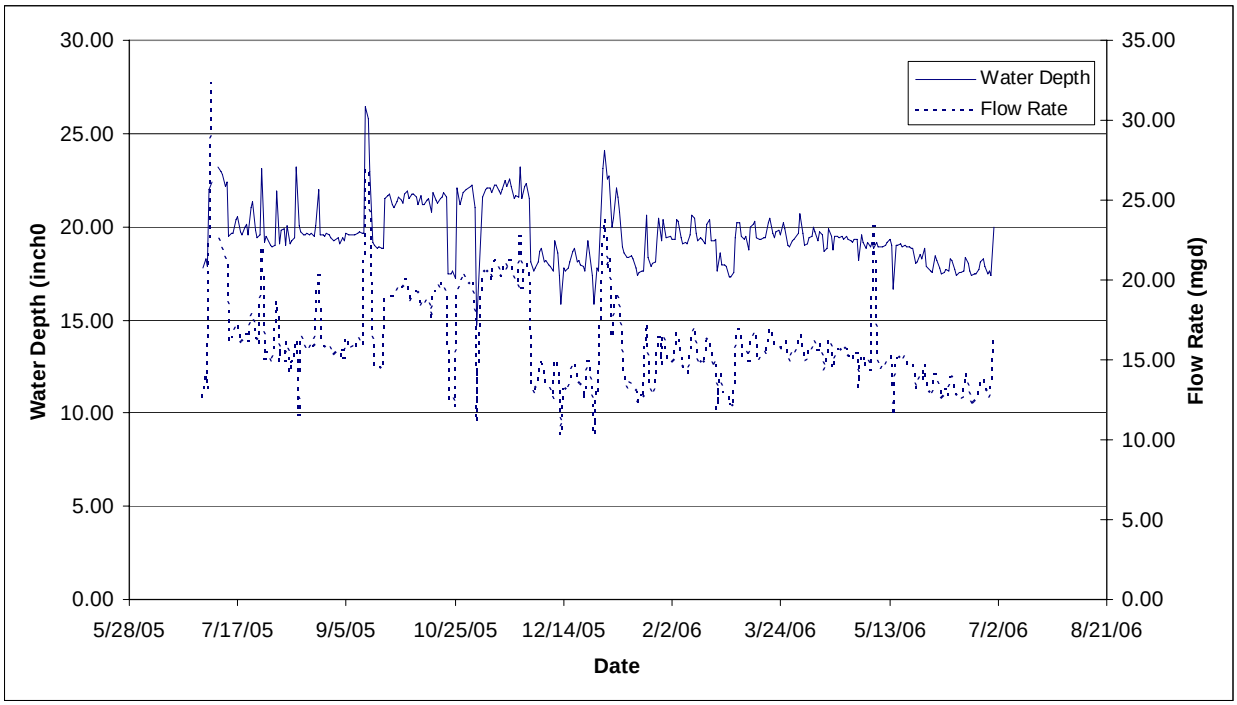


Figure NRI-2-1 Daily Peak Water Depths and Flow Rates (site: NRI-2)

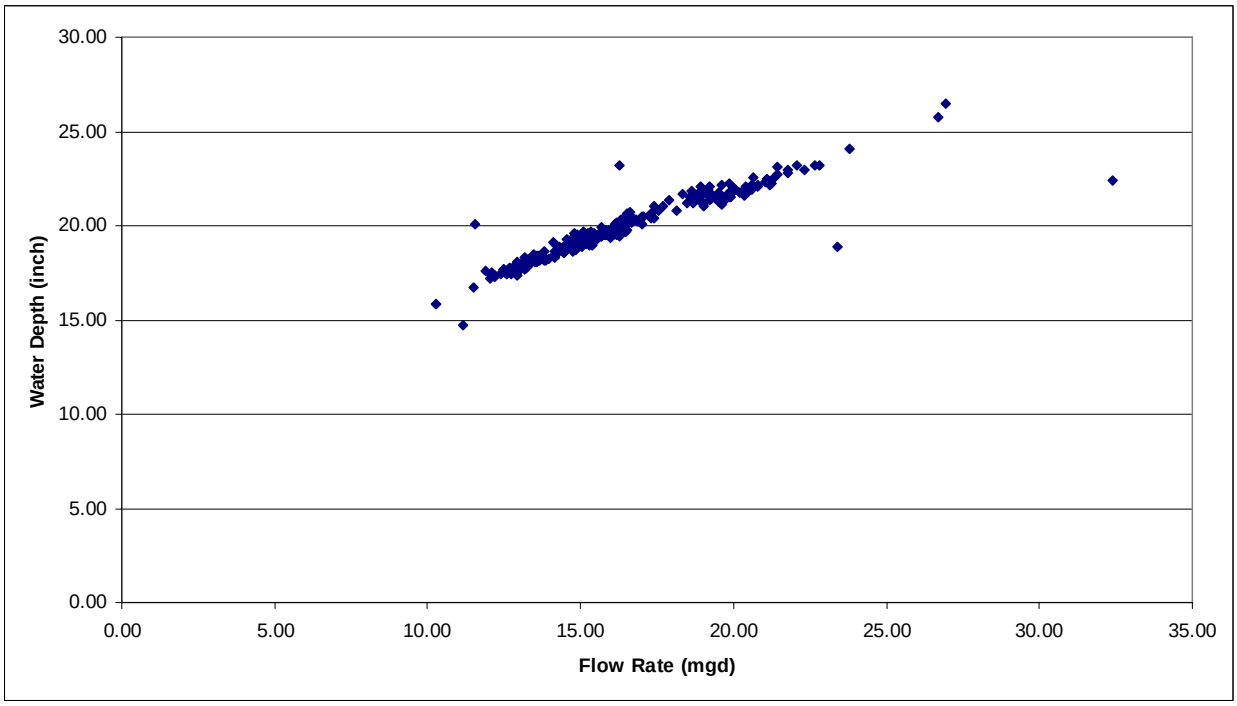


Figure NRI-2-2 Correlation between Daily Peak Water Depths and Flow Rates (site: NRI-2)

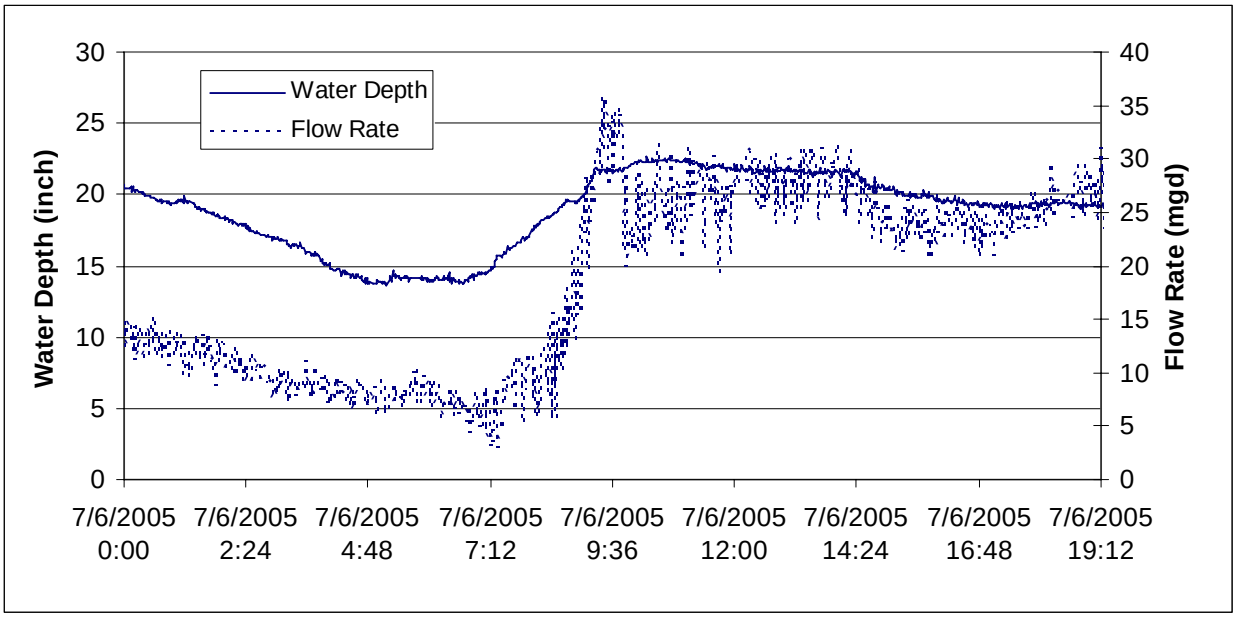


Figure NRI-2-3 One-minute Data Points with the Maximum Flow Rate (site: NRI-2)

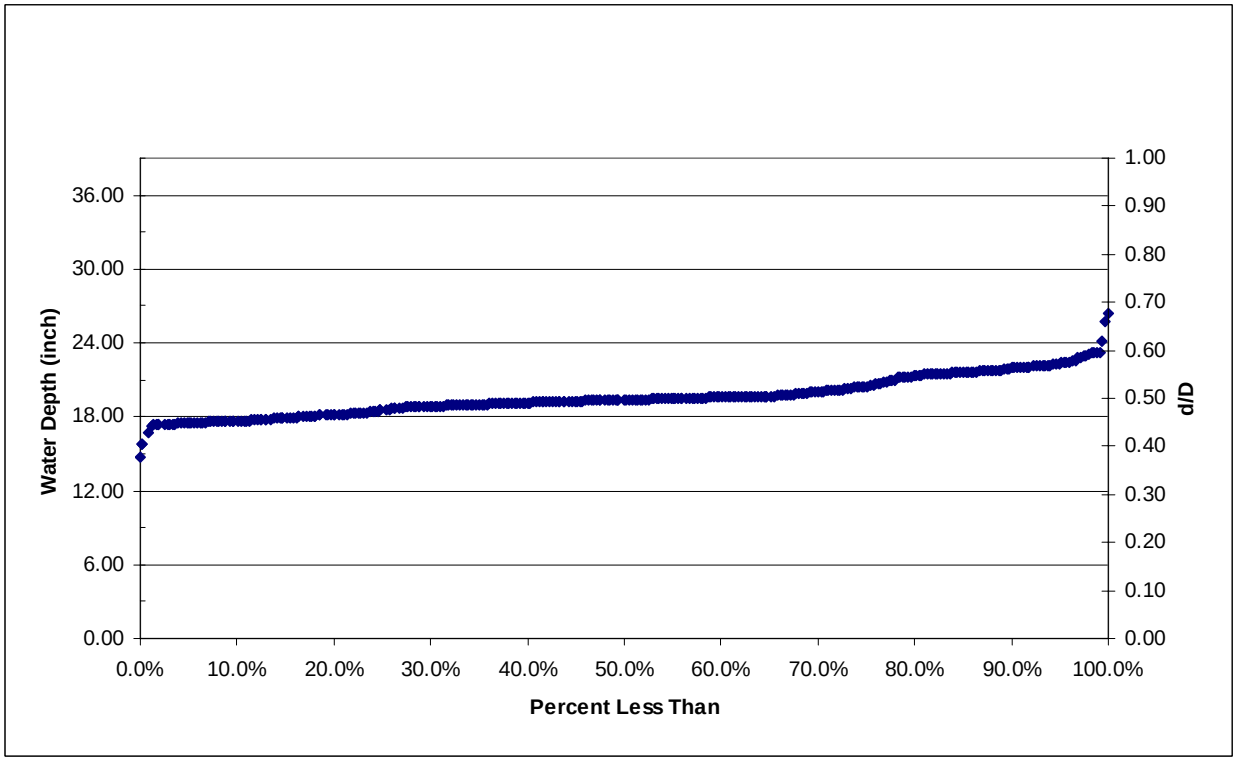


Figure NRI-2-4 Historical Percentile Values of Water Depth (site: NRI-2)

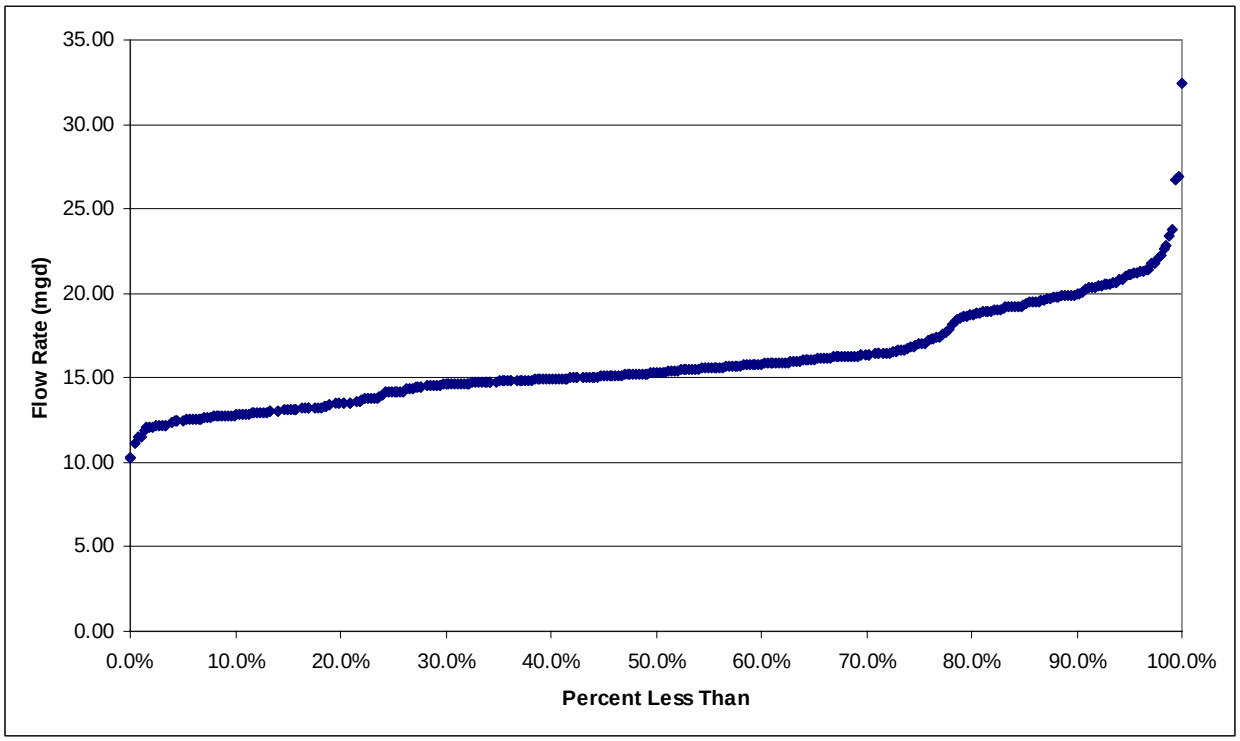


Figure NRI-2-5 Historical Percentile Values of Flow Rate (site: NRI-2)

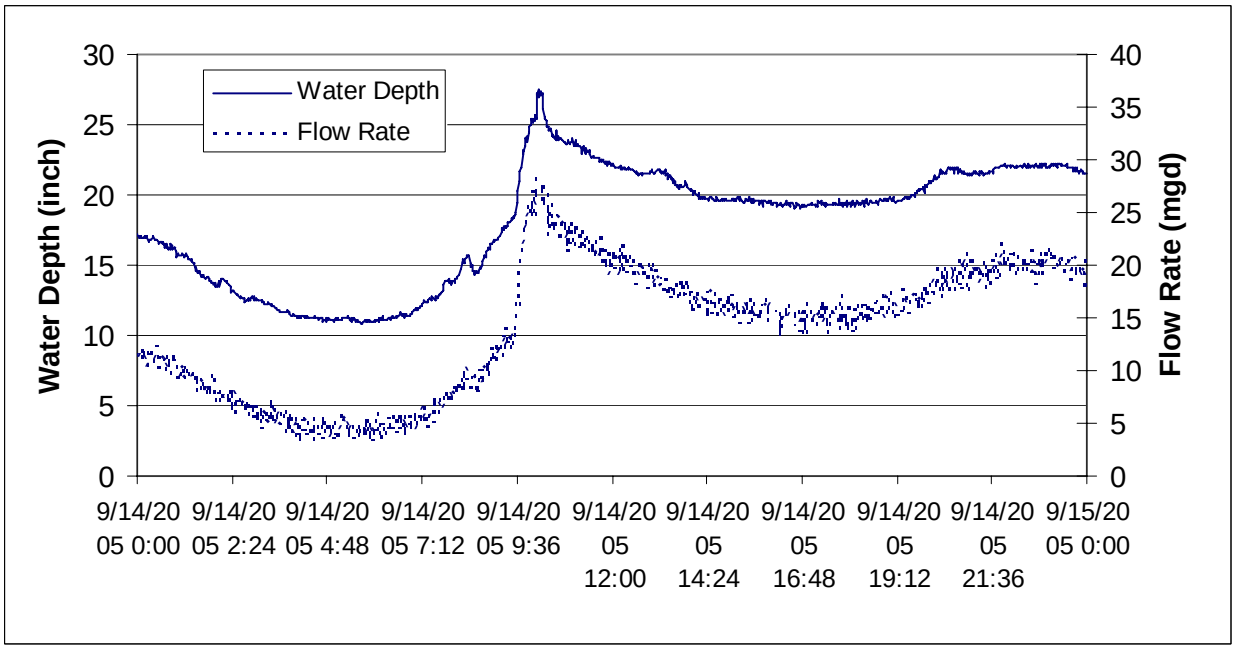


Figure NRI-2=6 One-minute Data Points with the Maximum Water Depth (NRI-2)

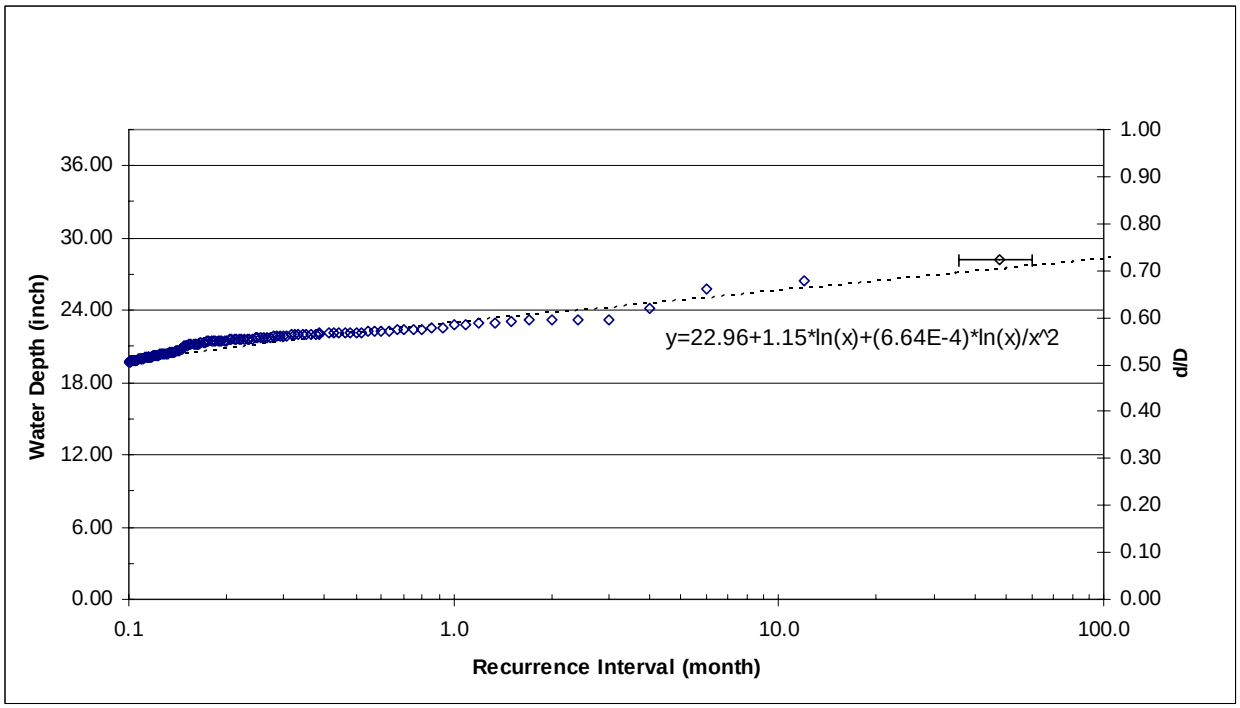


Figure NRI-2-7 Water Depth at Different Recurrence Intervals (site: NRI-2)

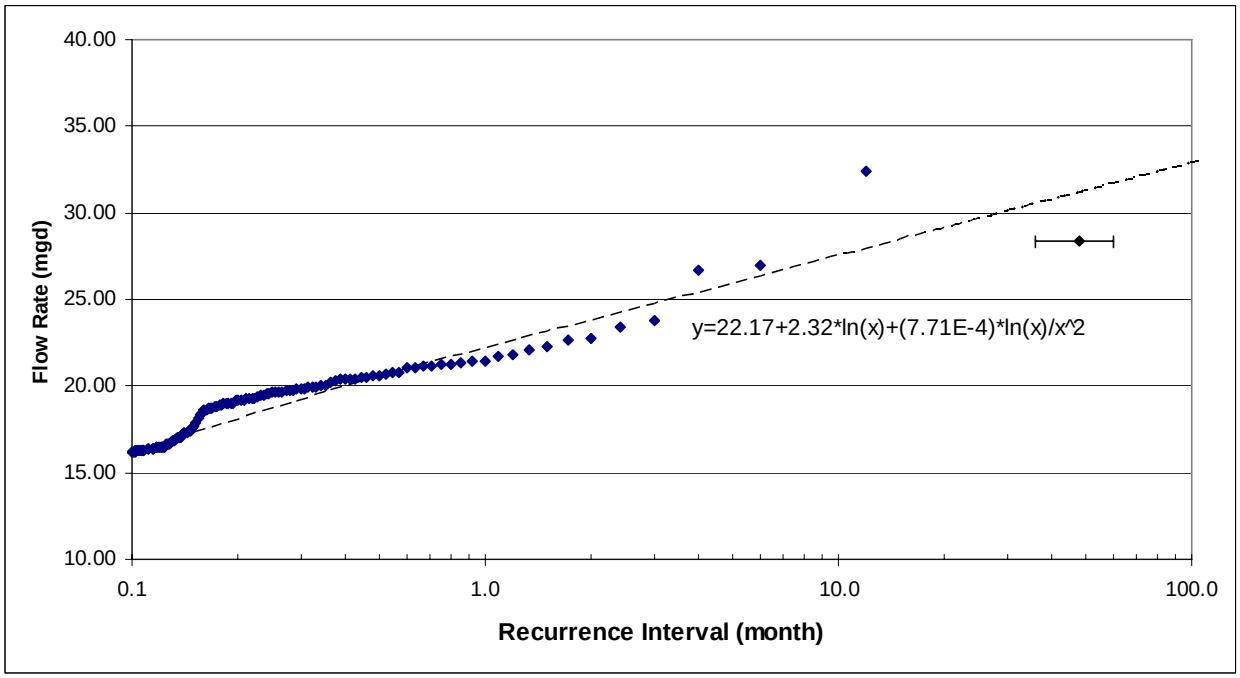


Figure NRI-2-8 Flow Rates at Different Recurrence Intervals (site: NRI-2)

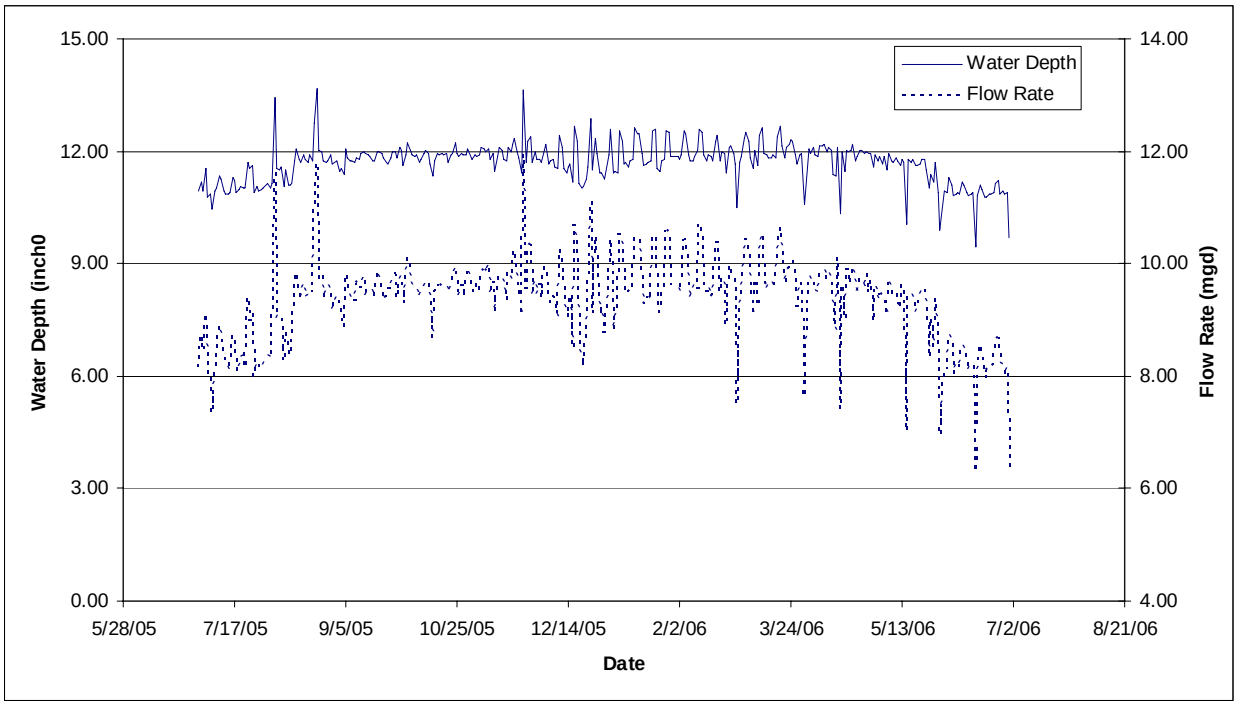


Figure NRI-3-1 Daily Peak Water Depths and Flow Rates (site: NRI-3)

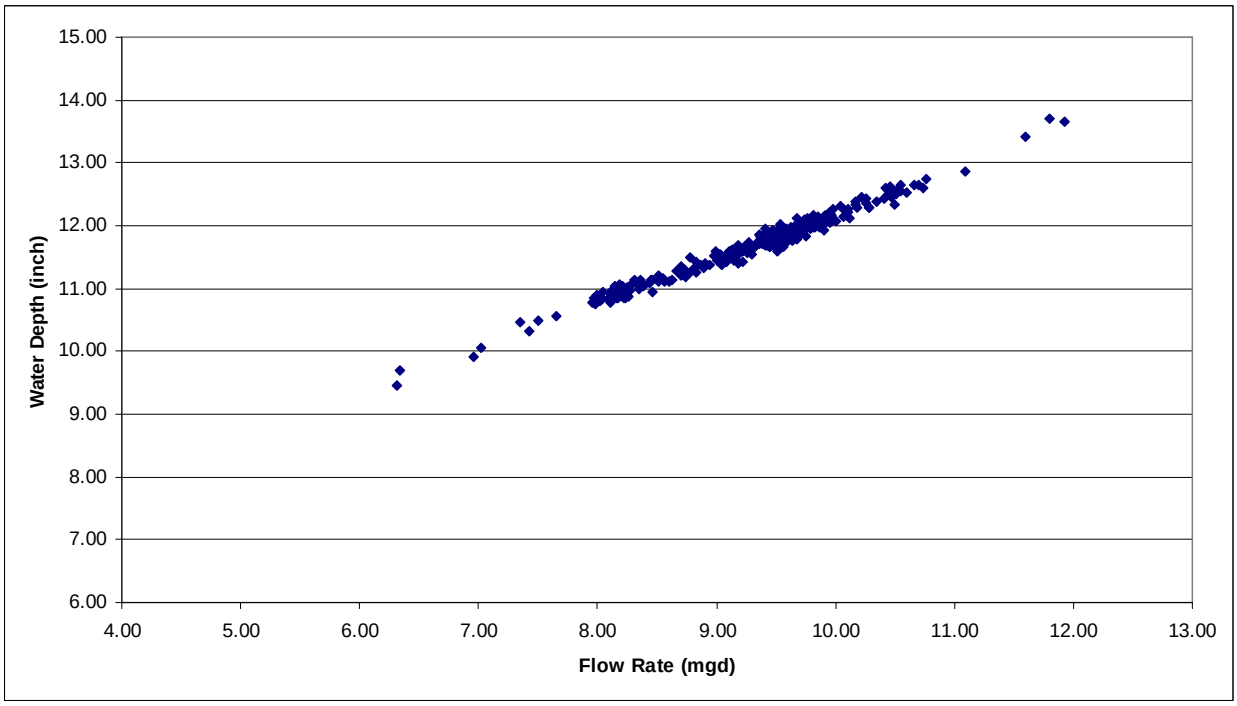


Figure NRI-3-2 Correlation between Daily Peak Water Depths and Flow Rates (site: NRI-3)

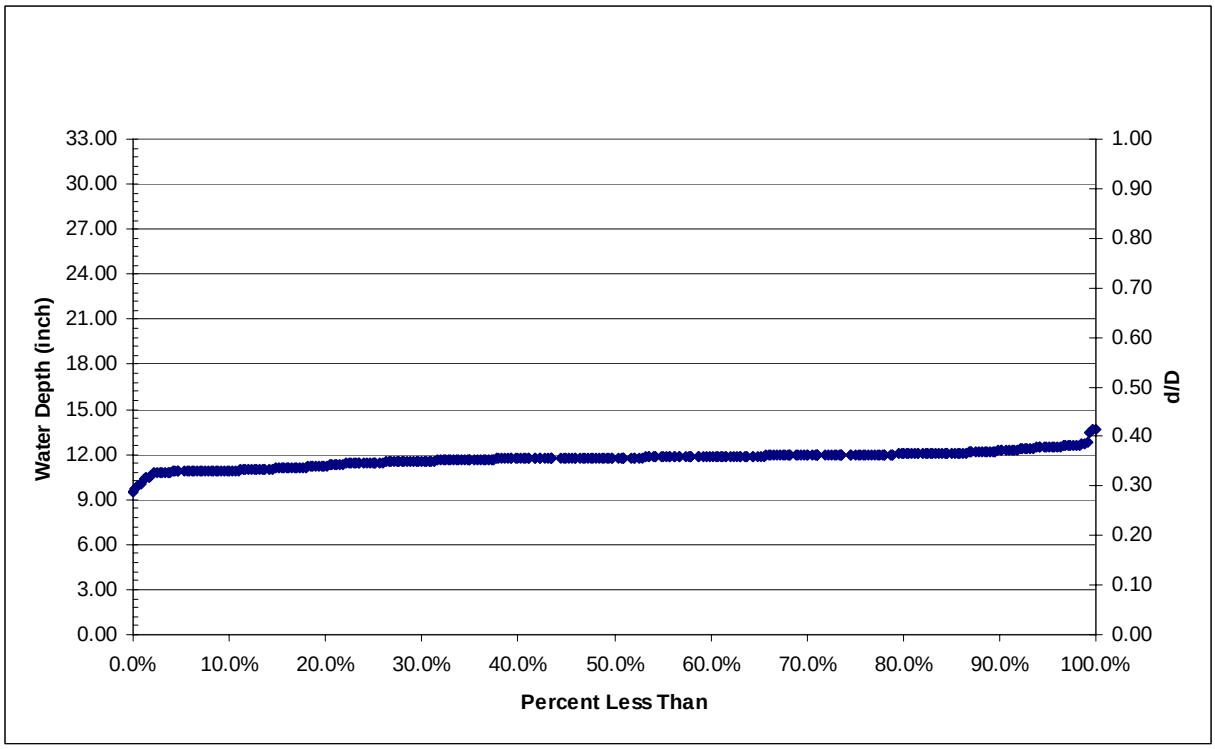


Figure NRI-3-3 Historical Percentile Values of Water Depth (site: NRI-3)

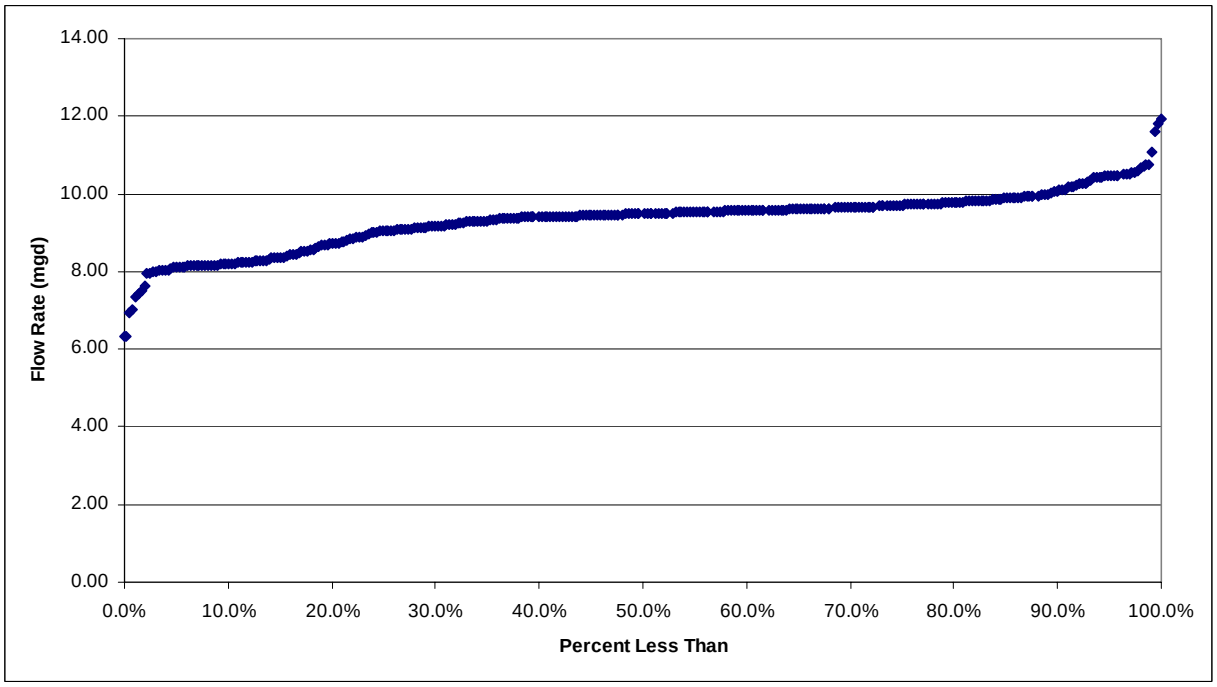


Figure NRI-3-4 Historical Percentile Values of flow Rate (site: NRI-3)

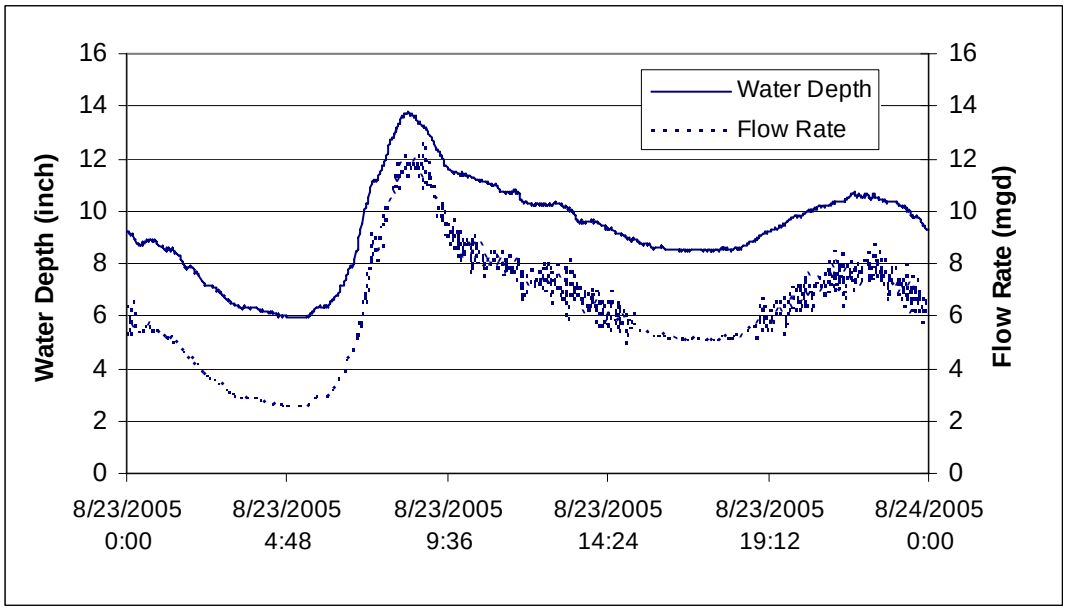


Figure NRI-3-5 One-minute Data Points with the Maximum Water Depth and Second Maximum Flow Rate (site: NRI-3)

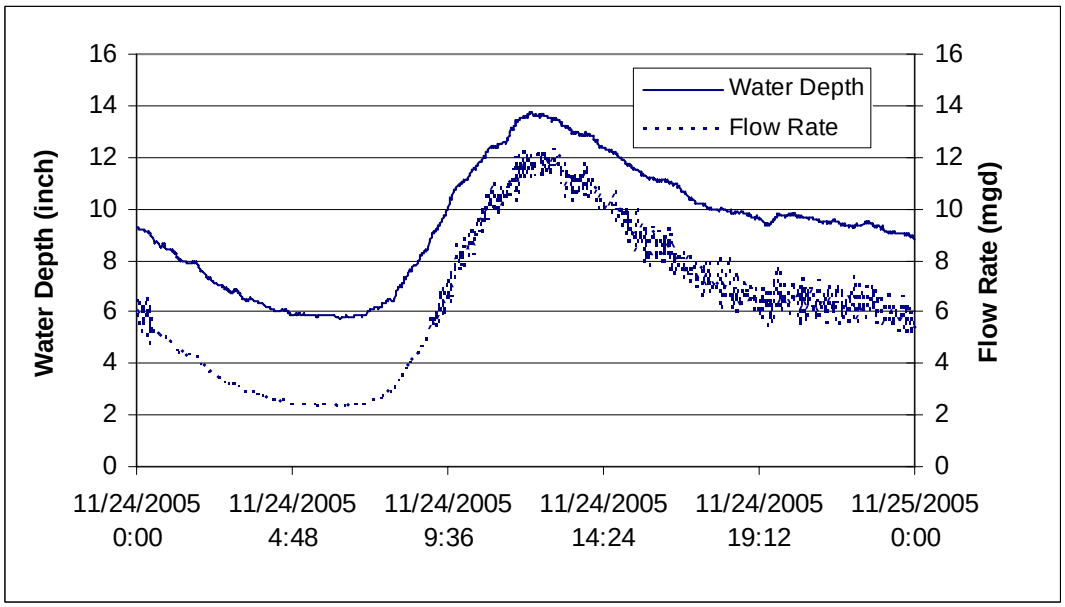


Figure NRI-3-6 One-minute Data Points with the Second Maximum Water Depth and Maximum Flow Rate (site: NRI-3)

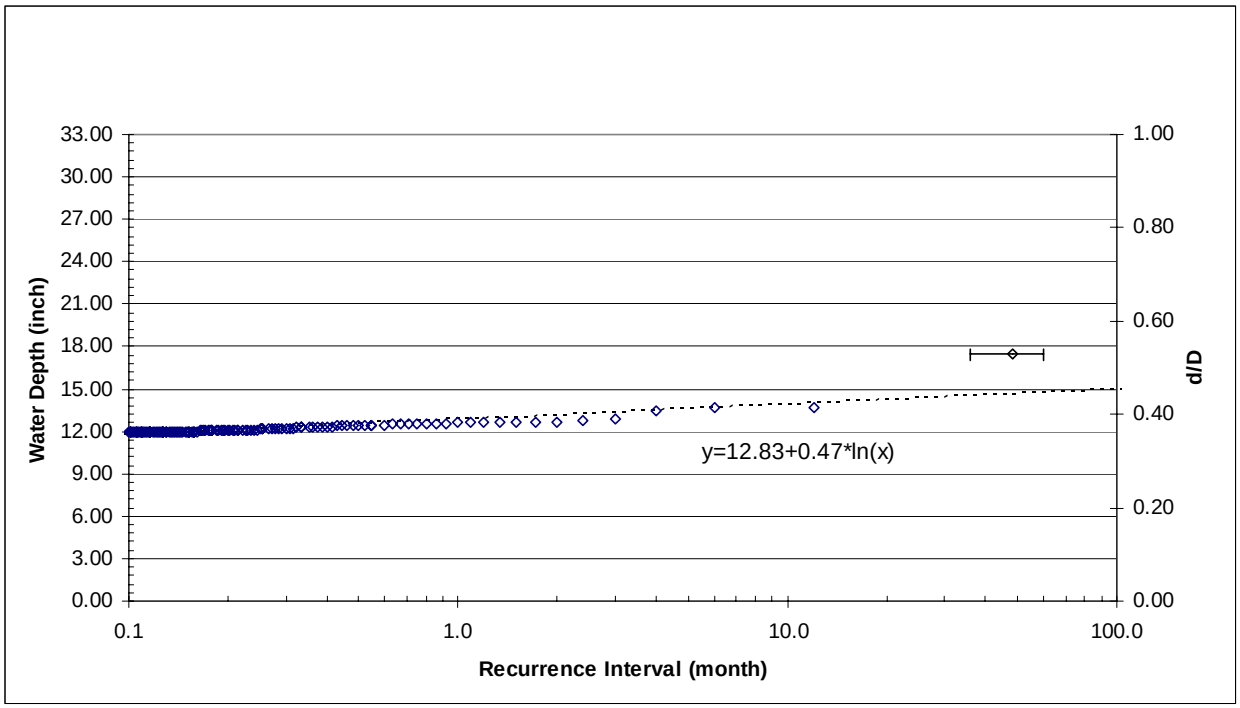


Figure NRI-3-7 Water Depths at Different Recurrence Intervals (site: NRI-3)

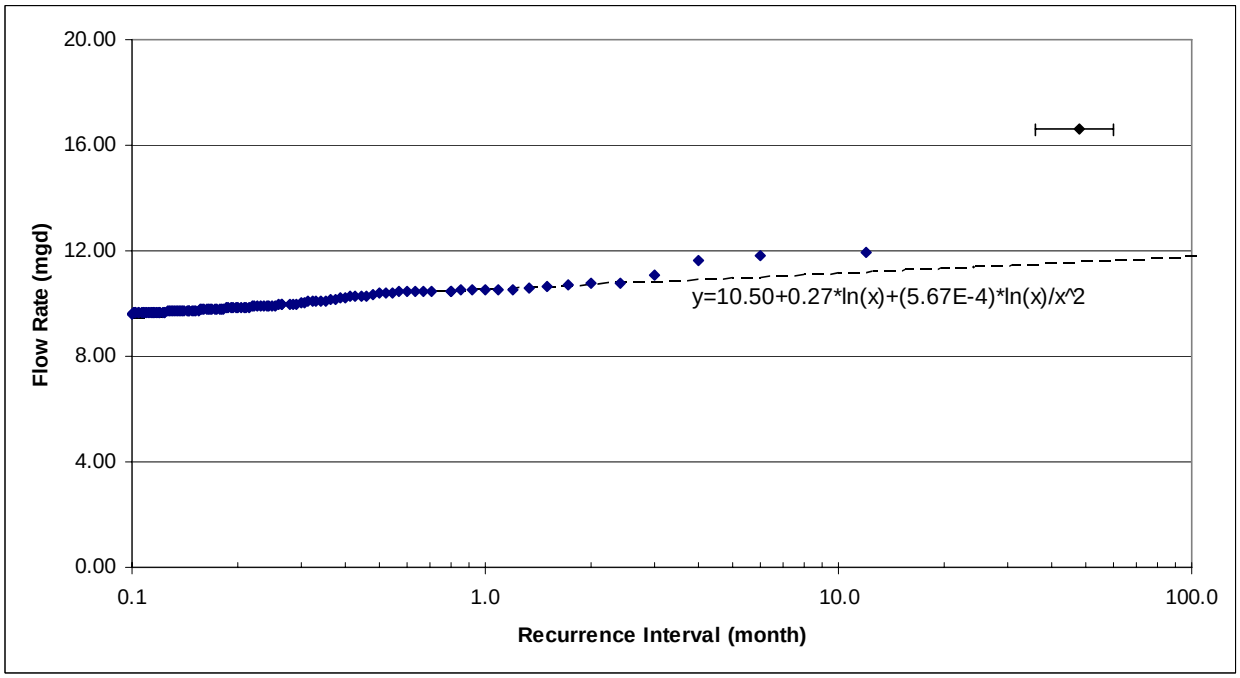


Figure NRI-3-8 Flow Rates at Different Recurrence Intervals (site: NRI-3)

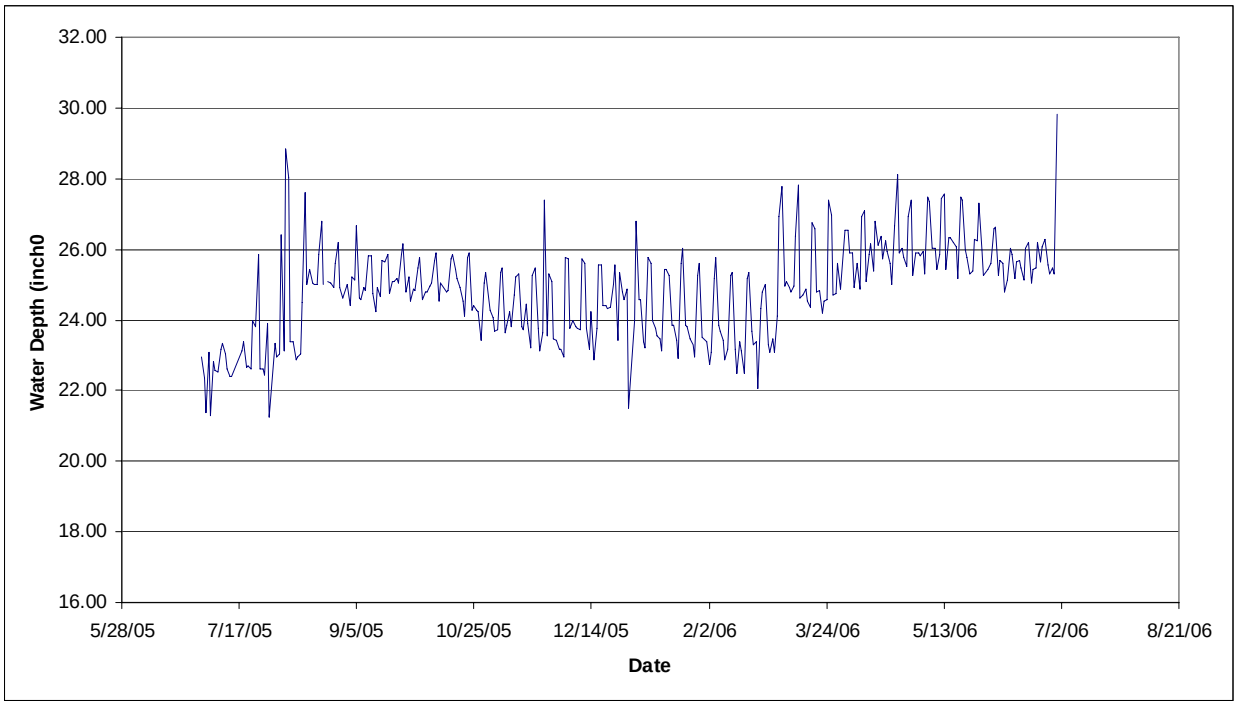


Figure NWO-1-1 Daily Peak Water Depths (site: NWO-1).

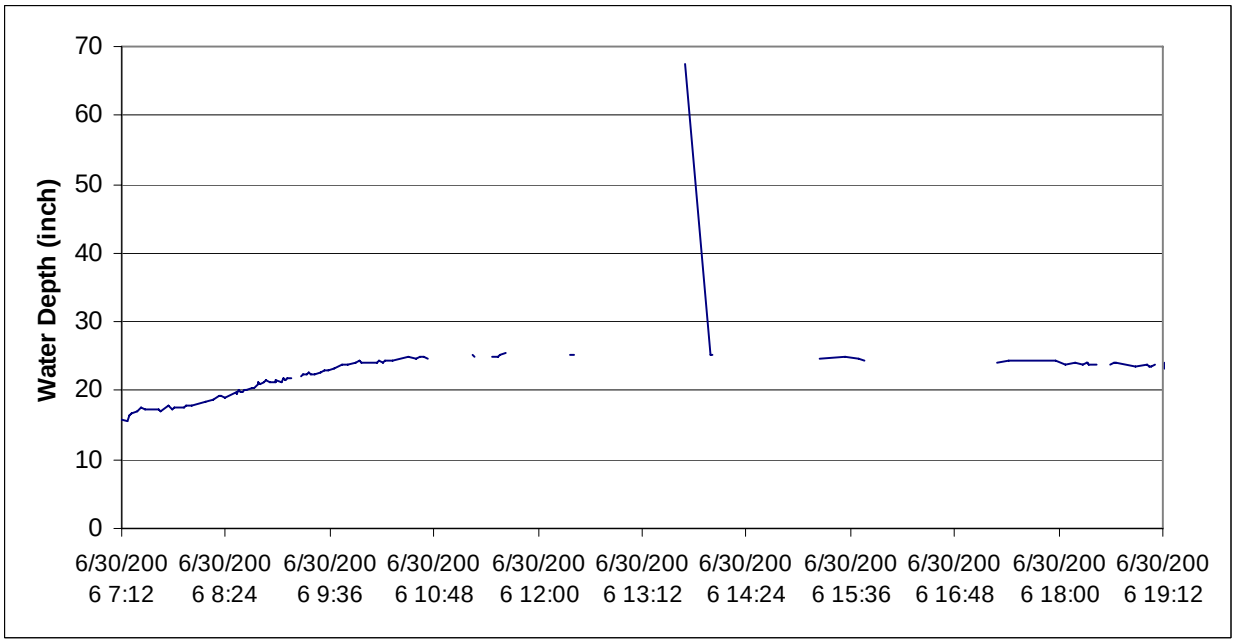


Figure NWO-1-2 Questionable 1-minute Data Points (site: NOW-1)

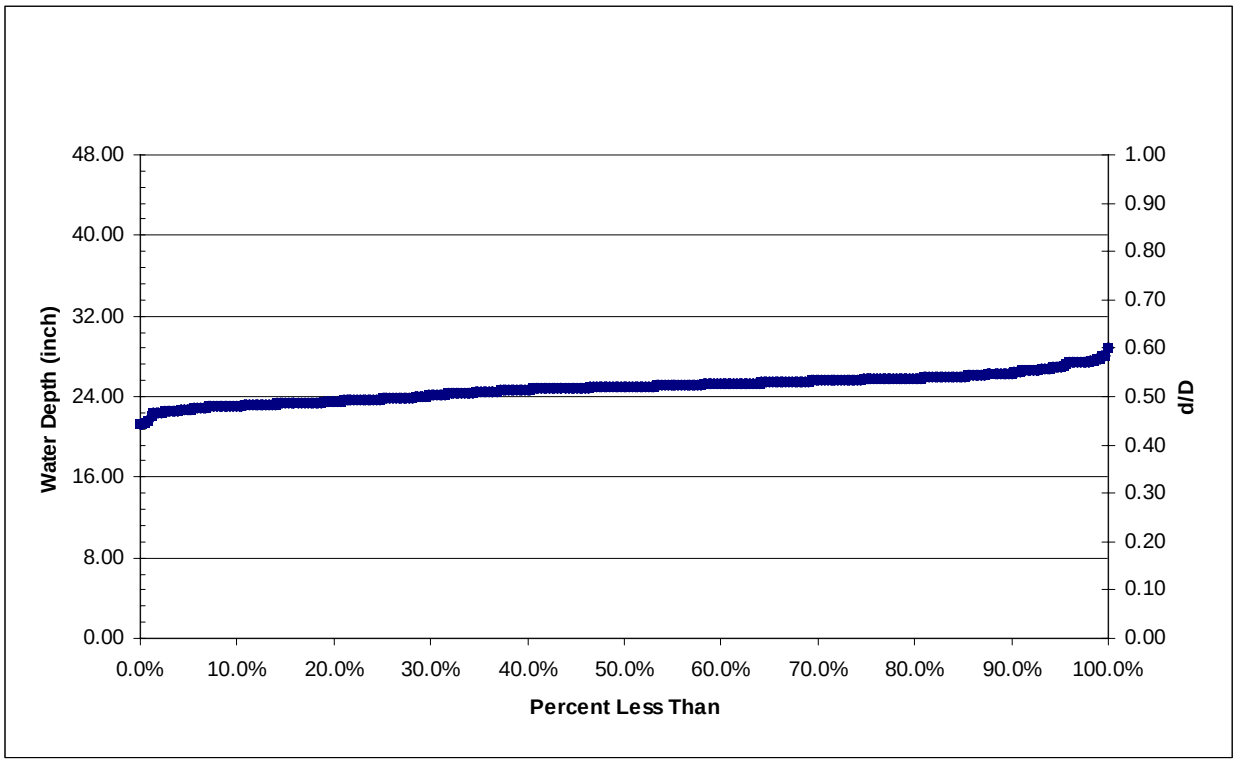


Figure NWO-1-3 Historical Percentile Values of Water Depth (site: NOW-1).

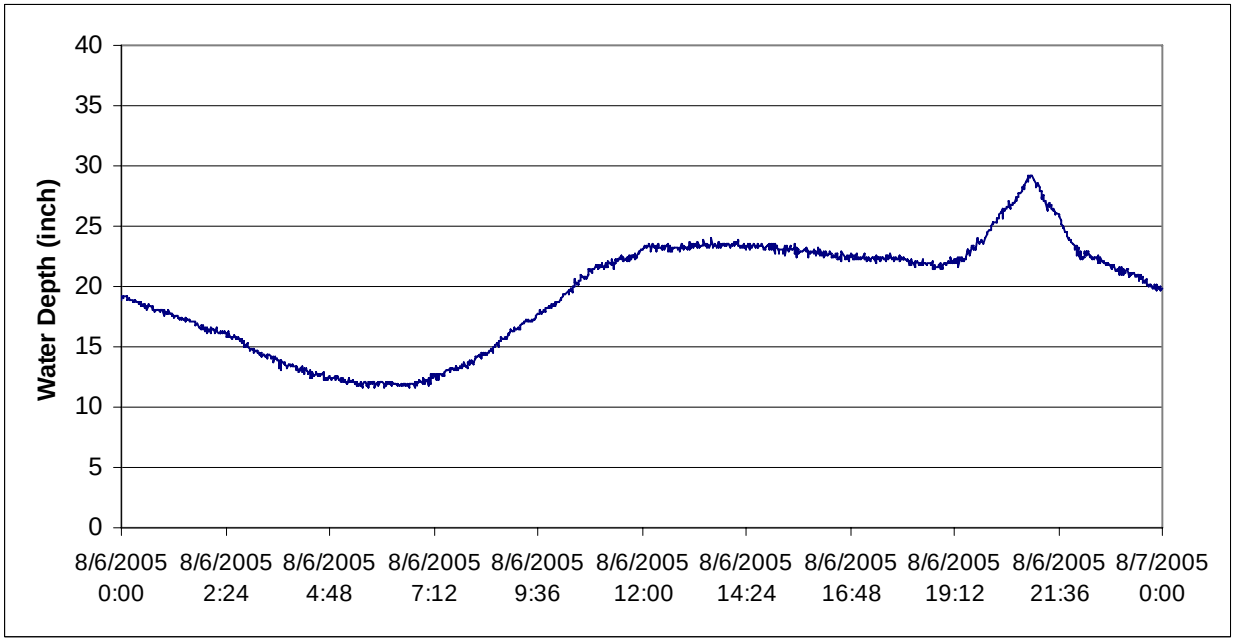


Figure NWO-1-4 One-minute Data Points with the Maximum Water Depth (site: NOW-1).

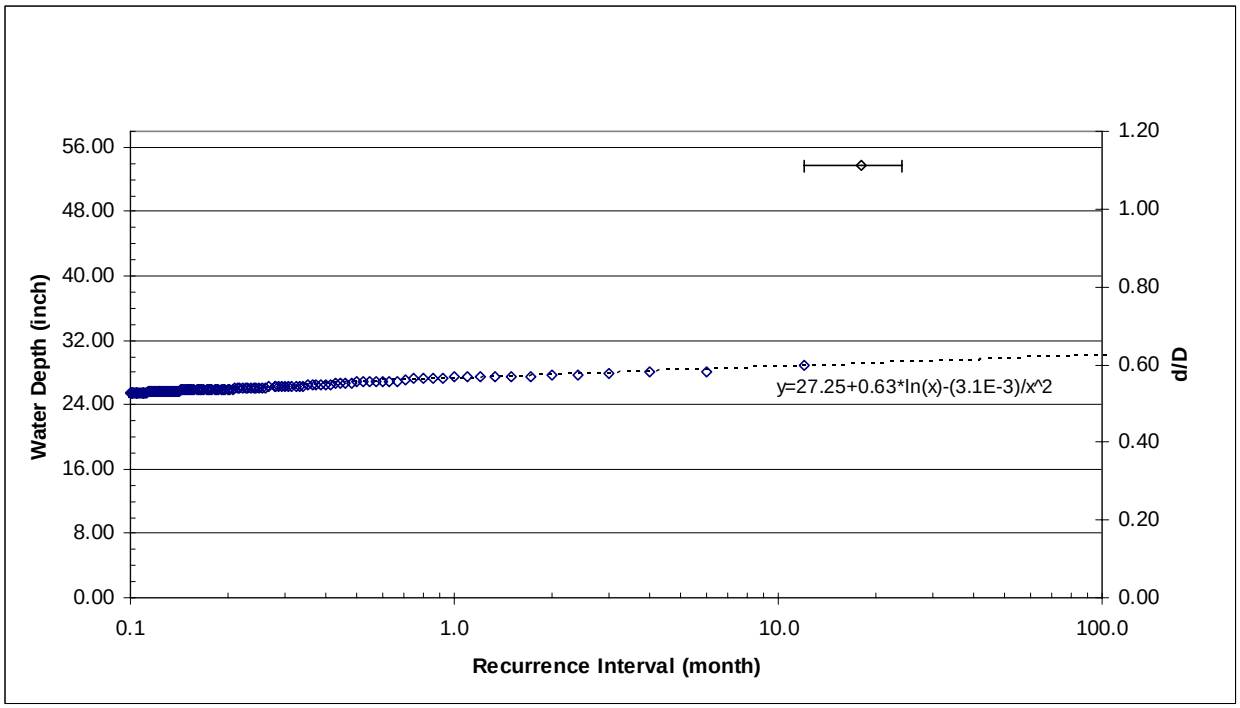


Figure NWO-1-5 Water Depths at Different Recurrence Intervals (site: NOW-1).

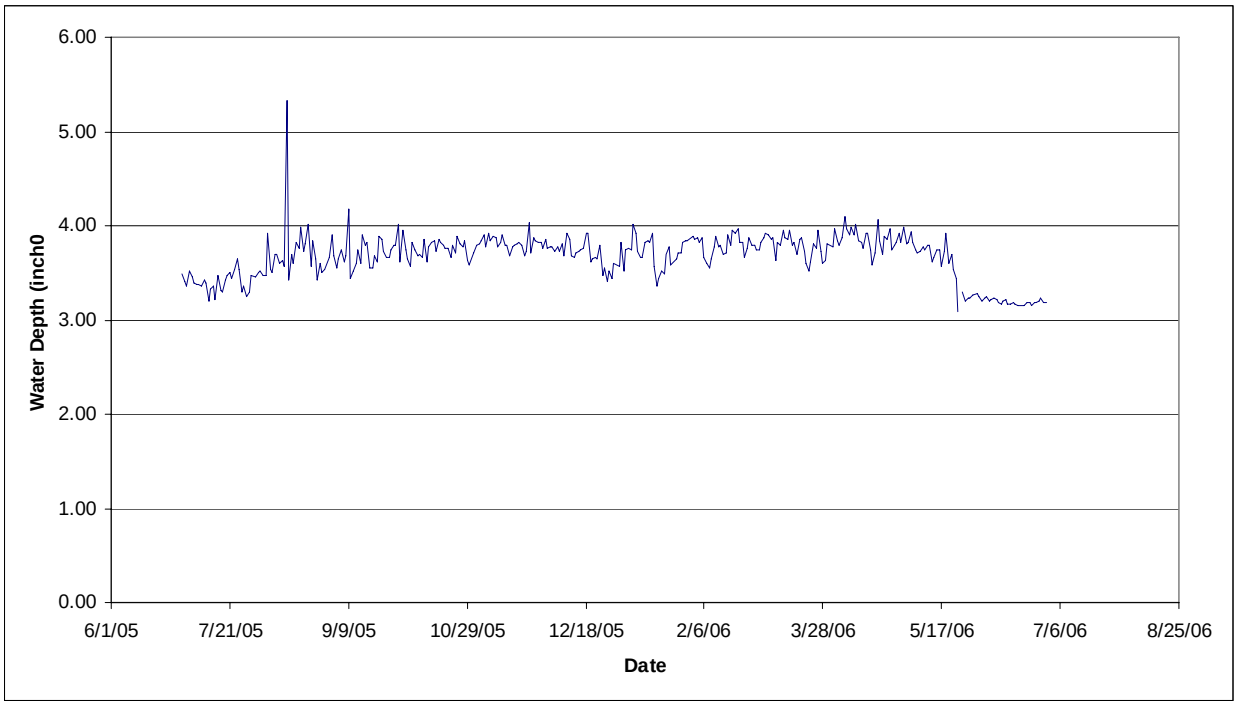


Figure PONT-1-1 Daily Peak Water Depths (site: PONT-1).

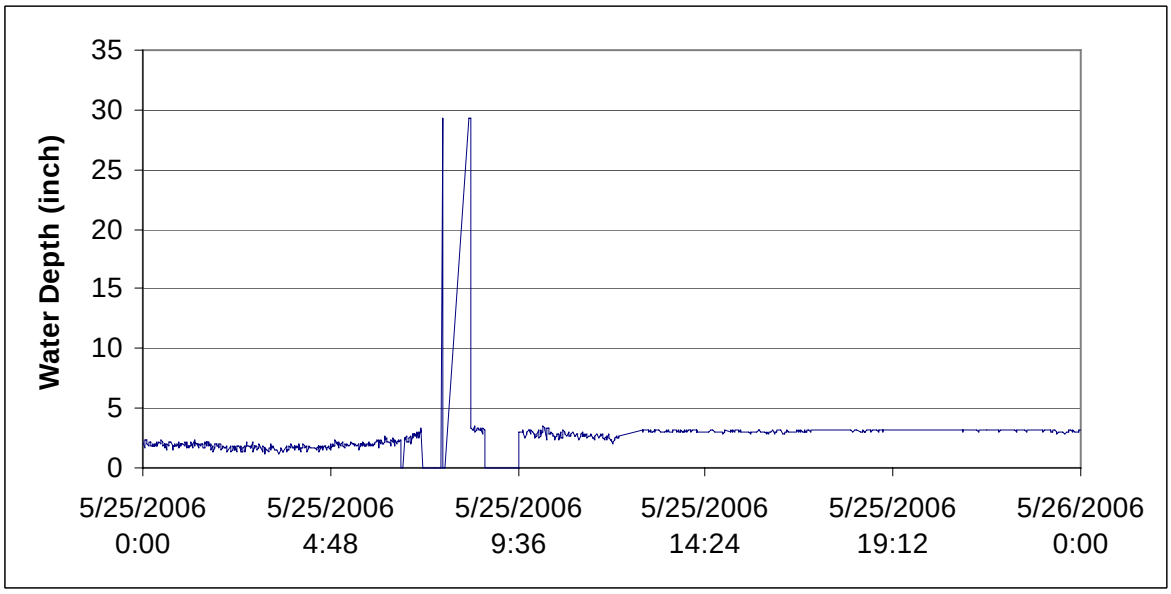


Figure PONT-1-2 Questionable 1-minute Data Points (already excluded in Figure PONT-1-1) (site: PONT-1).

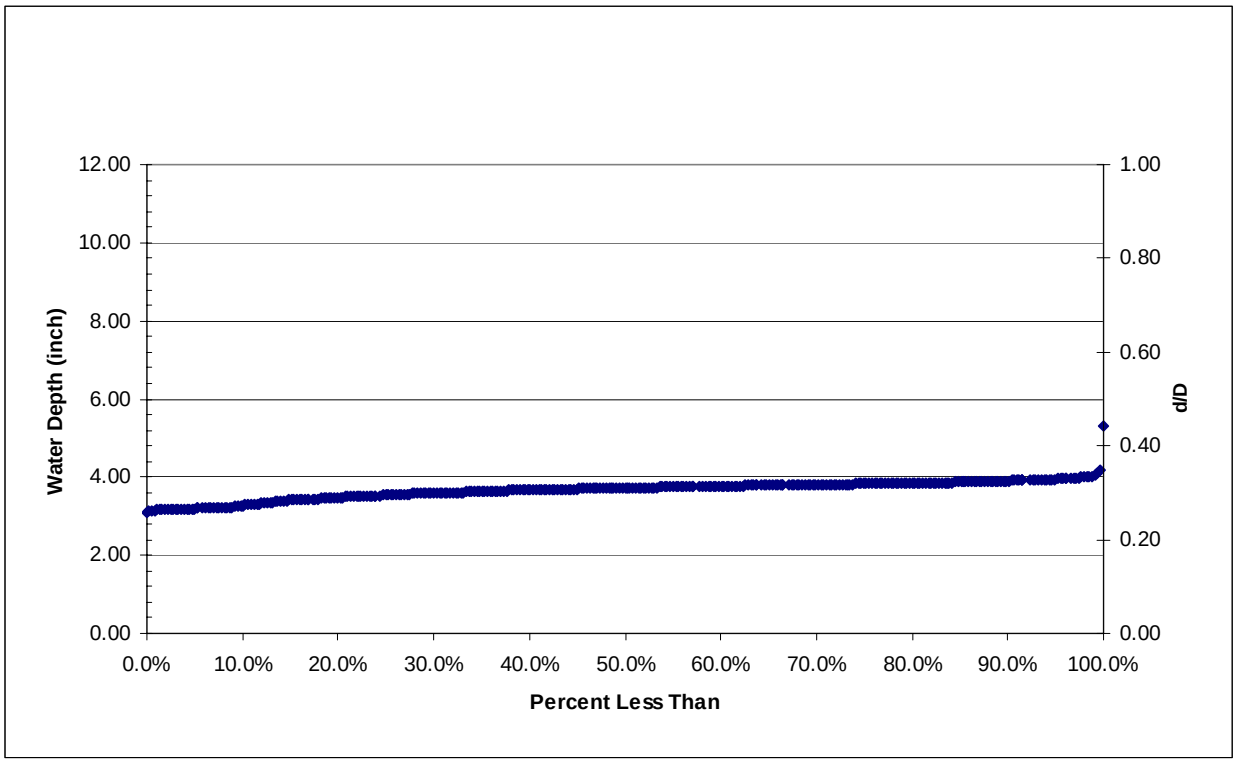


Figure PONT-1-3 Historical Percentile Values of Water Depth (site: PONT-1).

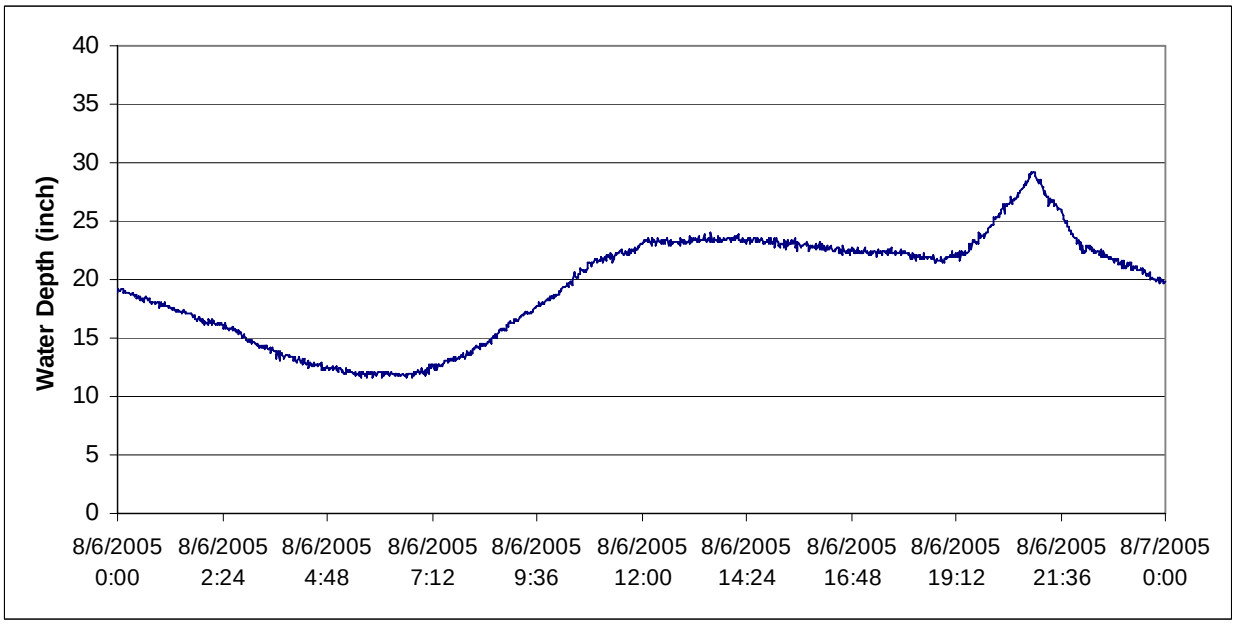


Figure PONT-1-4 One-minute Data Points with the Maximum Water Depth (site: PONT-1).

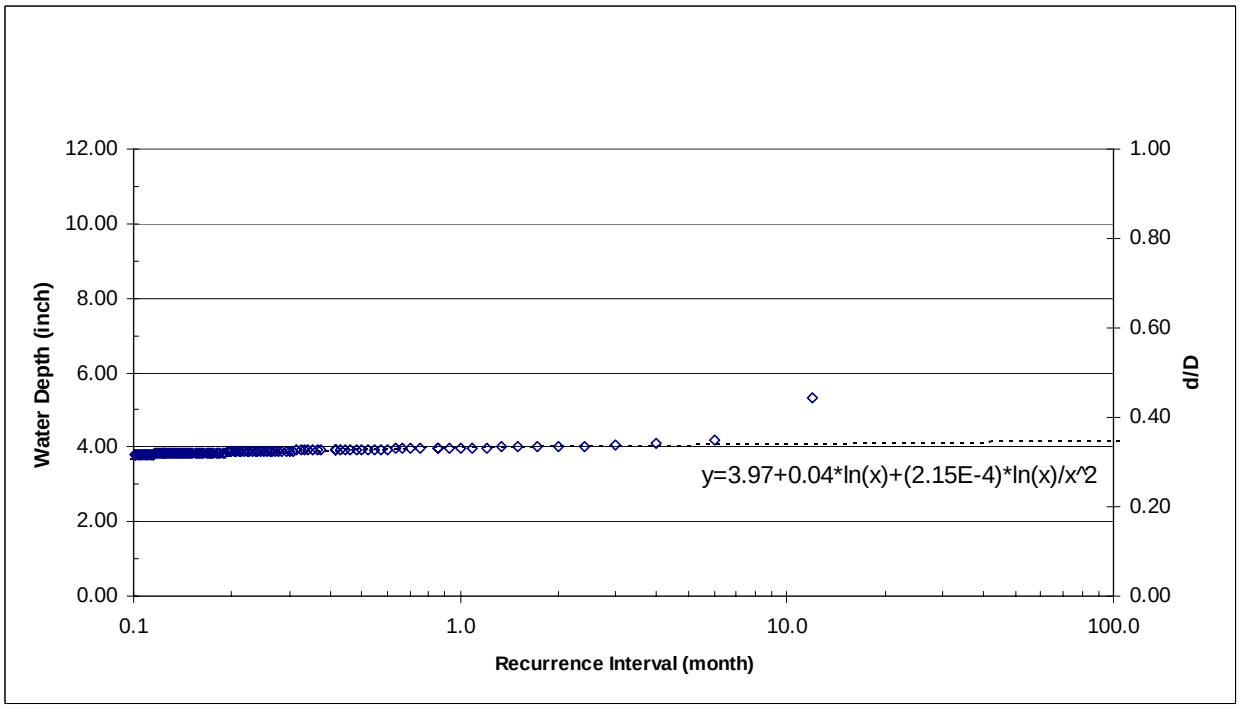


Figure PONT-1-5 Water Depths at Different Recurrence Intervals (site: PONT-1).

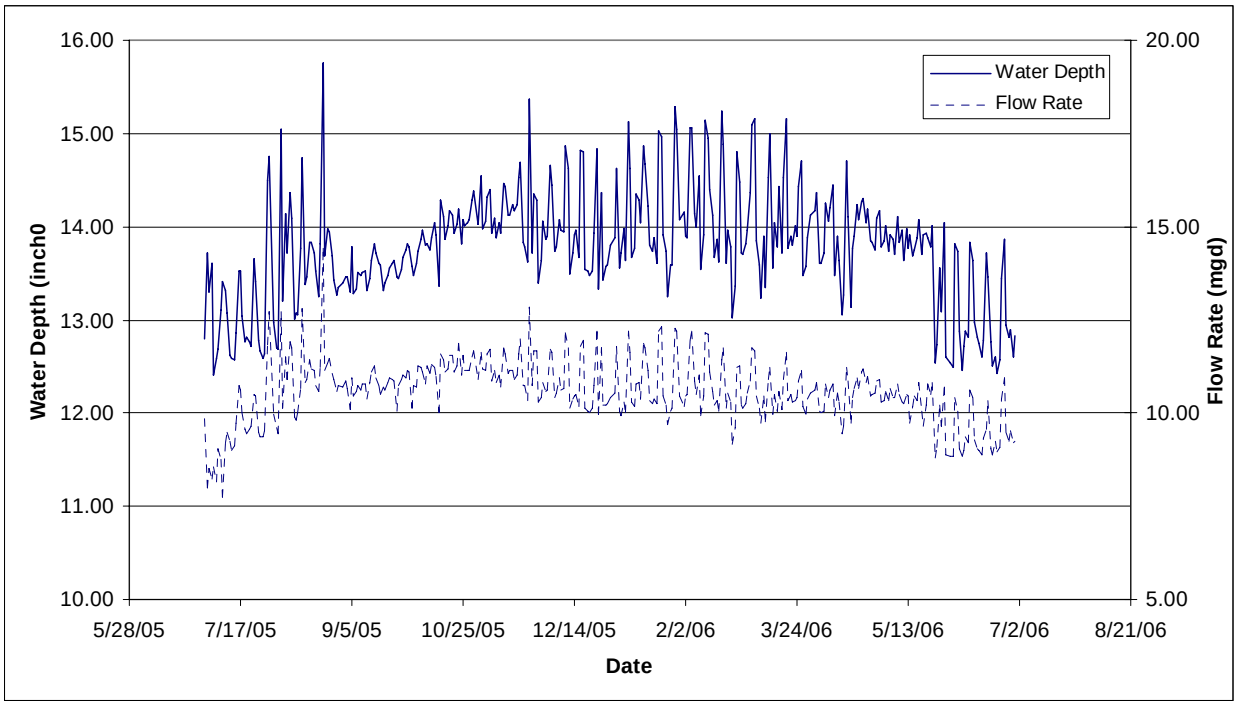


Figure PTI-1-1 Daily Peak Water Depths and Flow Rates (site: PTI-1-1).

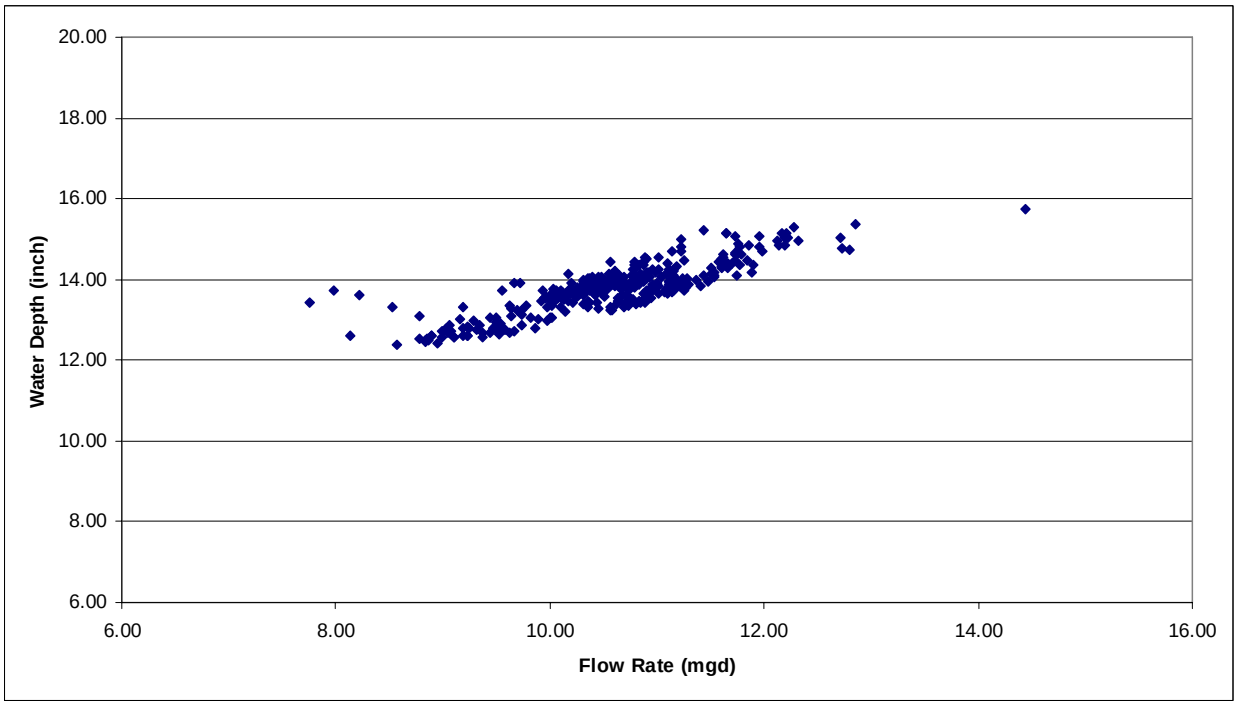


Figure PTI-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: PTI-1).

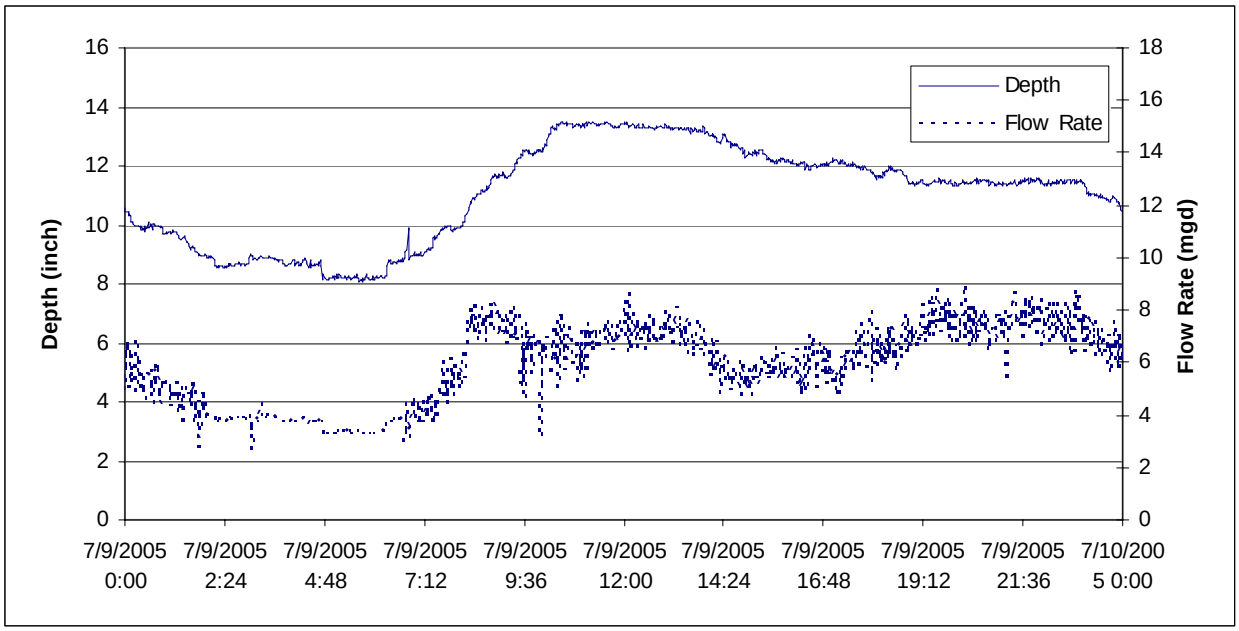


Figure PTI-1-3 One-minute Data Points with Relatively Low Flow Rate Readings (site: PTI-1)

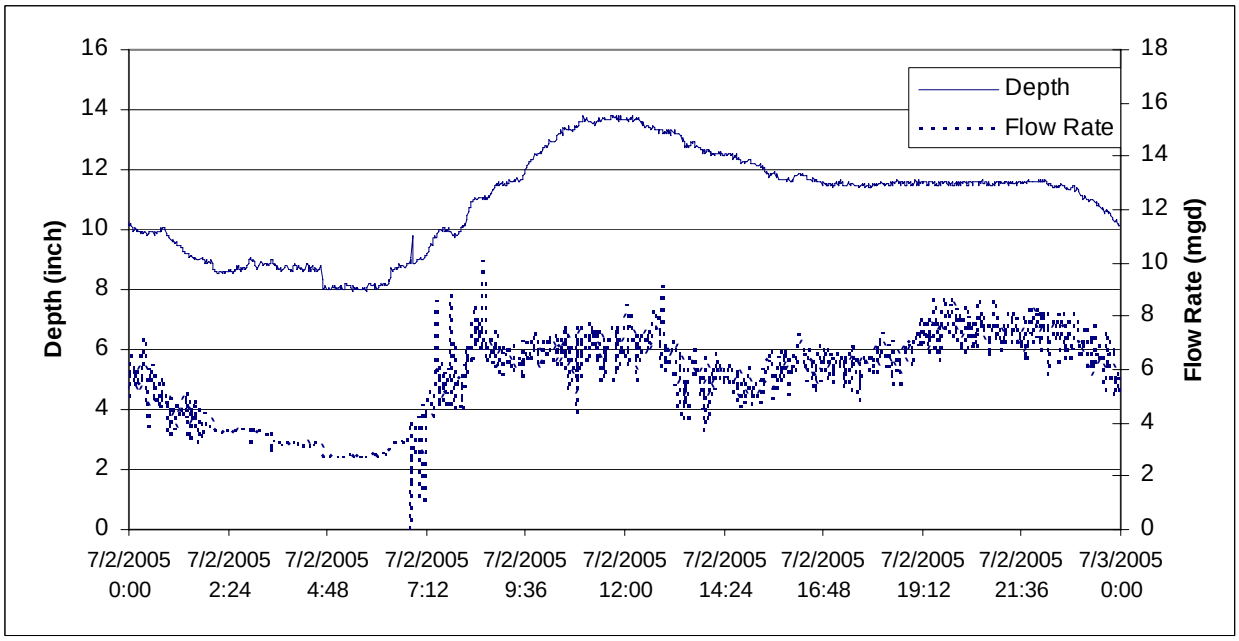


Figure PTI-1-4 One-minute Data Points with Relatively Low Flow Rate Readings (site: PTI-1).

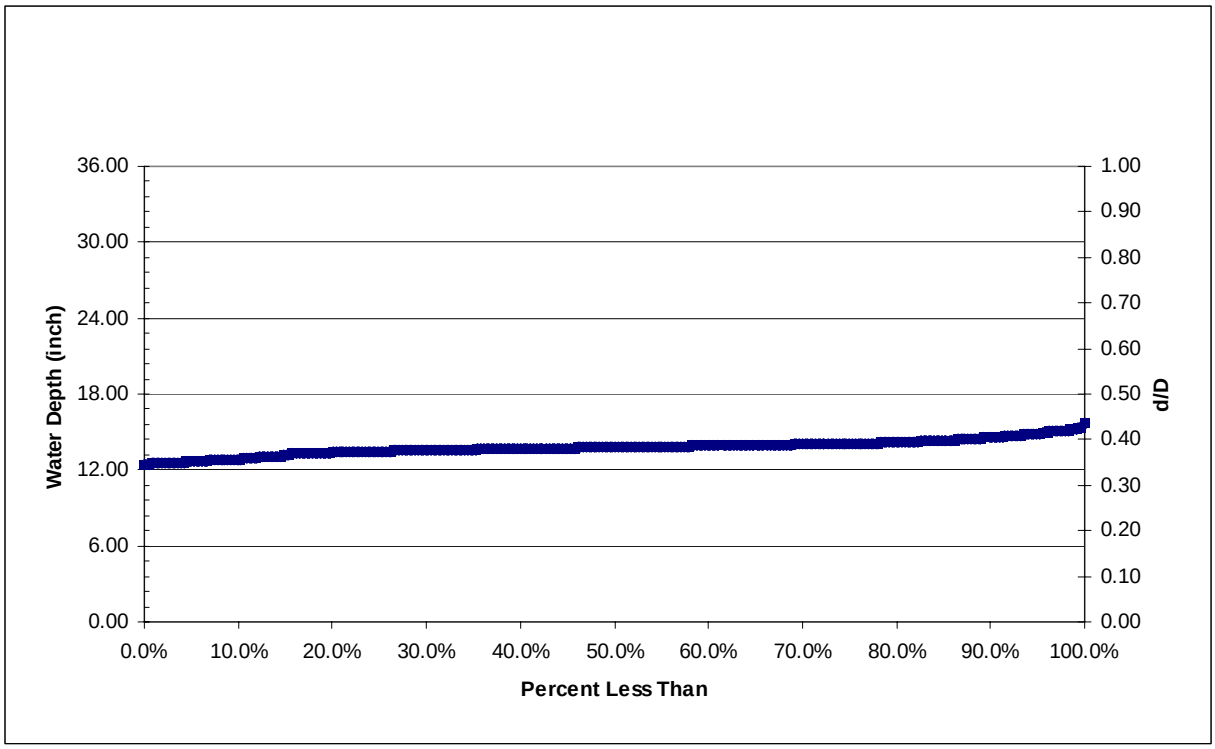


Figure PTI-1-5 Historical Percentile Values of Water Depth (site: PTI-1).

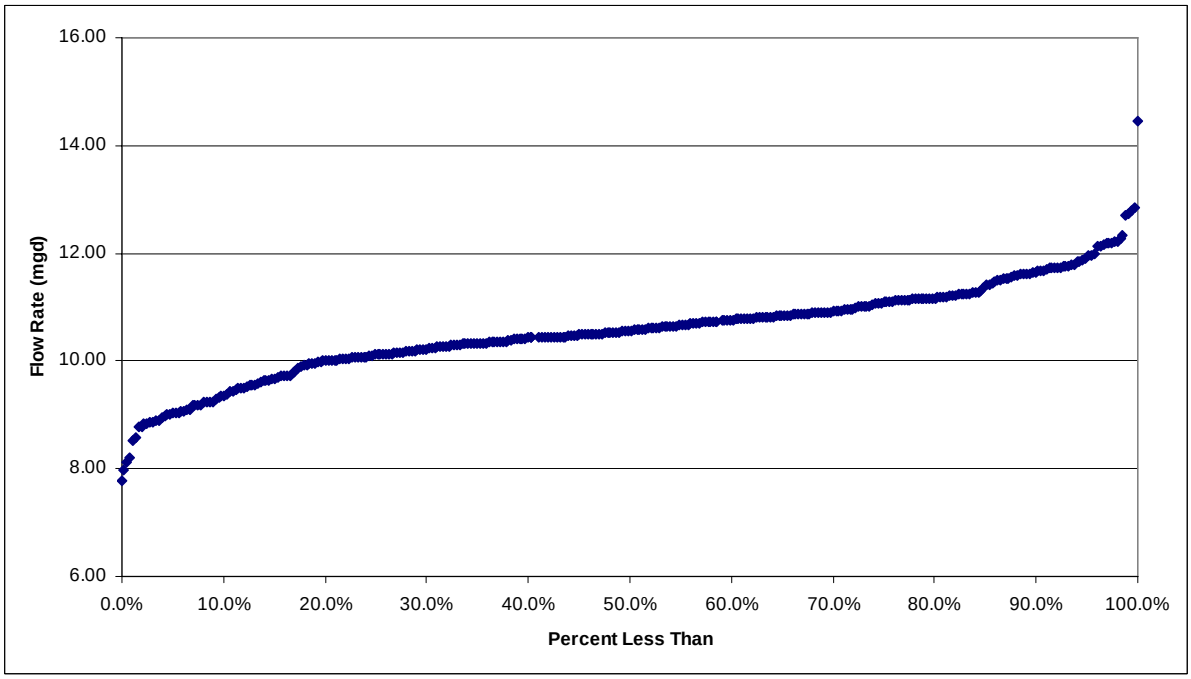


Figure PTI-1-6 Historical Percentile Values of Flow Rate (site: PTI-1).

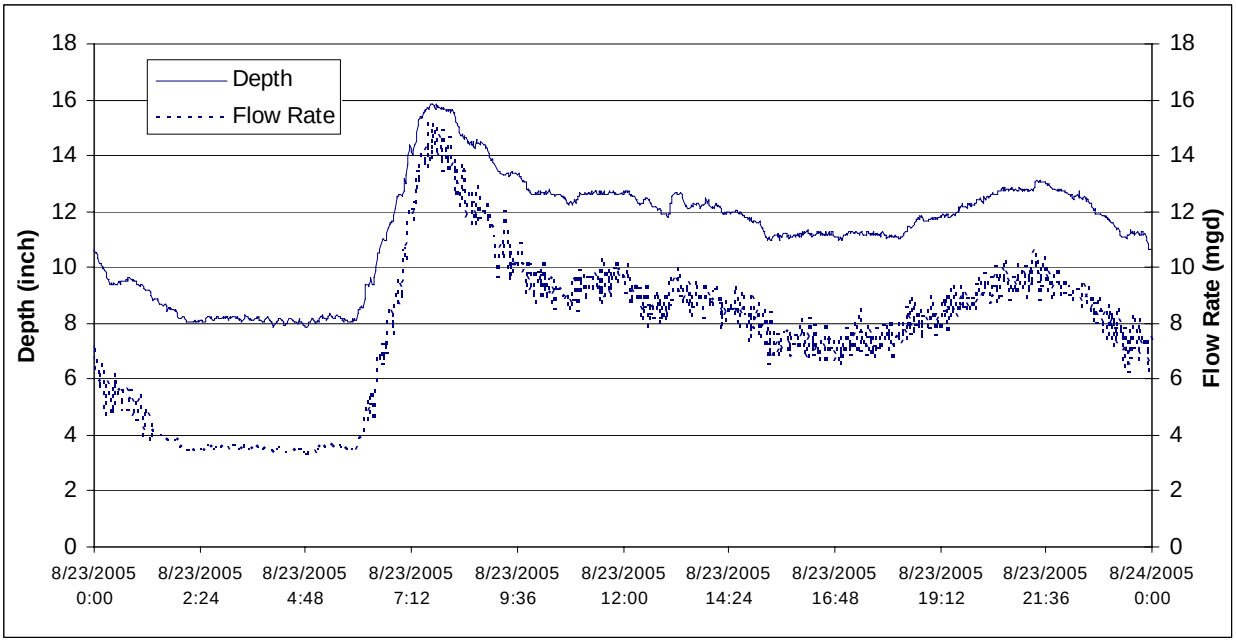


Figure PTI-1-7 One-minute Data Points with the Maximum Water Depth and Flow Rate (site: PTI-1).

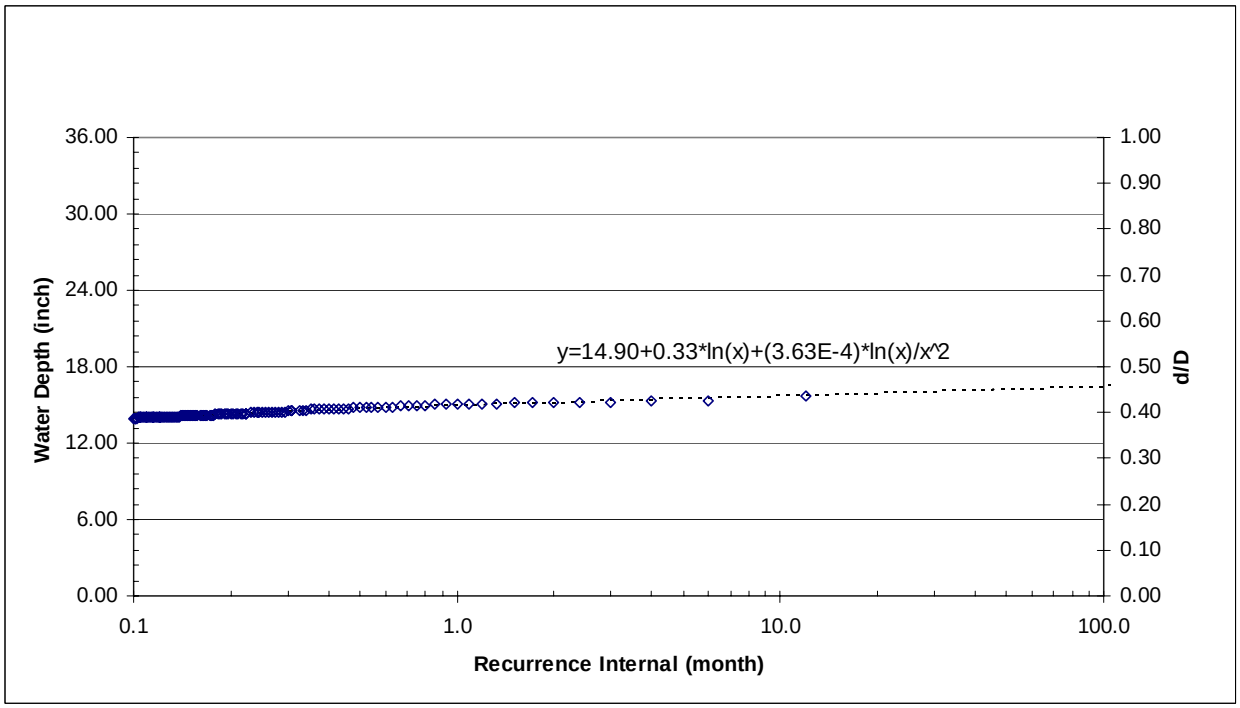


Figure PTI-1-8 Water Depths at Different Recurrence Intervals (site: PTI-1).

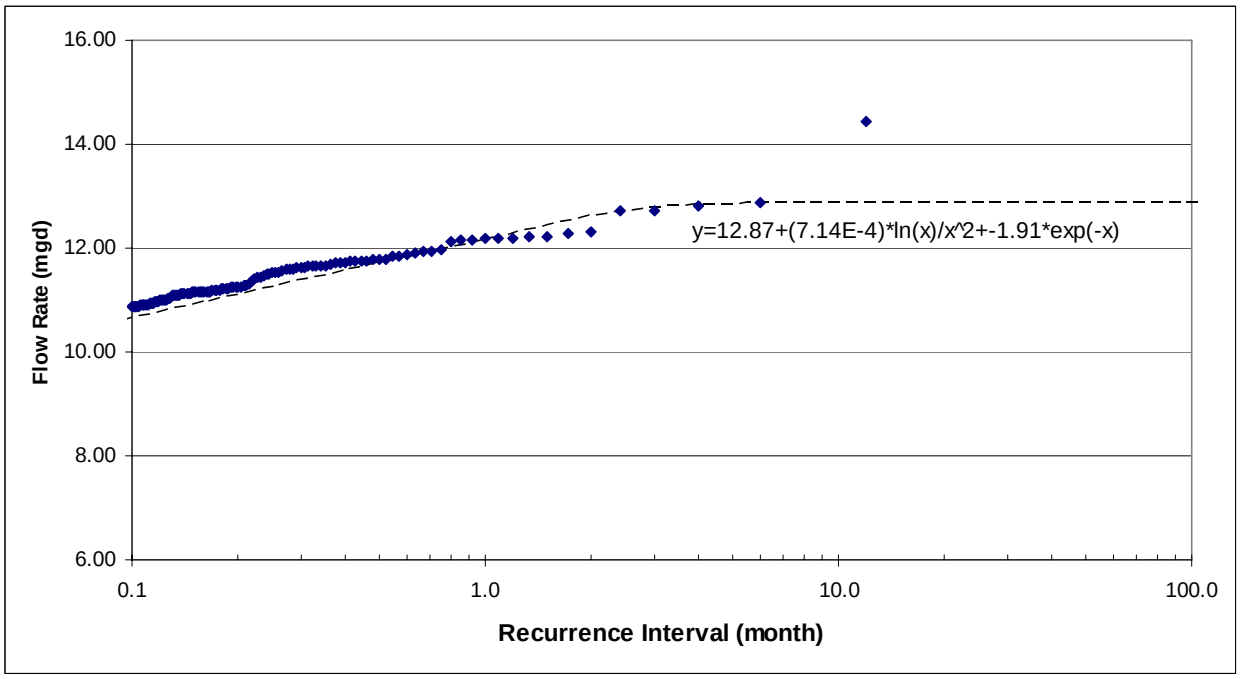


Figure PTI-1-9 Flow Rates at Different Recurrence Intervals (site: PTI-1).

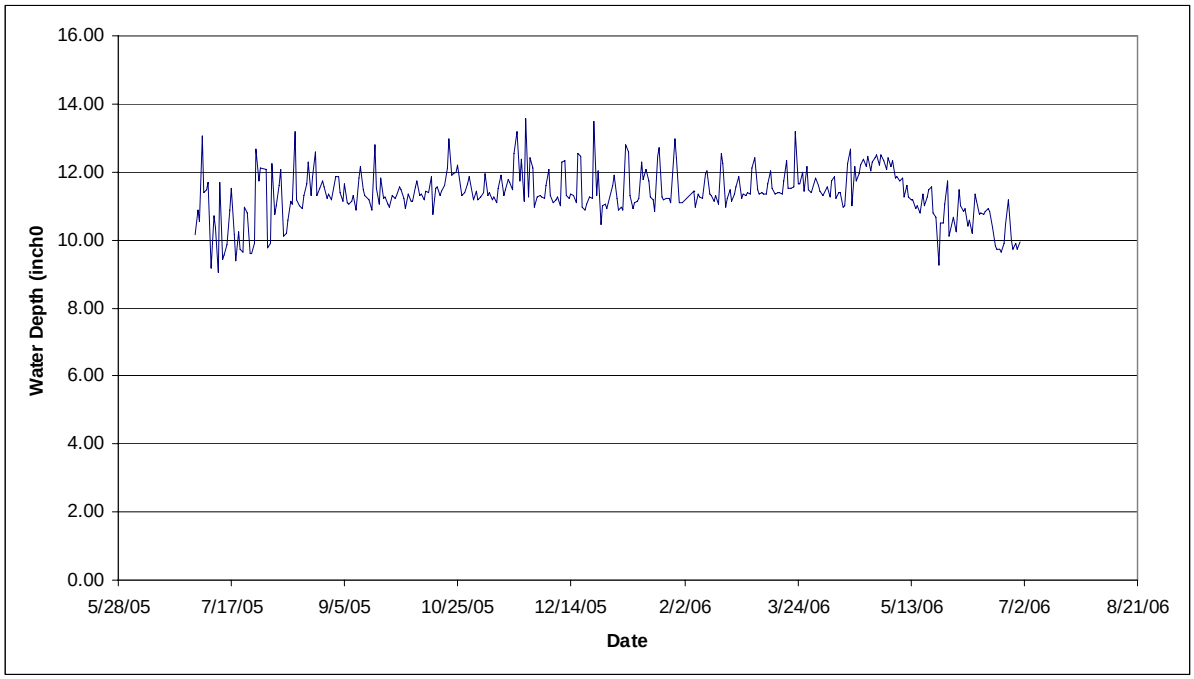


Figure PTI-2-1 Daily Peak Water Depths (site: PTI-2).

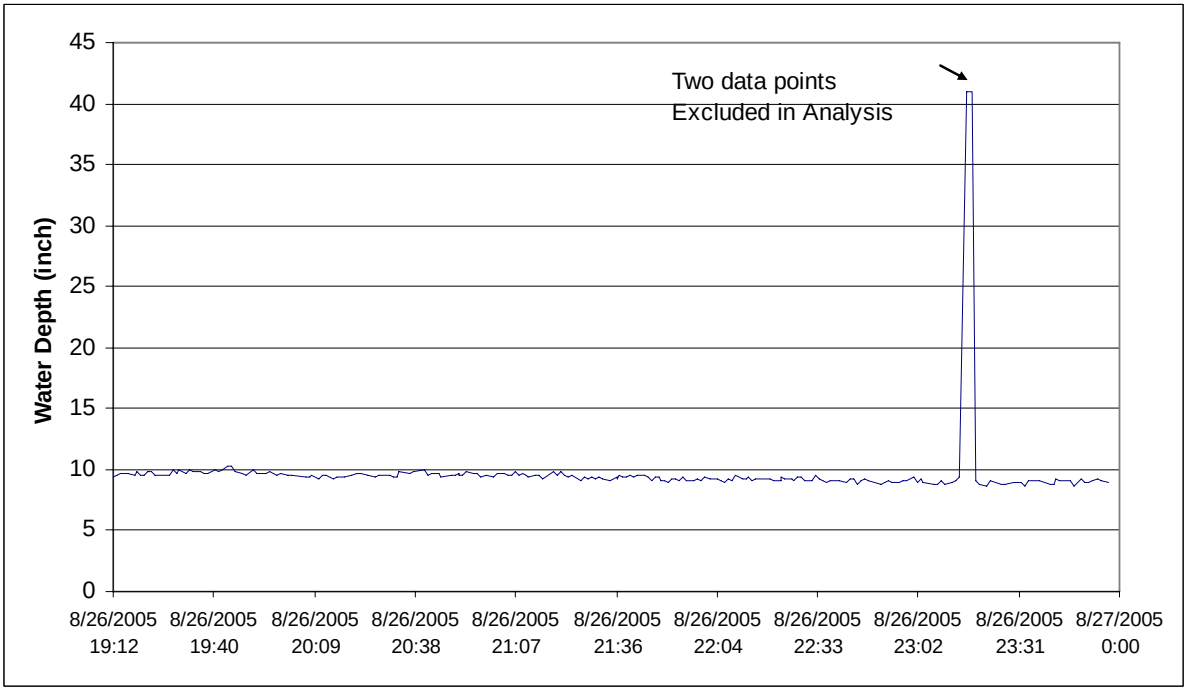


Figure PTI-2-2 Questionable Data Points Excluded from Analysis (site: PRI-2).

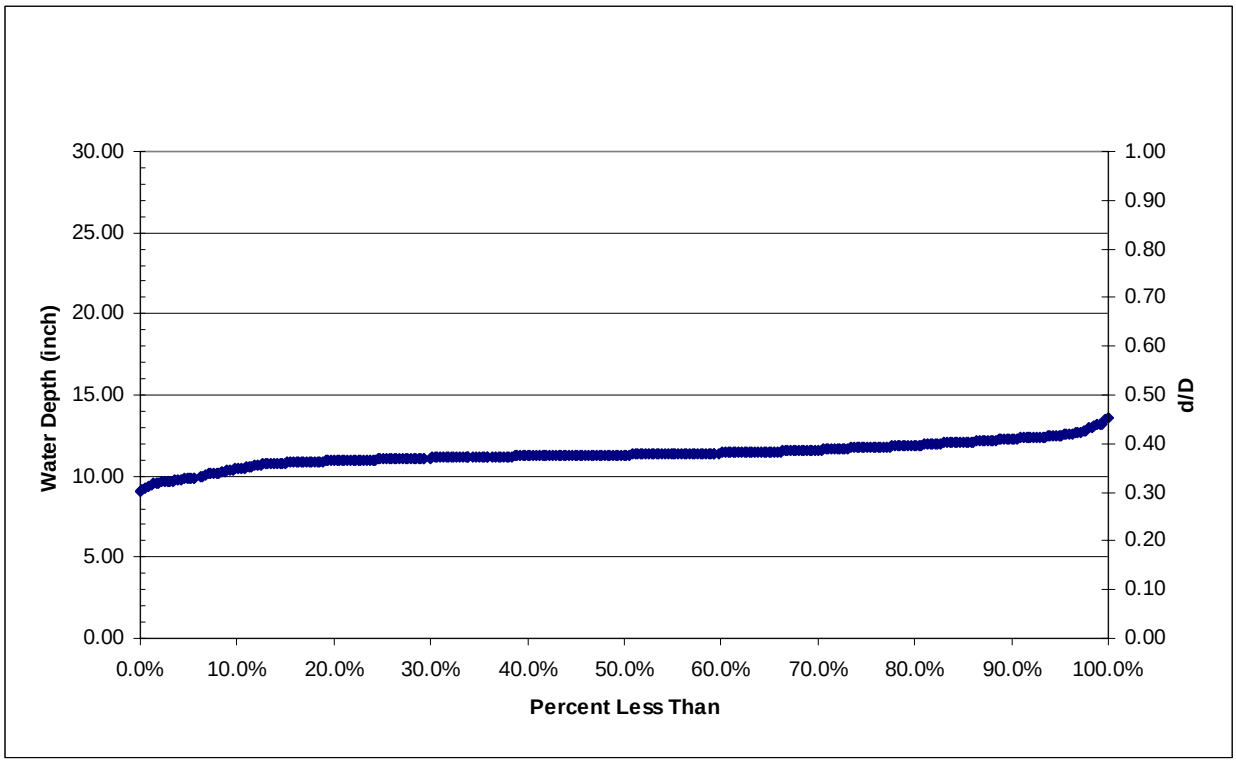


Figure PTI-2-3 Historical Percentile Values of Water Depth (site: PTI-2).

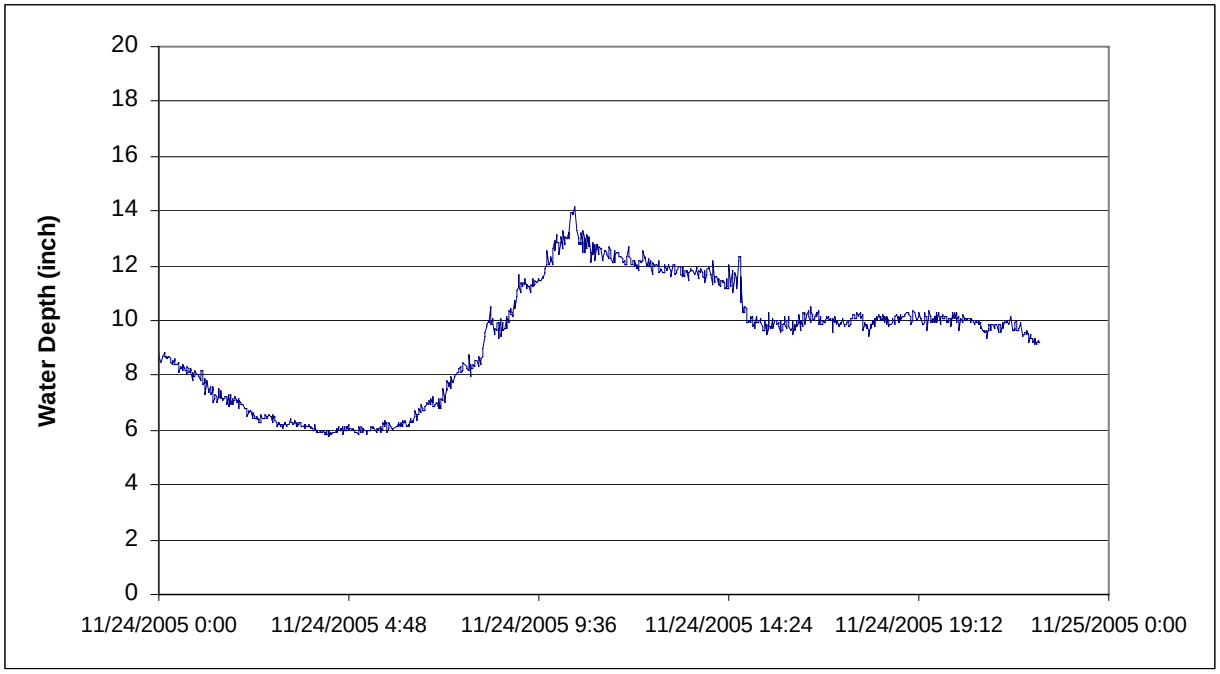


Figure PTI-2-4 One-minute Data Points with the Maximum Water Depth (site: PTI-2).

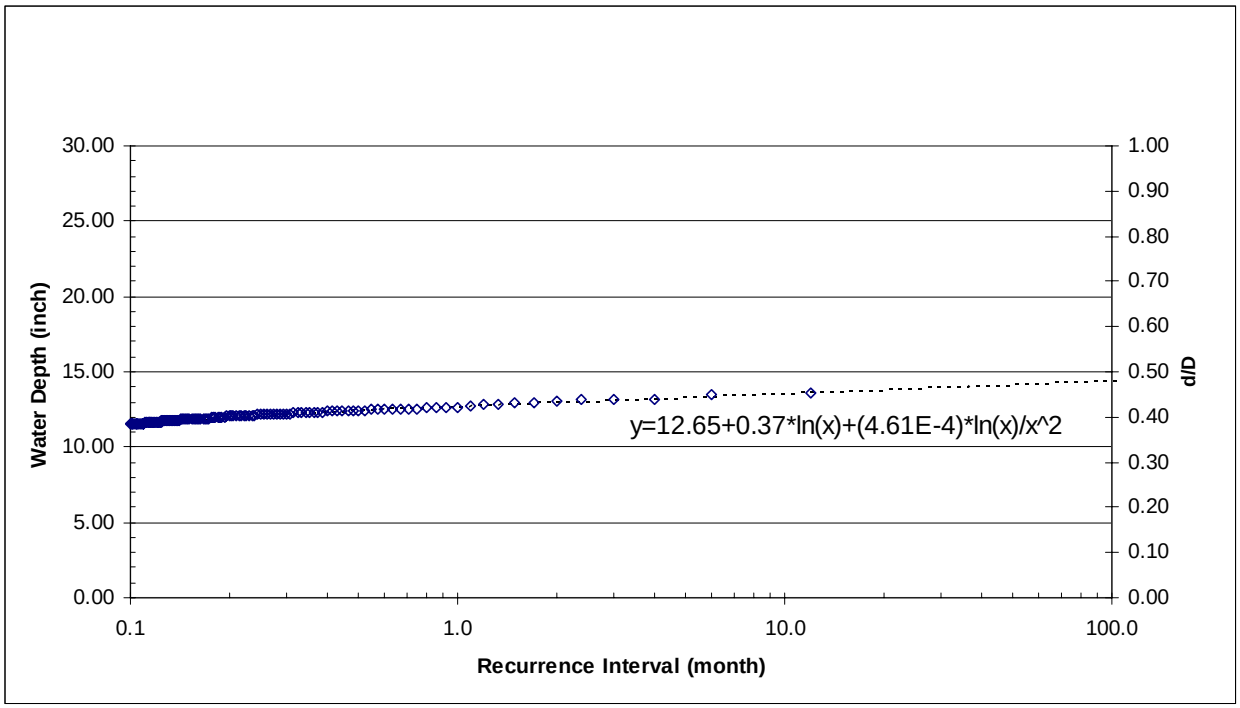


Figure PTI-2-5 Water Depths at Different Recurrence Intervals (site: PTI-2-5).

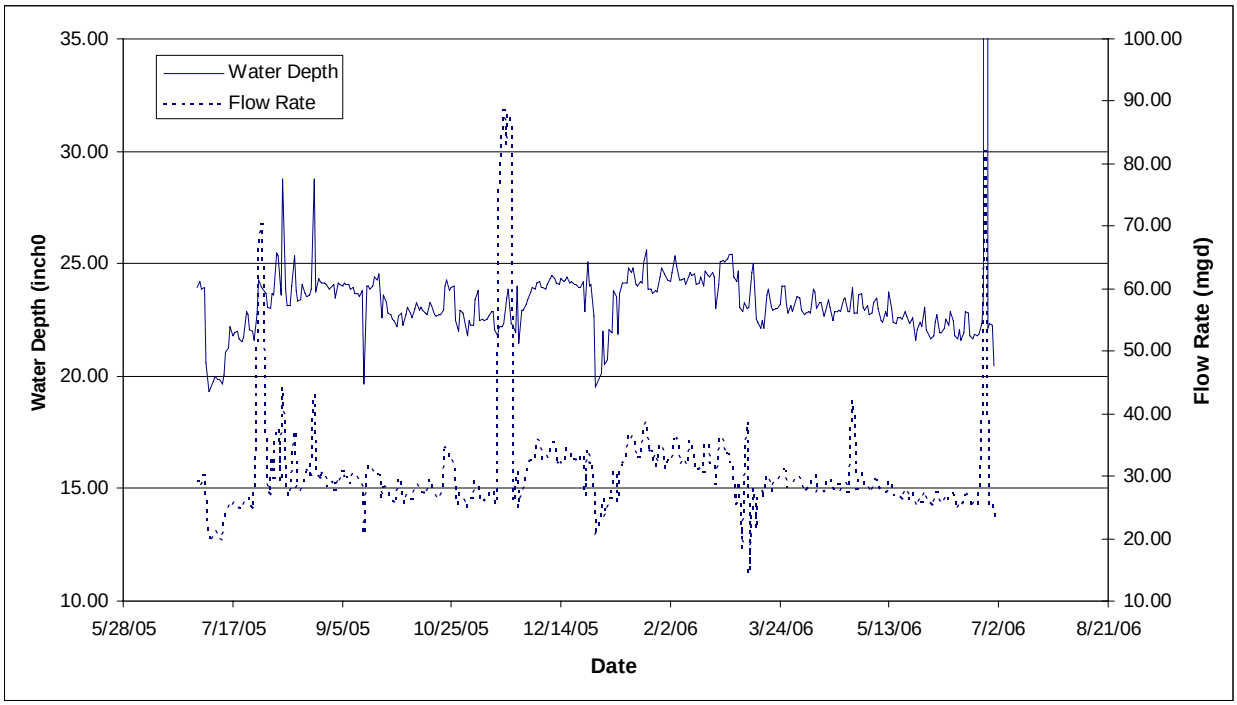


Figure SCE-1-1 Daily Peak Water Depths and Flow Rates (site: SCE-1).

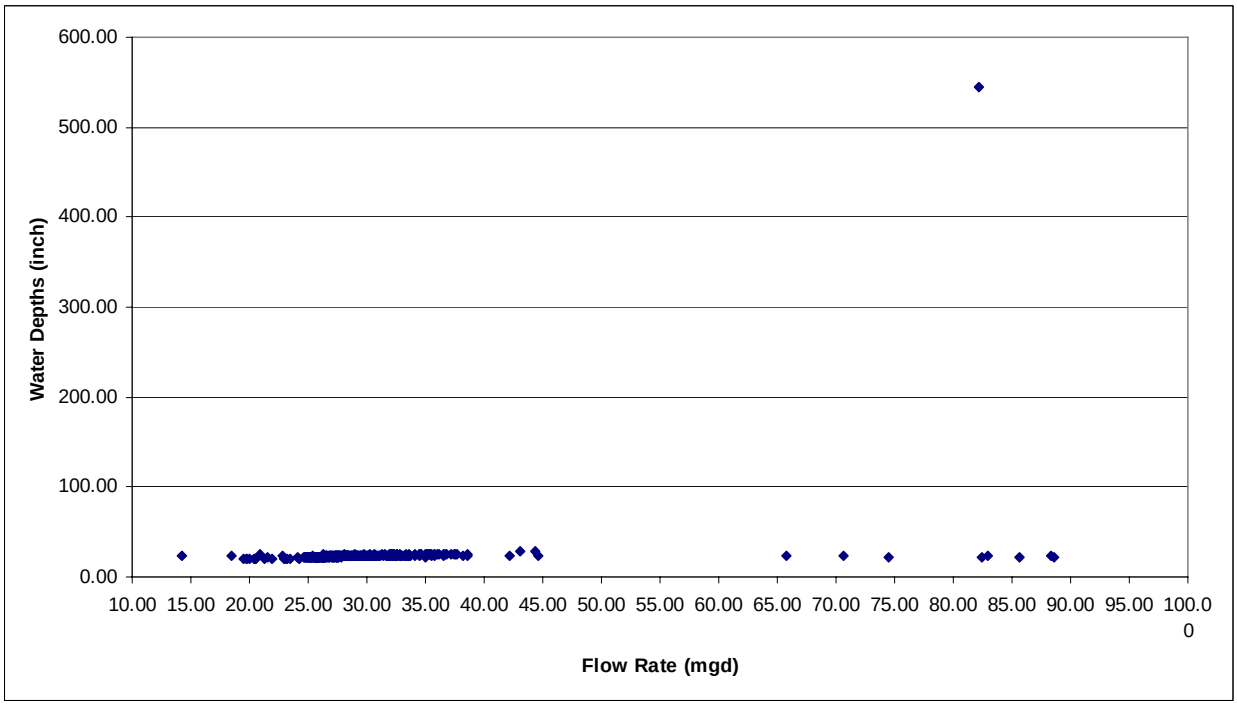


Figure SCE-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: SCE-1).

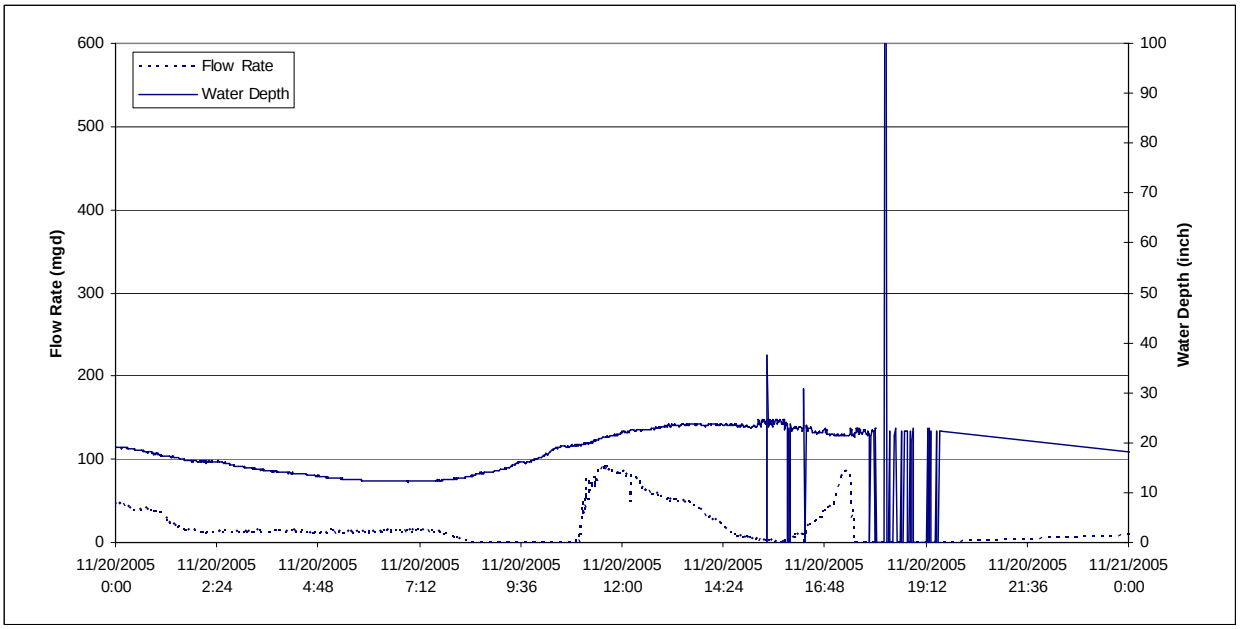


Figure SCE-1-3 Questionable 1-minute Flow Rate and Water Depth Data Points (site: SCE-1).

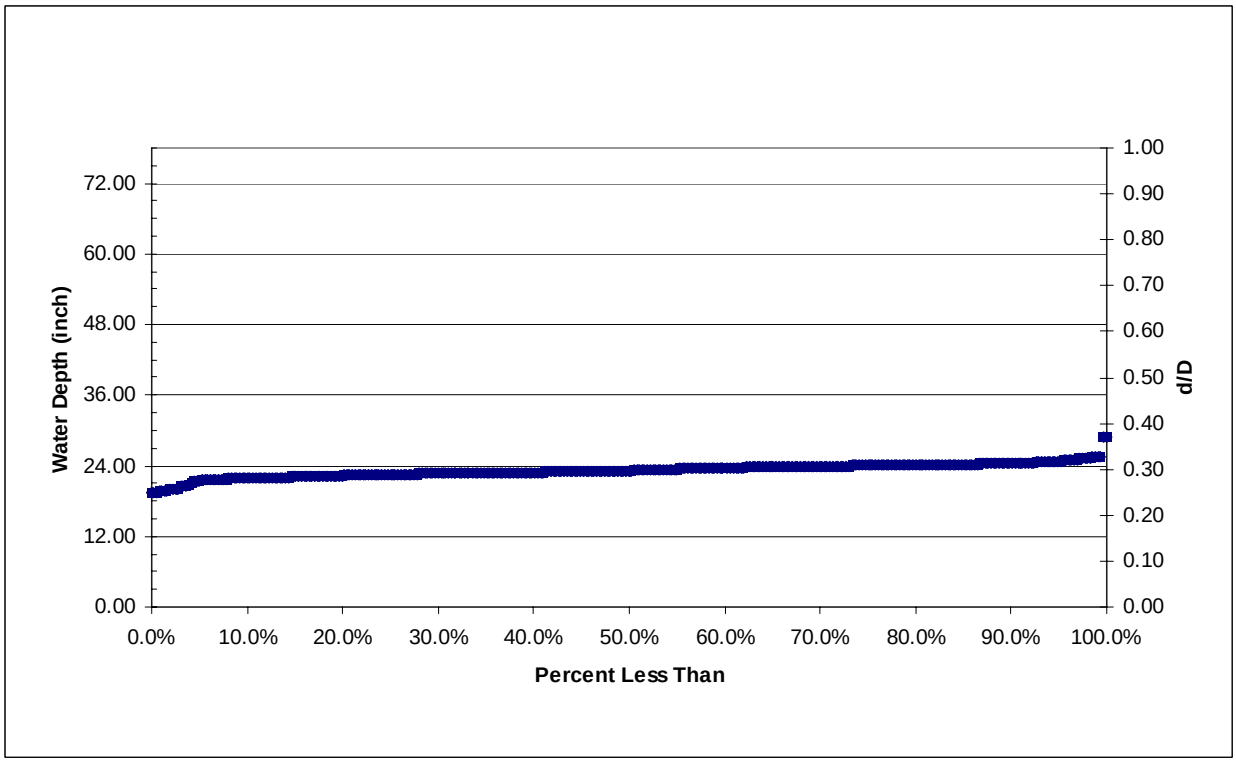


Figure SCE-1-4 Historical Percentile Values of Water Depth (site: SCE-1).

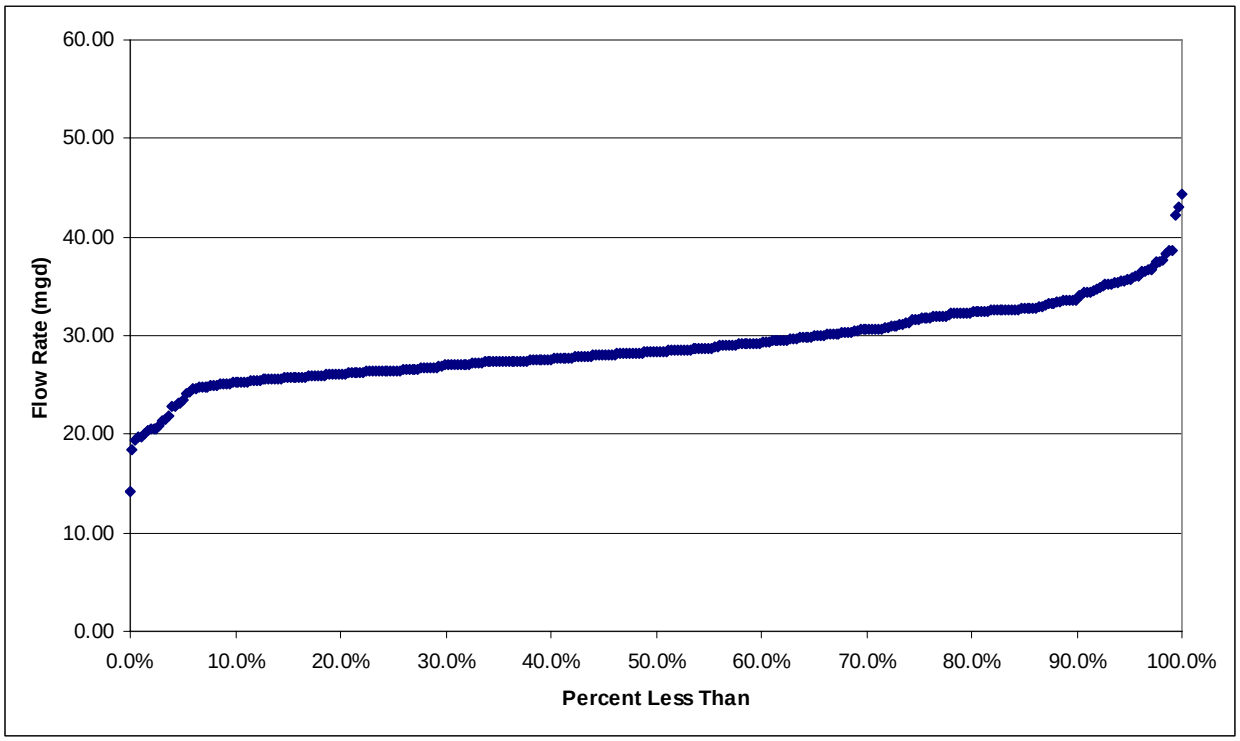


Figure SCE-1-5 Historical Percentile Values of Flow Rate (site: SCE-1).

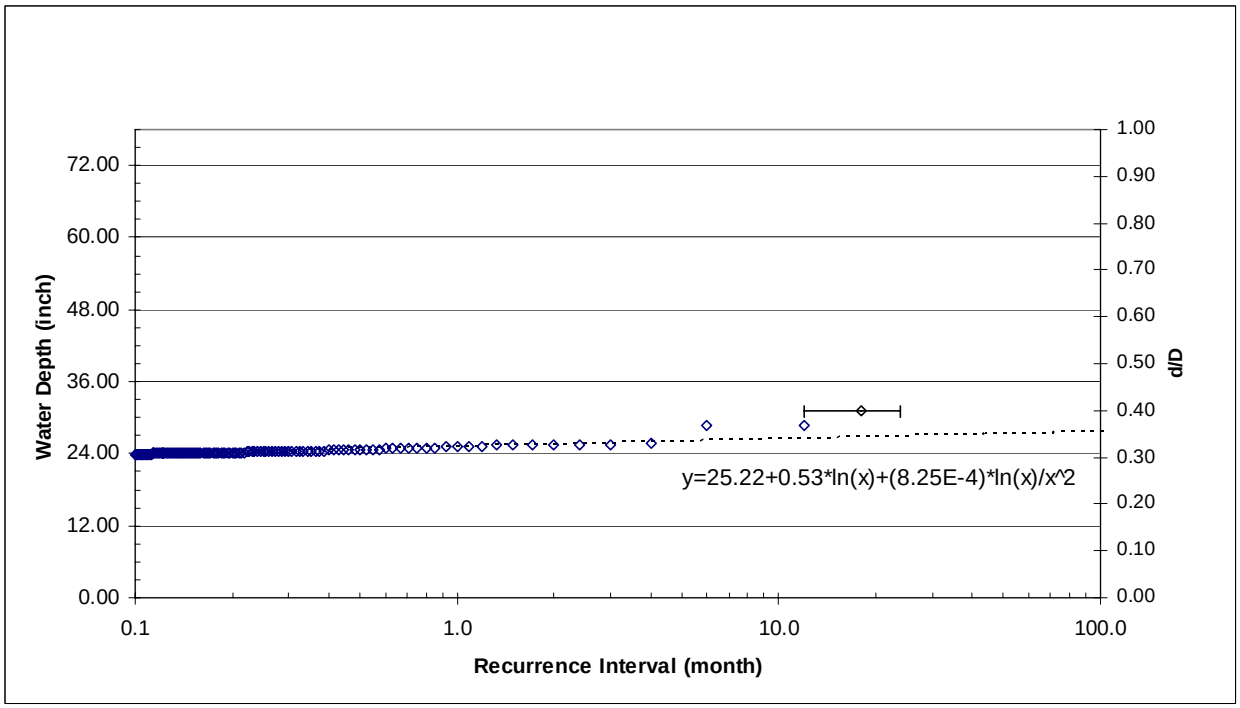


Figure SCE1-6 Water Depths at Different Recurrence Intervals (site: SCE-1).

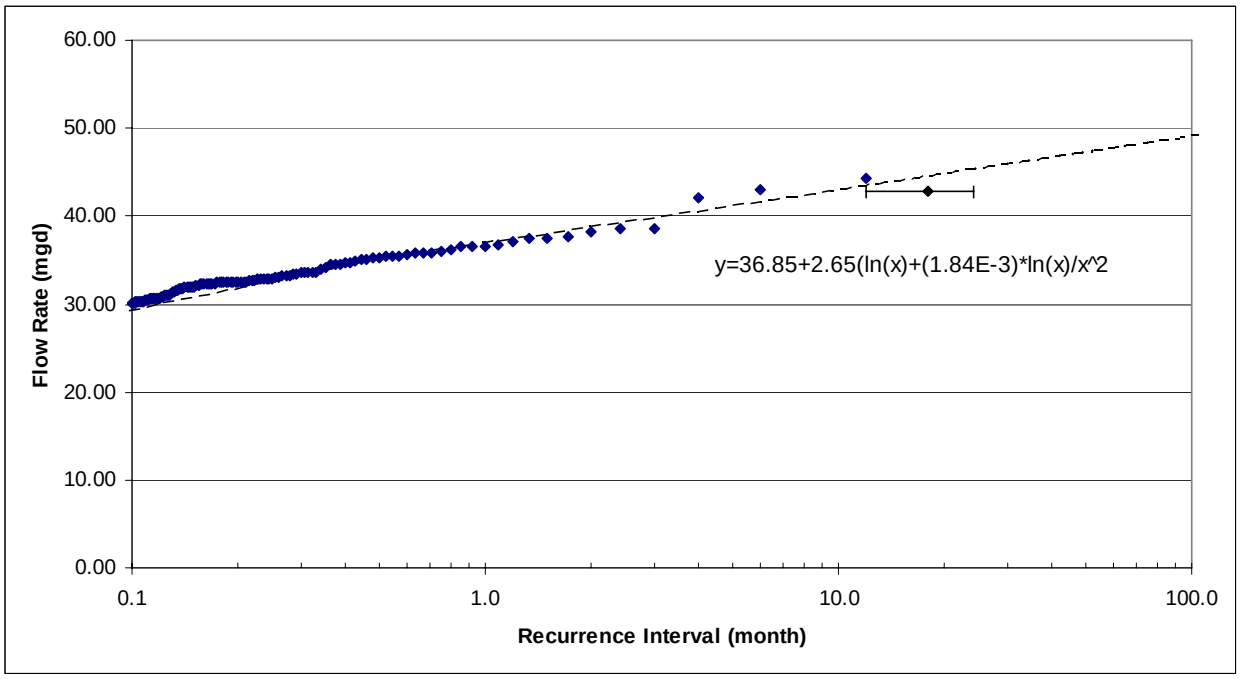


Figure SCE-1-7 Flow Rates at Different Recurrence Intervals (site: SCE-1).

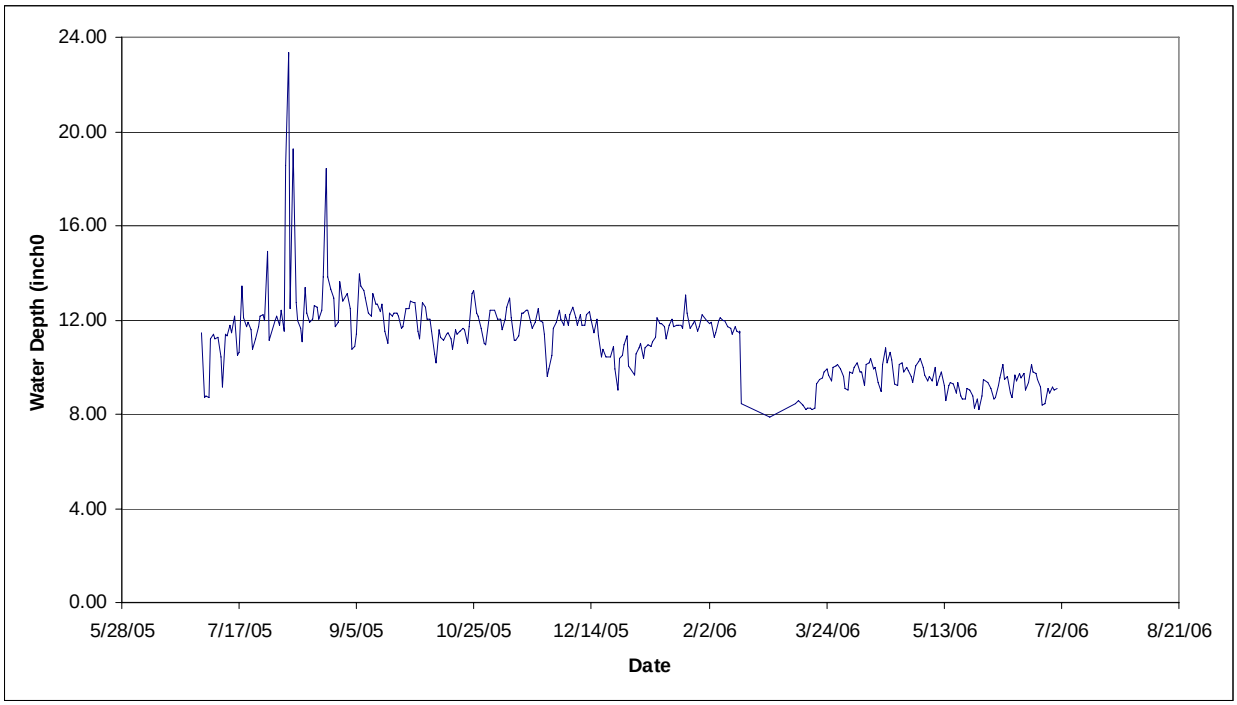


Figure SCE-2-1 Daily Peak Water Depths (site: SCE-2).

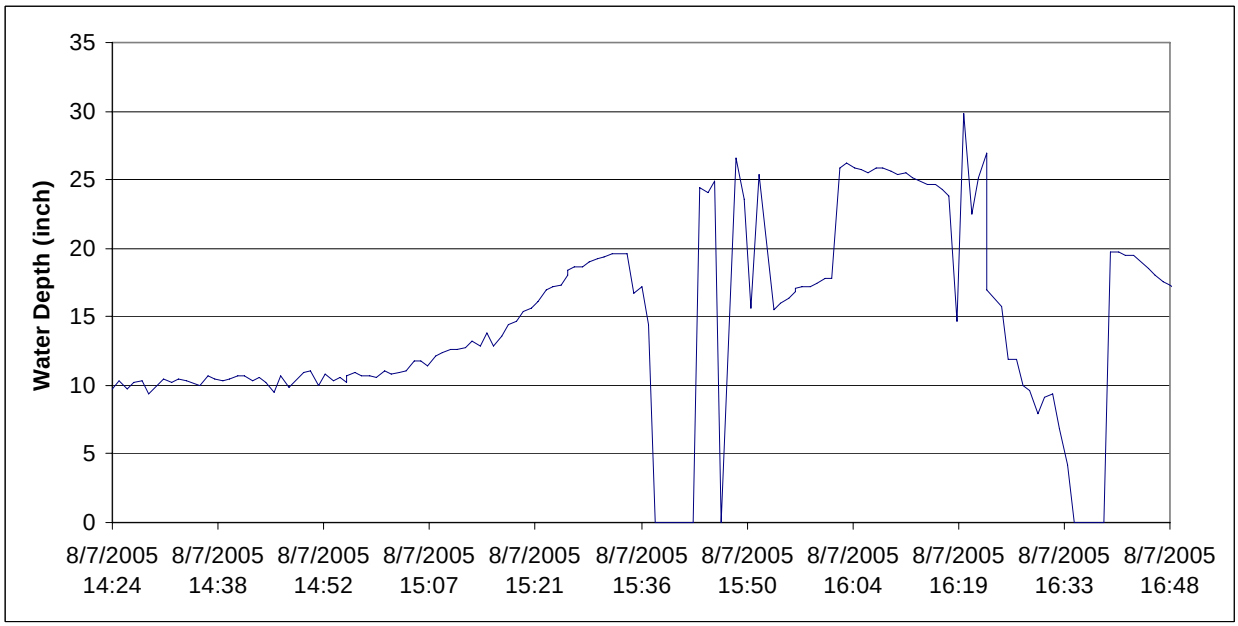


Figure SCE-2-2 Questionable 1-minute Data Points (site: SCE-2).

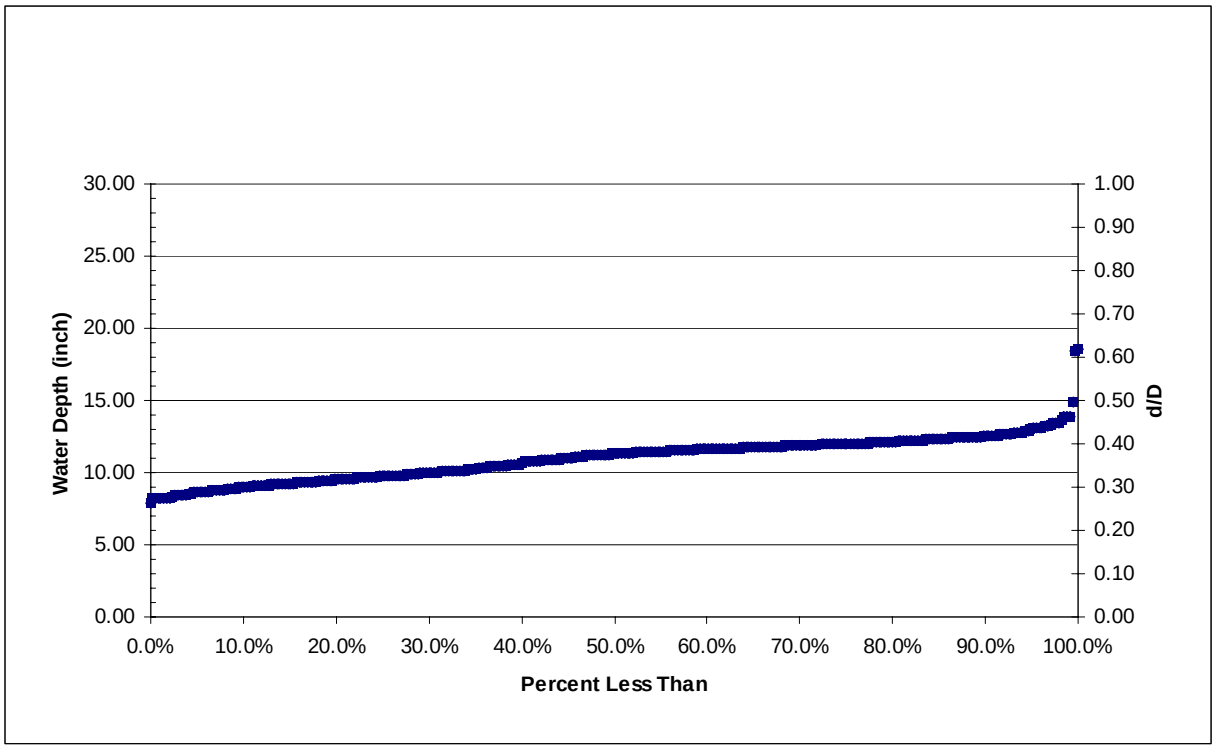


Figure SCE-2-3 Historical Percentile Values of Water Depth (site: SCE-2).

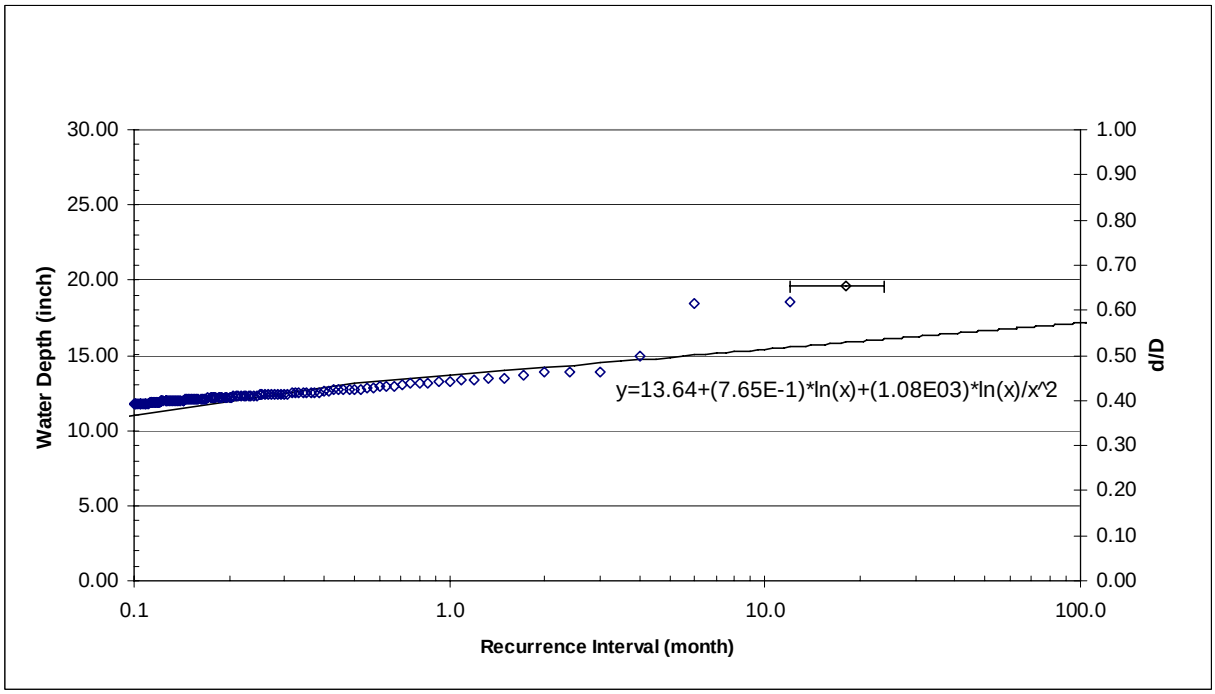


Figure SCE-2-4 Water Depths at Different Recurrence Intervals (site: SCE-2).

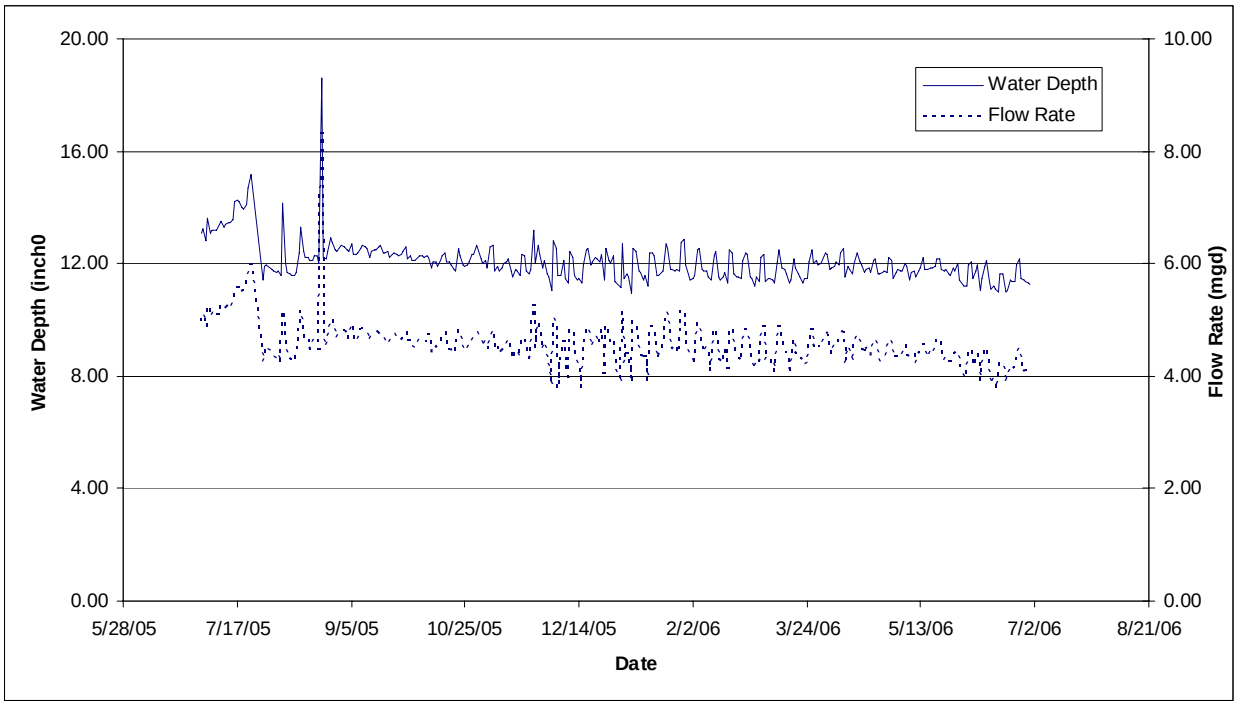


Figure SCI-1-1 Daily Peak Water Depths and Flow Rates (site: SCI-1).

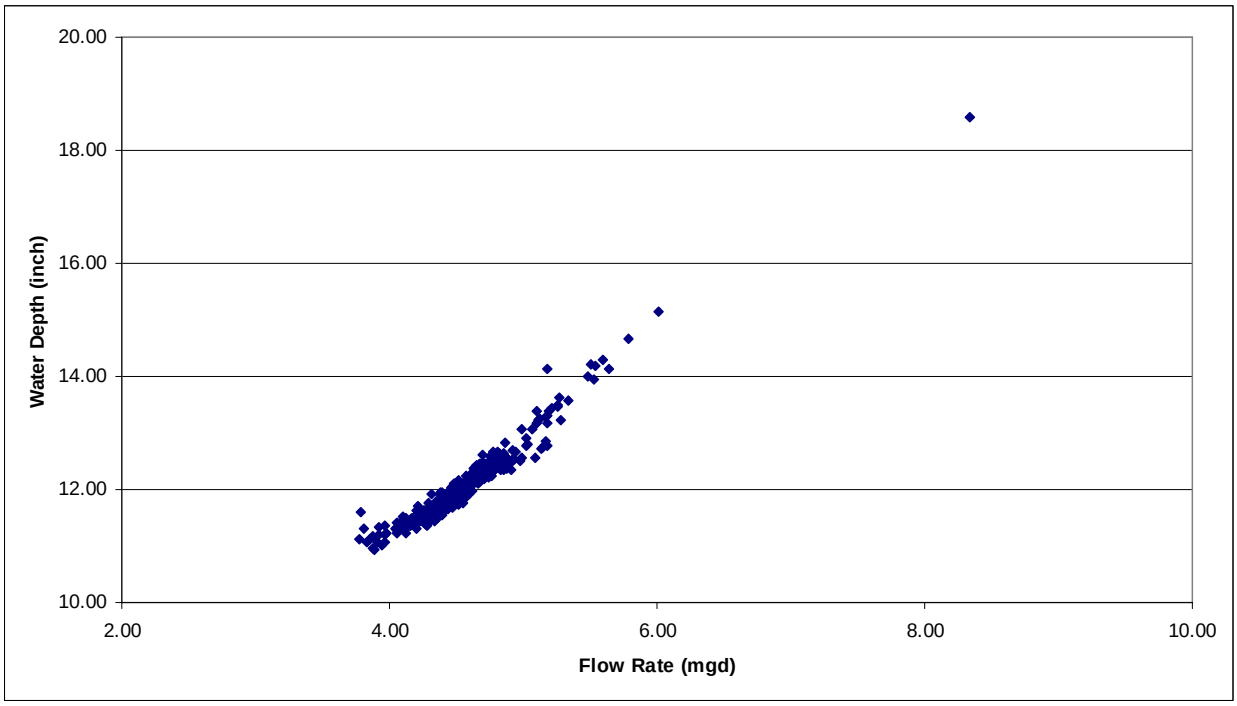


Figure SCI-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: SCI-1).

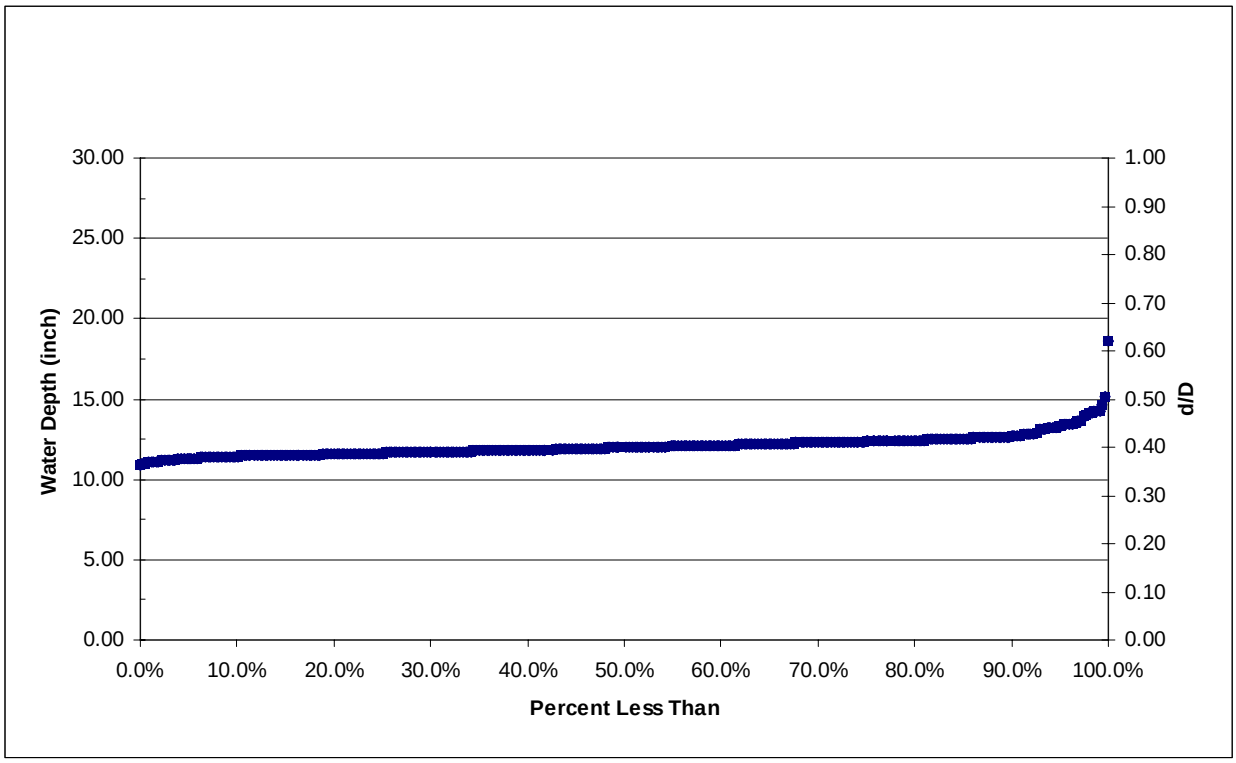


Figure SCI-1-3 Historical Percentile Values of Water Depth (site: SCI-1).

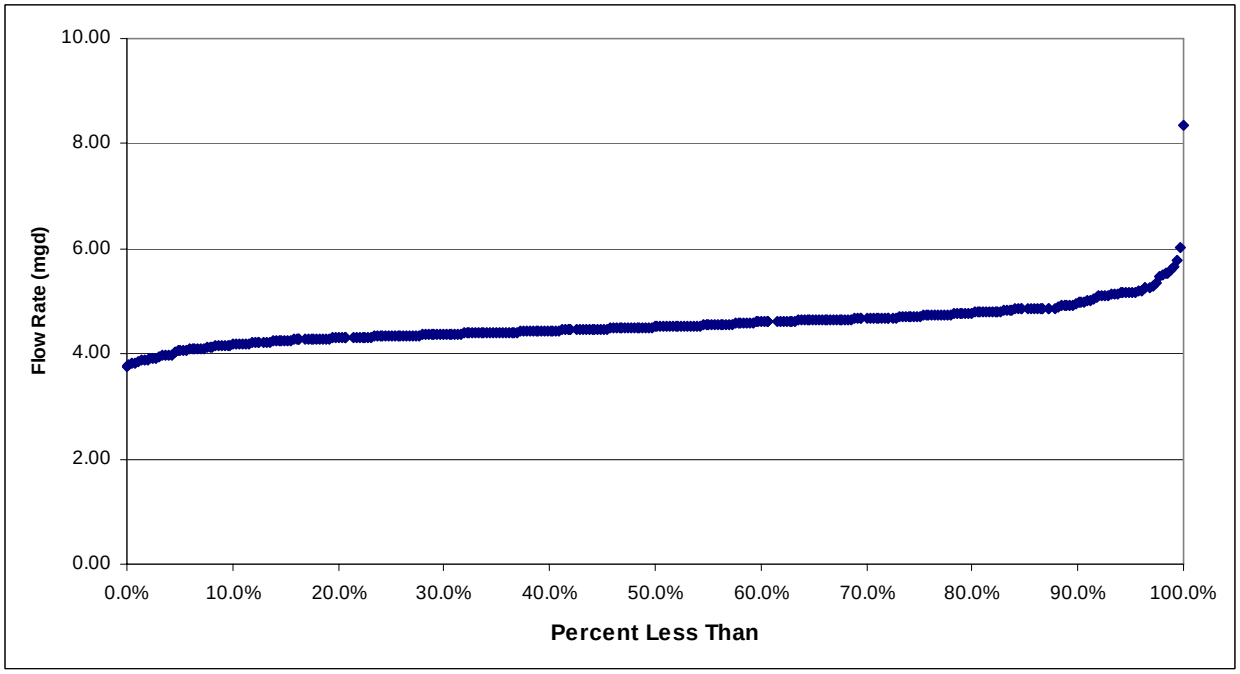


Figure SCI-1-4 Historical Percentile Values of Flow Rate (site: SCI-1).

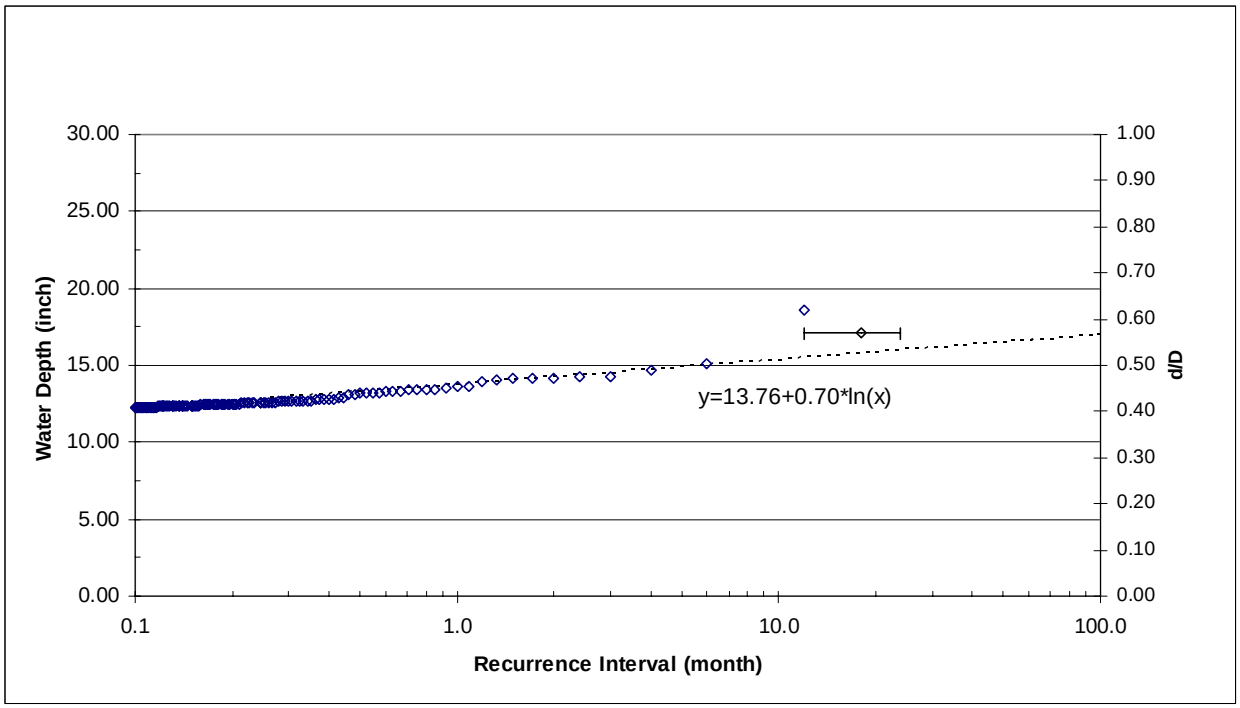


Figure SCI-1-5 Water Depths at Different Recurrence Intervals (site: SCI-1).

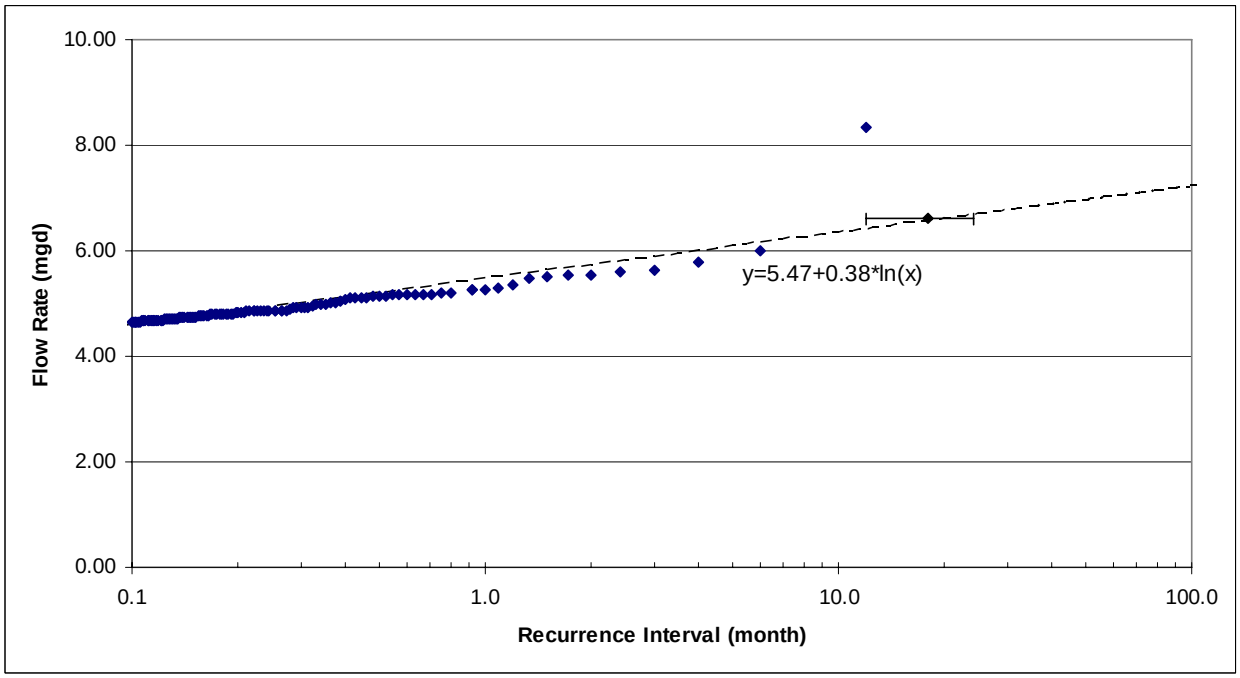


Figure SCI-1-6 Flow Rates at Different Recurrence Intervals (site: SCI-1).

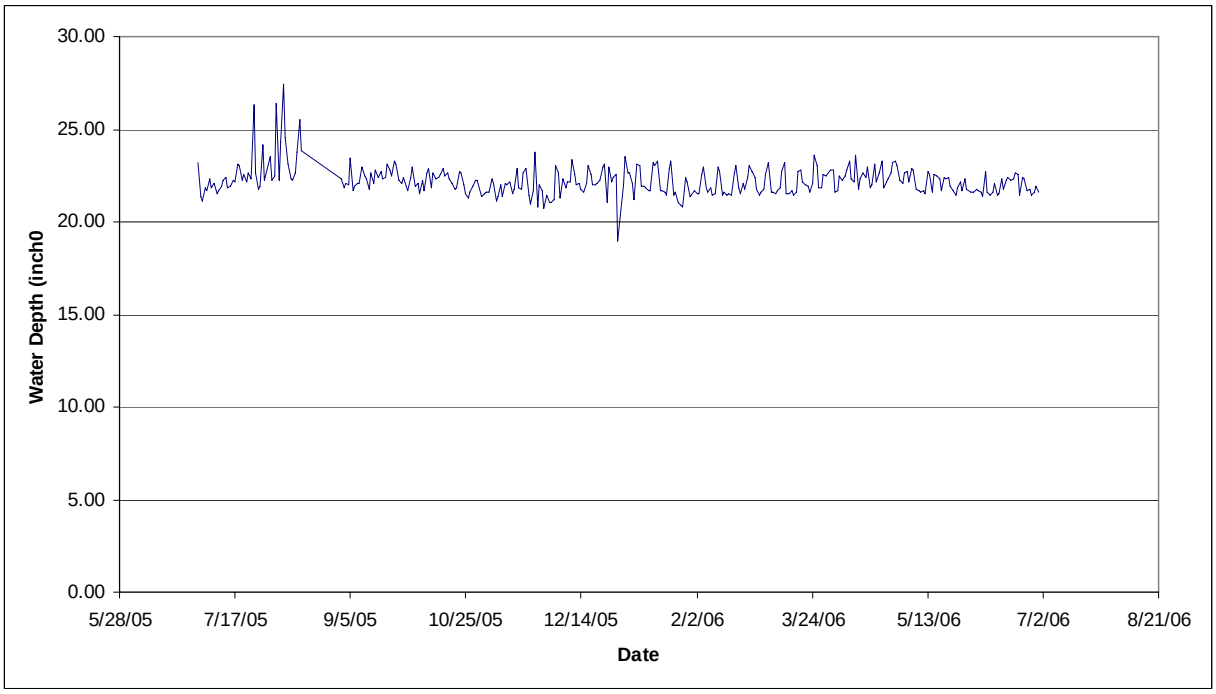


Figure SEI-1-1 Daily Peak Water Depths (site: SEI-1).

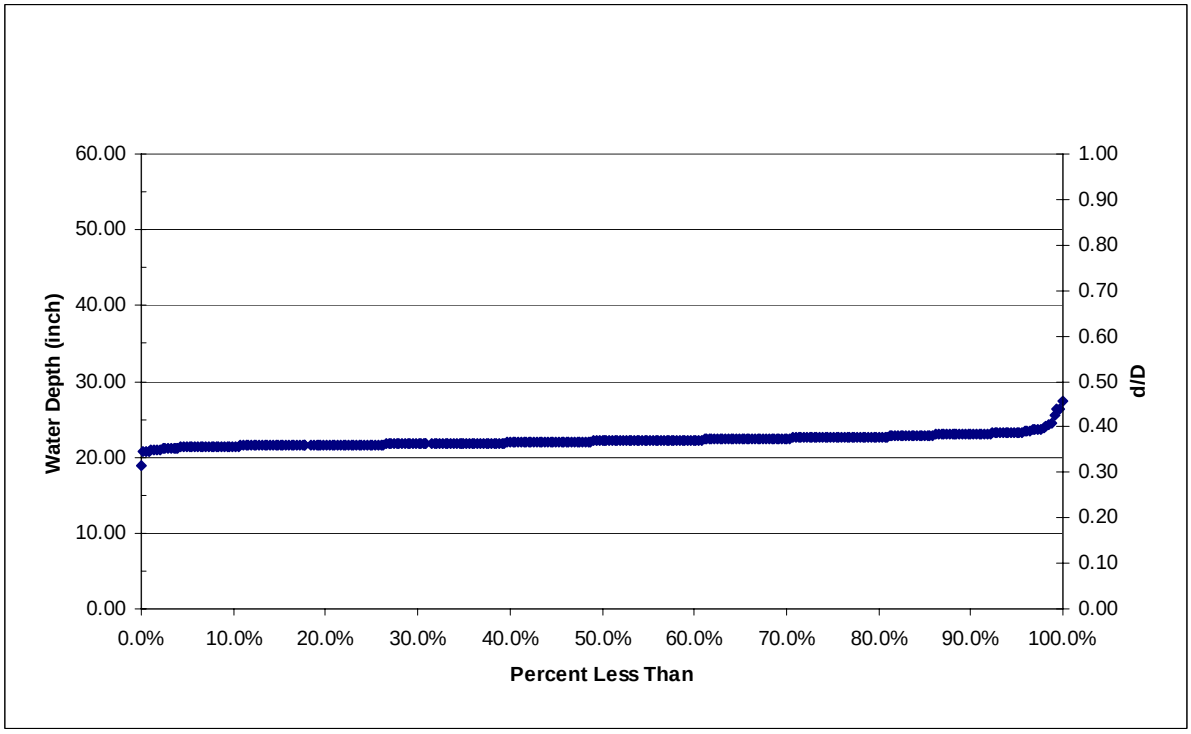


Figure SEI-1-2 Historical Percentile Values of Water Depth (SEI-1).

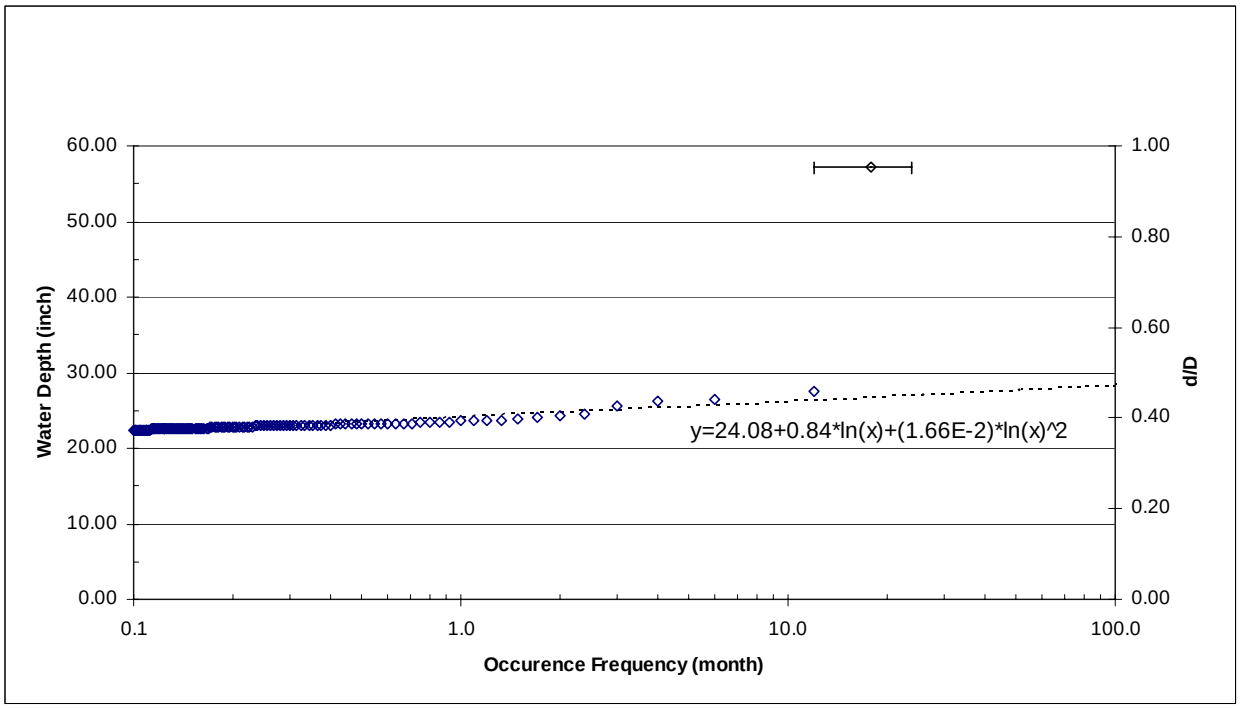


Figure SEI-1-3 Water Depths at Different Recurrence Intervals (site: SEI-1).

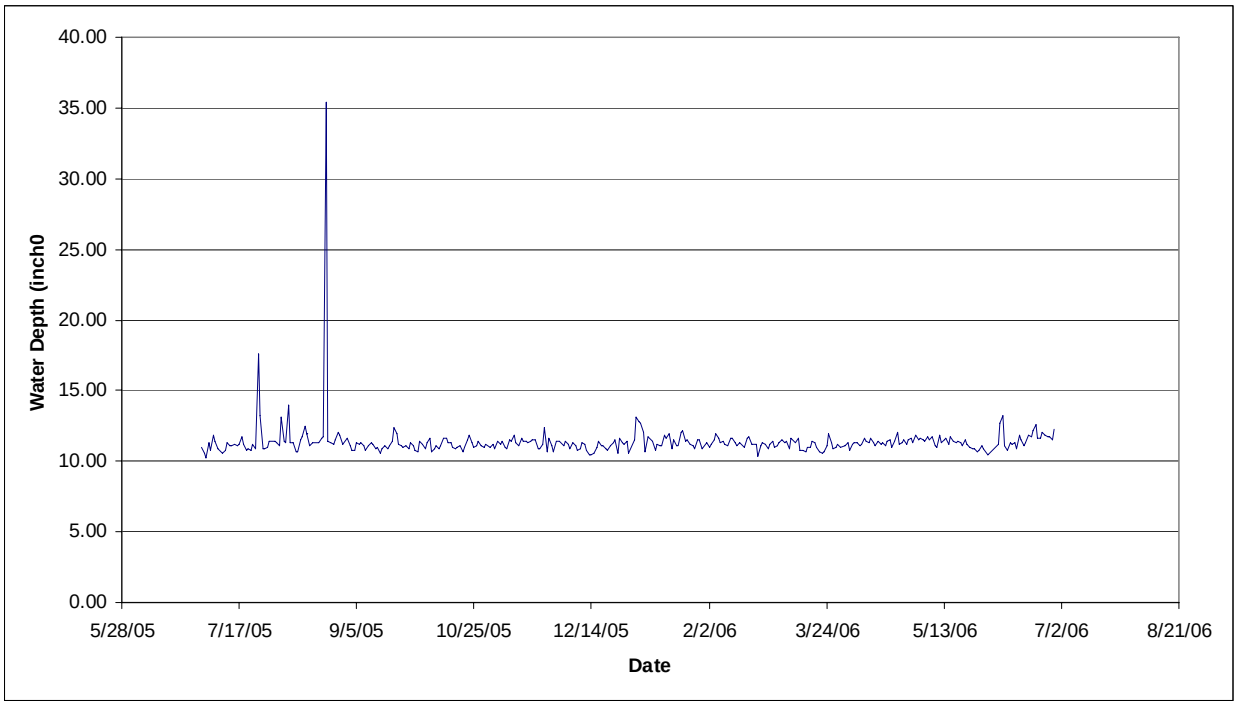


Figure SEI-2-1 Daily Water Depths (site: SEI-2).

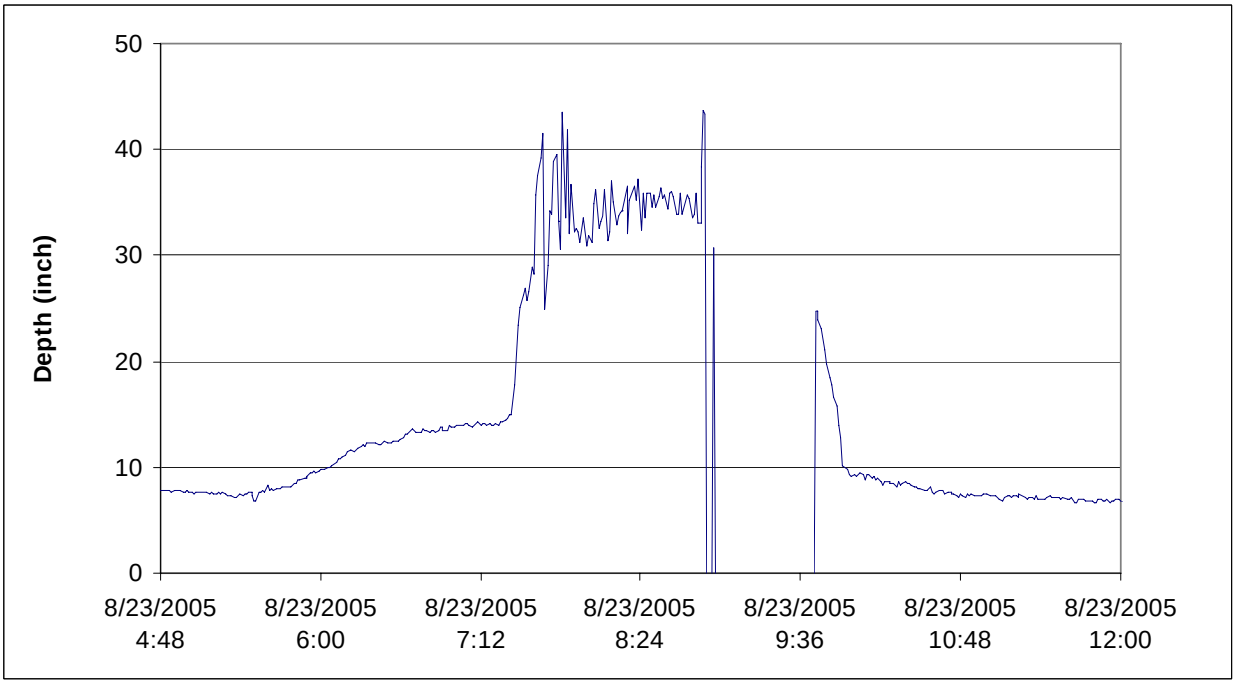


Figure SEI-2-2 One-minute Data with the Maximum Water Depth (site: SEI-2).

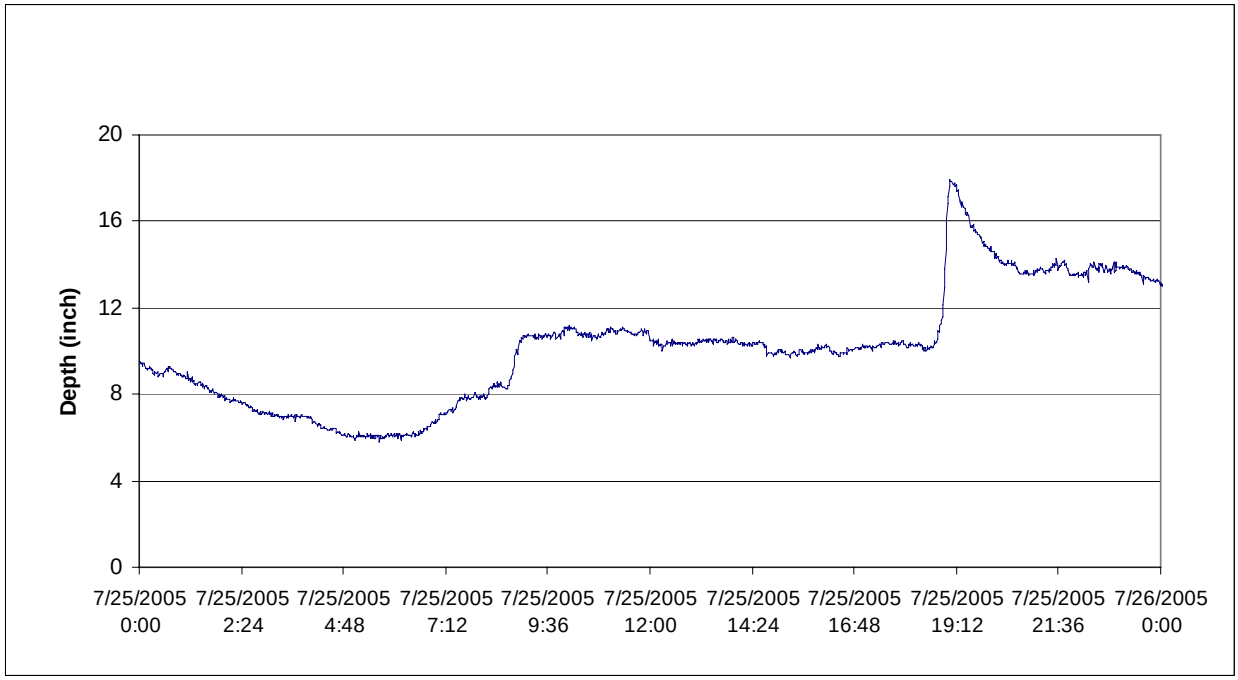


Figure SEI-2-3 One-minute Data with the Second Maximum Water Depth (site: SEI-2).

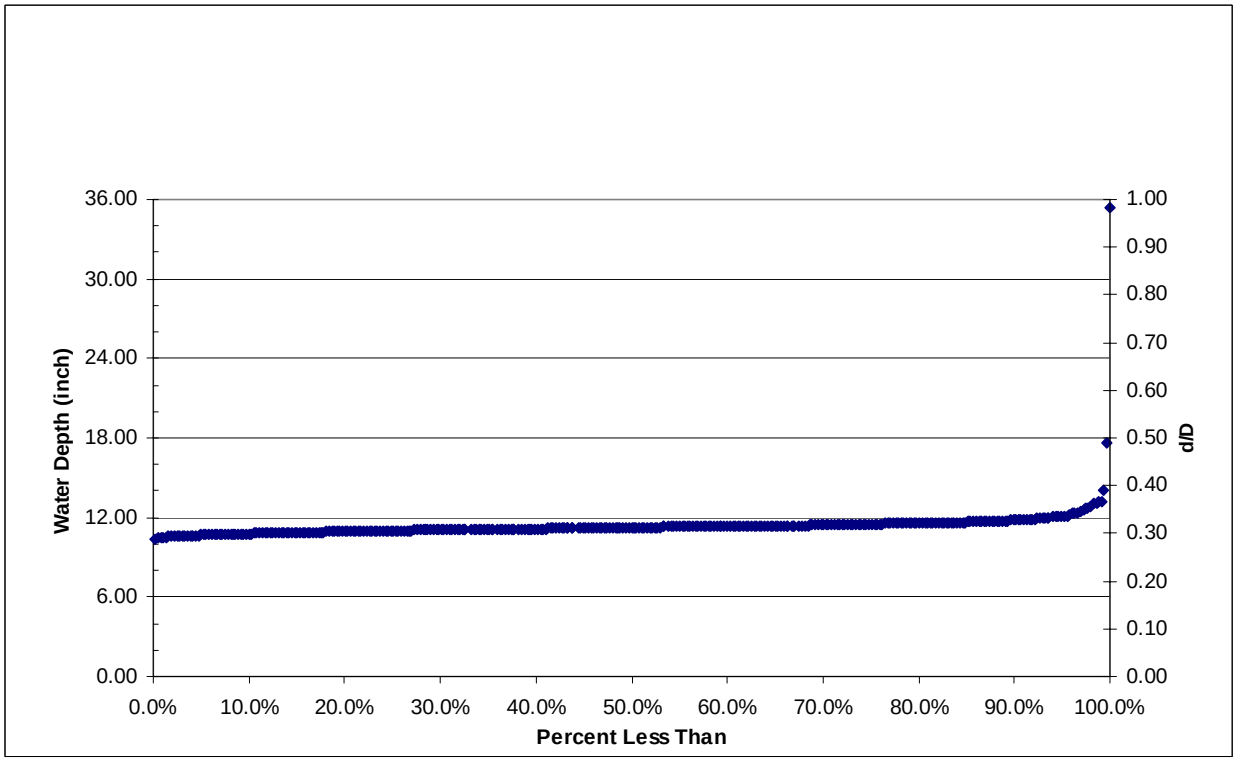


Figure SEI-2-4 Historical Percentile Values of Water Depths (site: SEI-2).

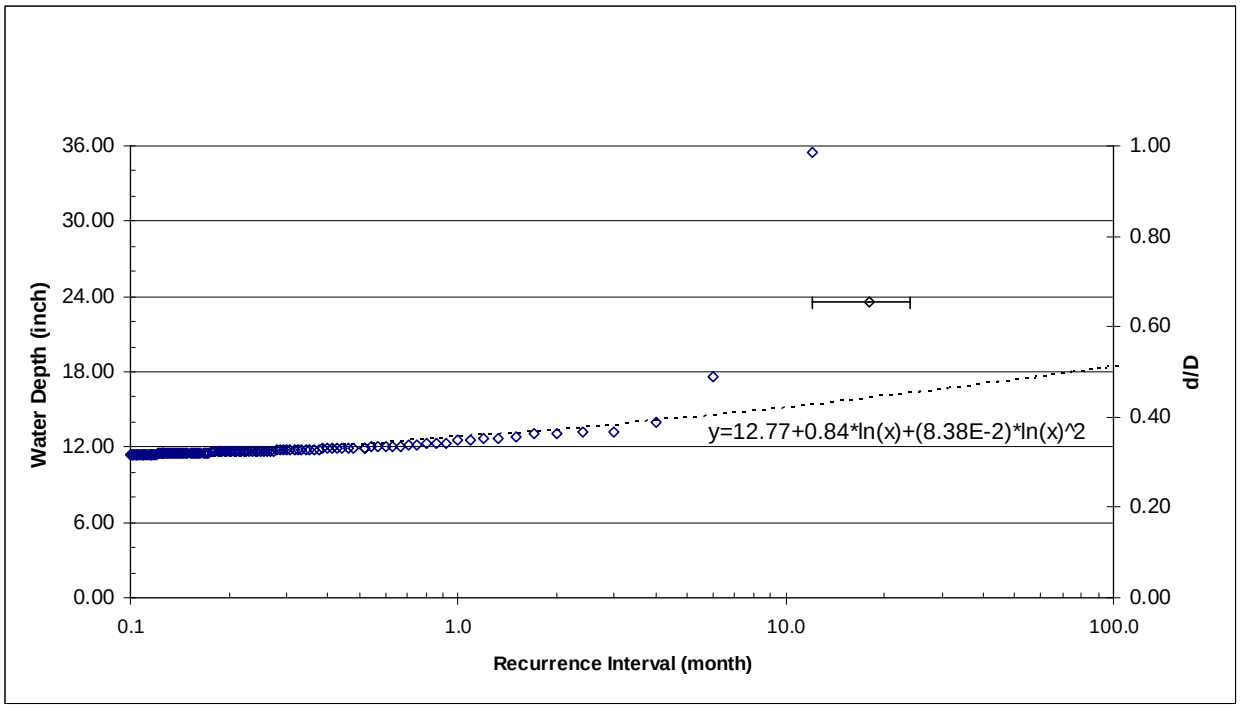


Figure SEI-2-5 Water Depths at Different Recurrence Intervals (site: SEI-2).

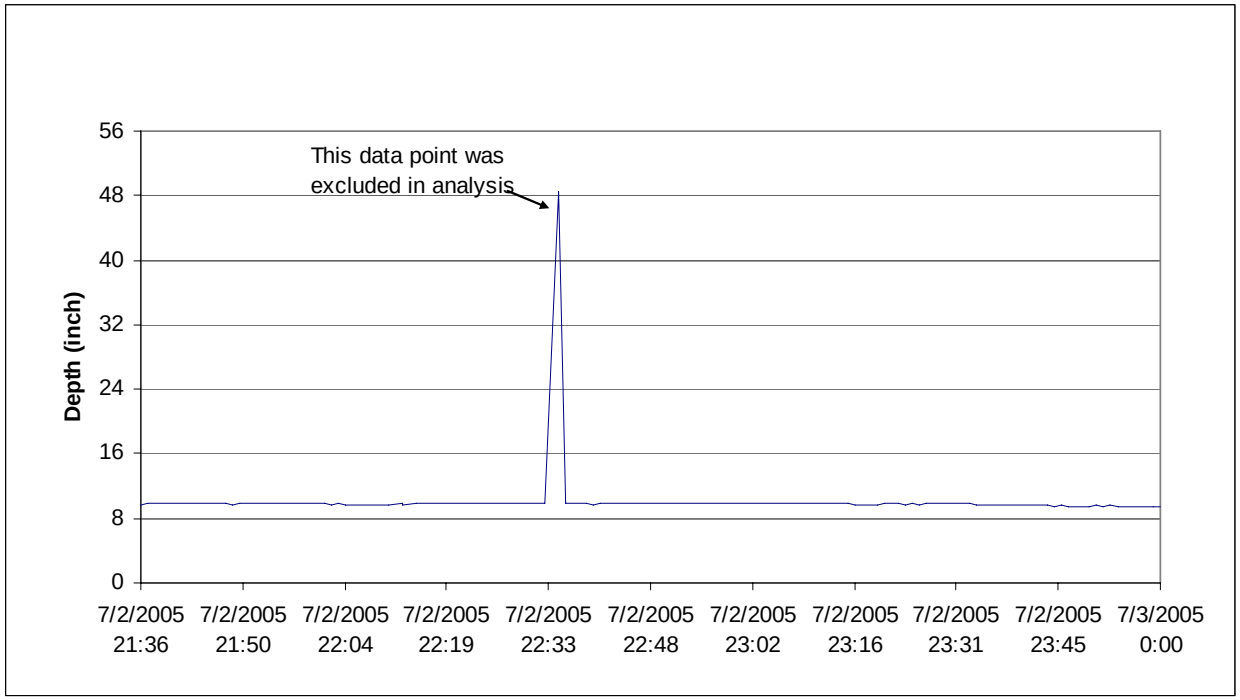


Figure SEI-3-1 An Example of Questionable 1-minute Data Points (site: SEI-3).

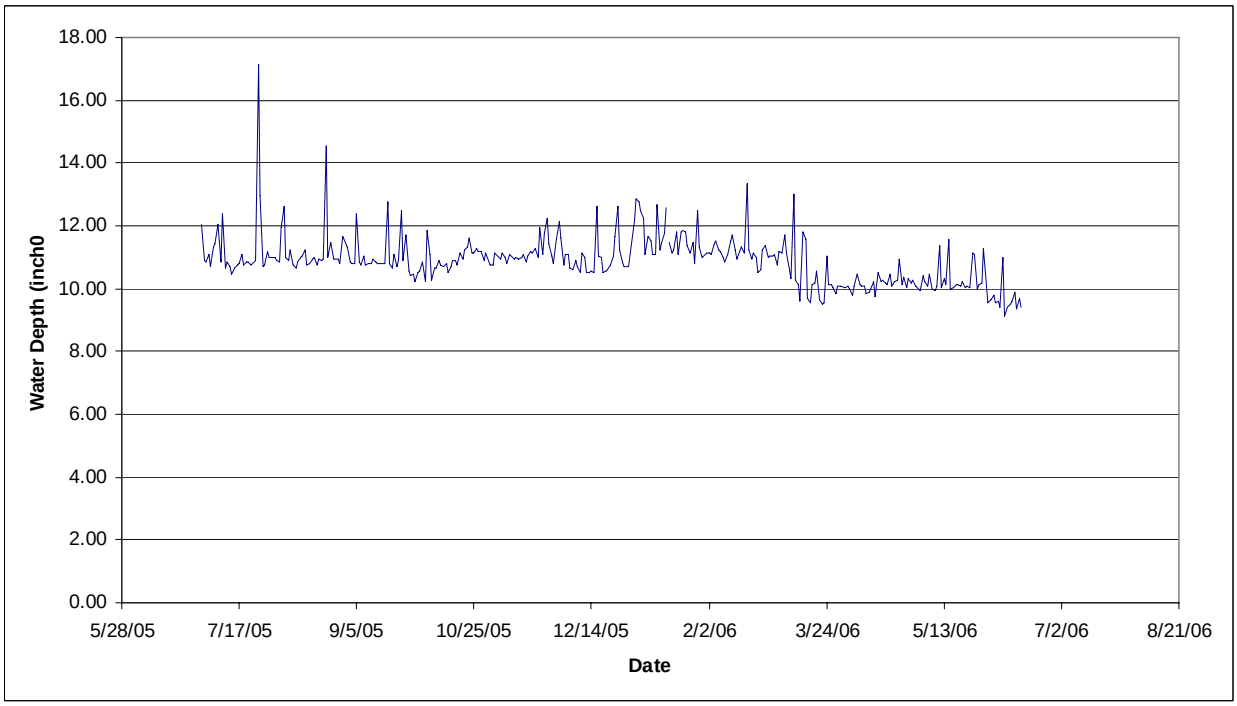


Figure SEI-3-2 Daily Peak Water Depths (site: SEI-3).

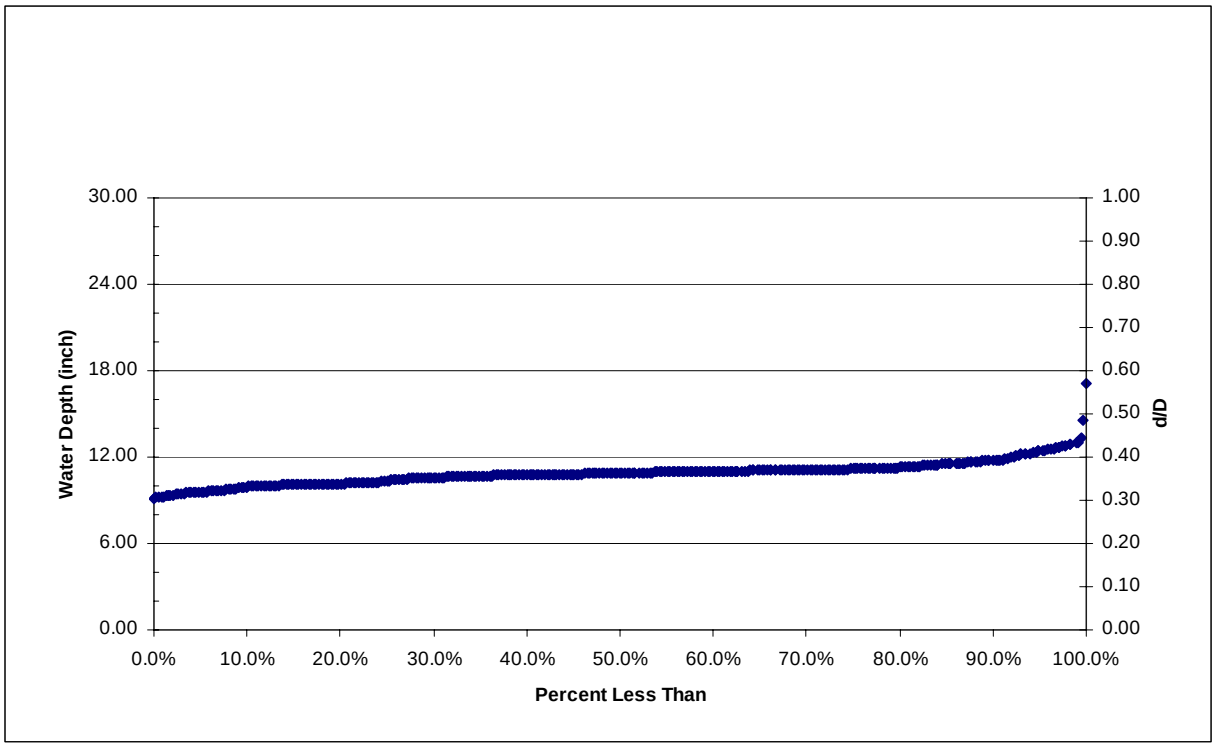


Figure SEI-3-3 Historical Percentile Values of Water Depth (site: SEI-3).

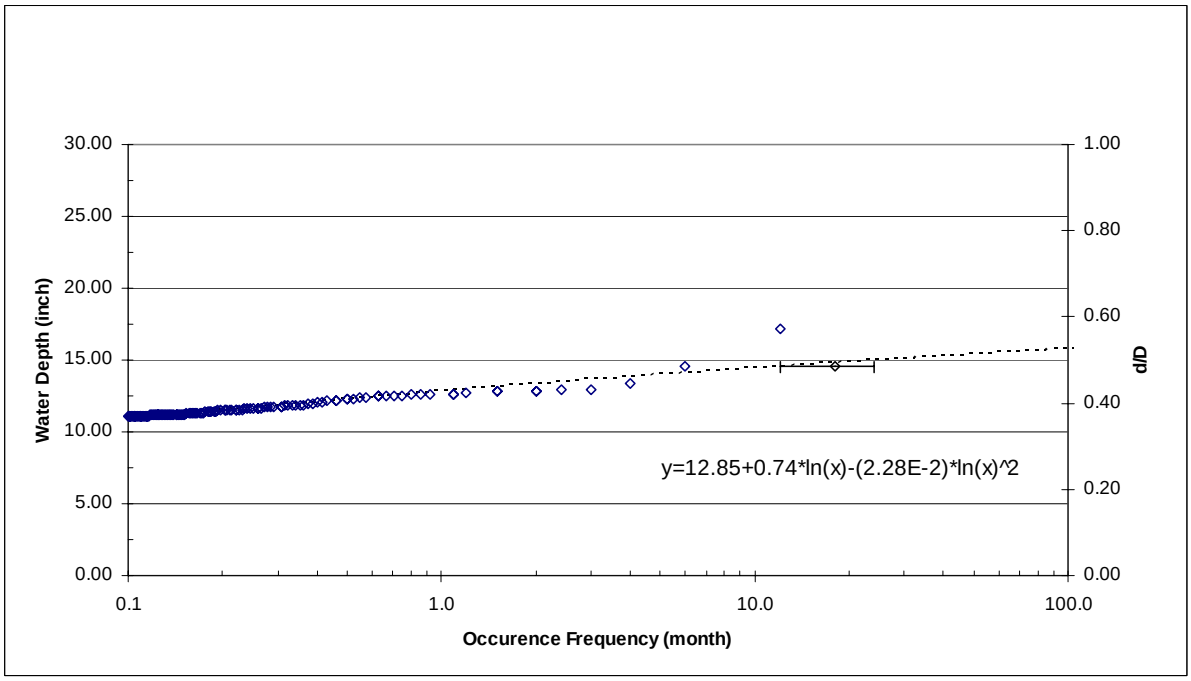


Figure SEI-3-4 Water Depths at Different Recurrence Intervals (site: SEI-3).

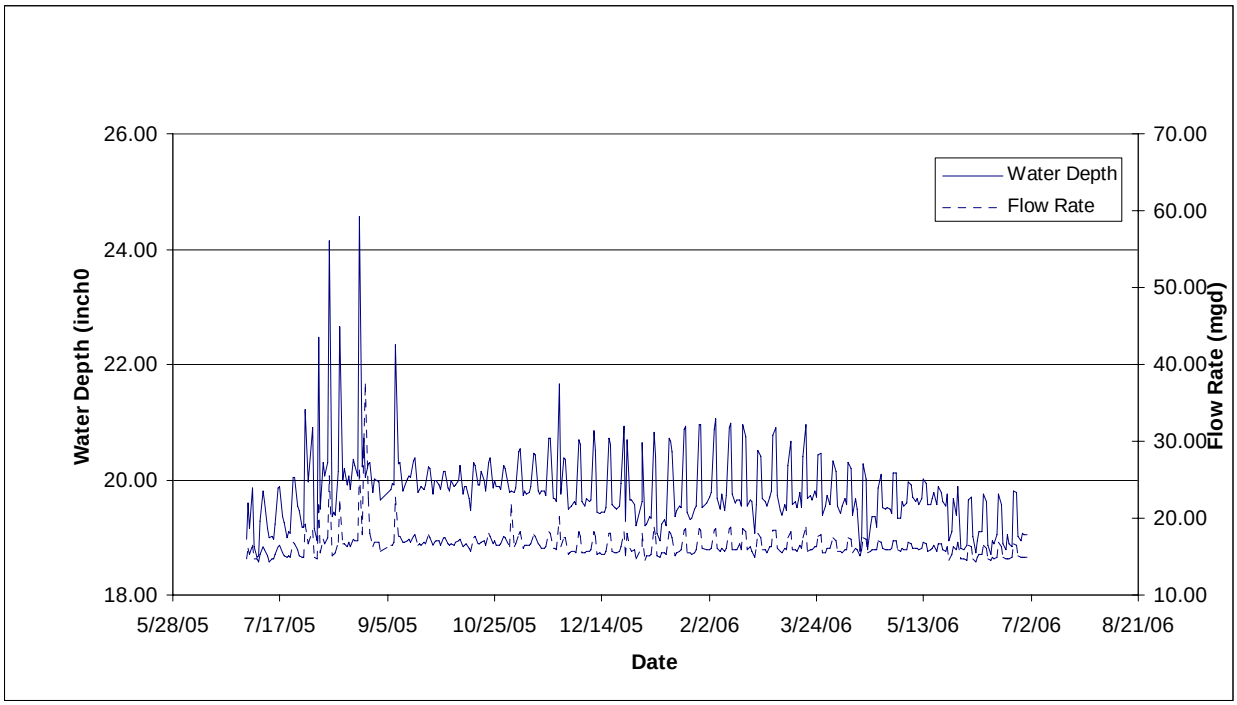


Figure SRC-1-1 Daily Peak Values of Water Depth and Flow Rate (site: SRC-1).

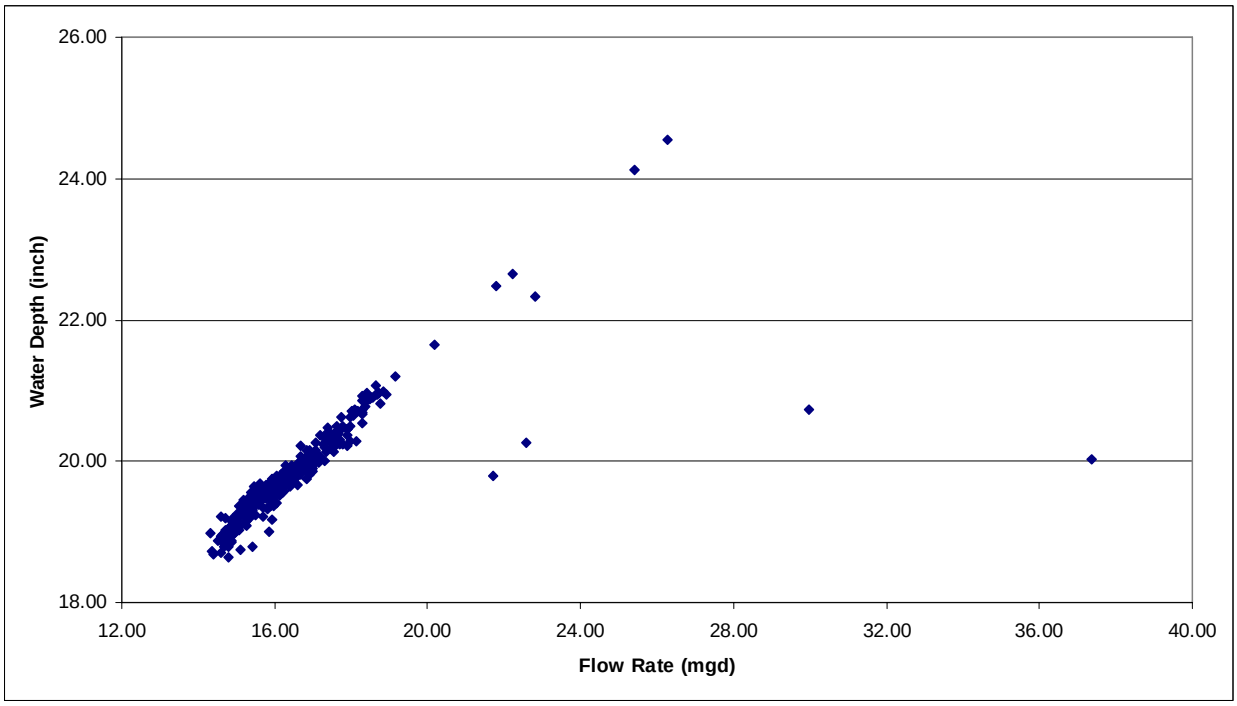


Figure SRC-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: SRC-1).

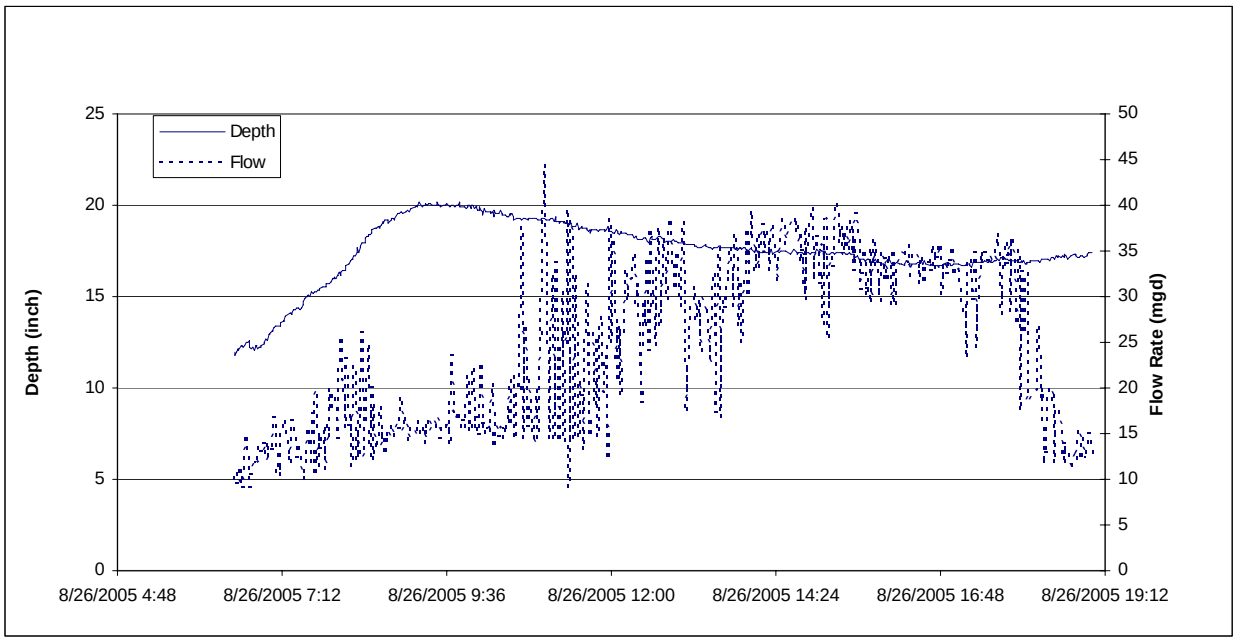


Figure SRC-1-3 An Example Questionable 1-minute Flow Rate Data Points (site: SRC-1).

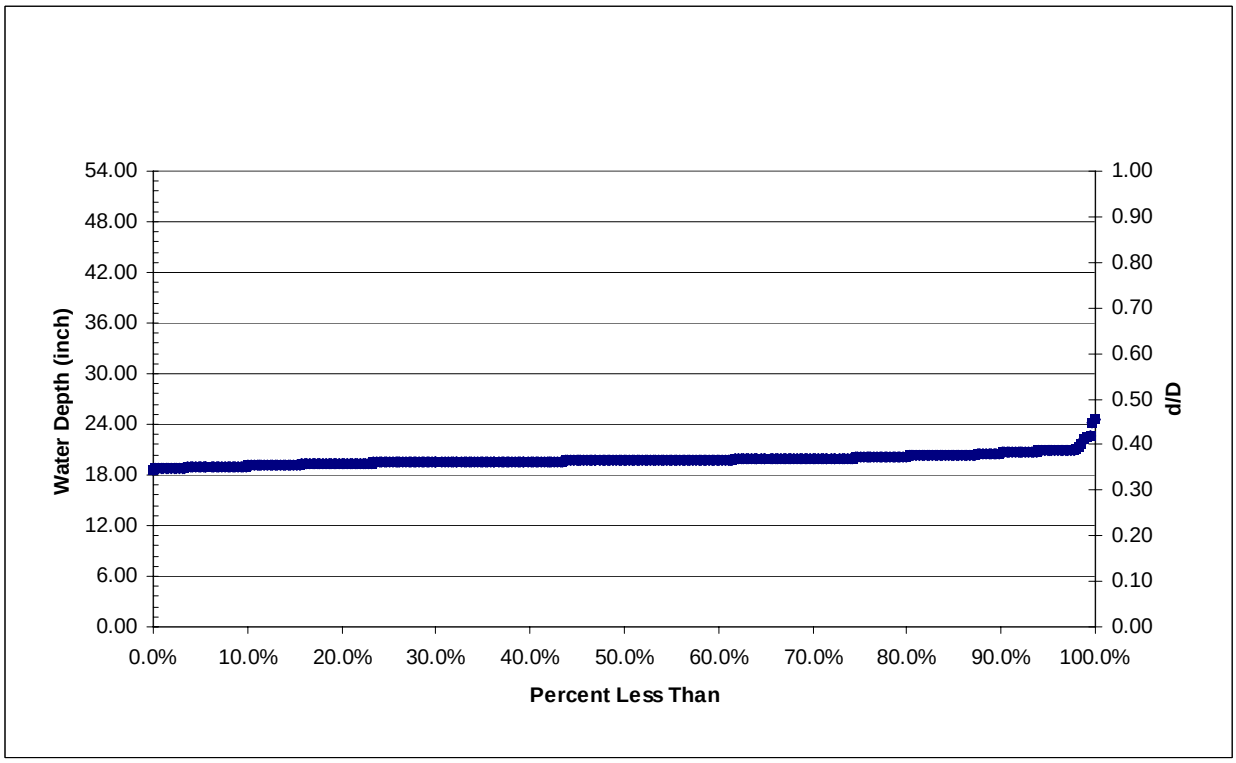


Figure SRC-1-4 Historical Percentile Values of Water Depth (site SRC-1).

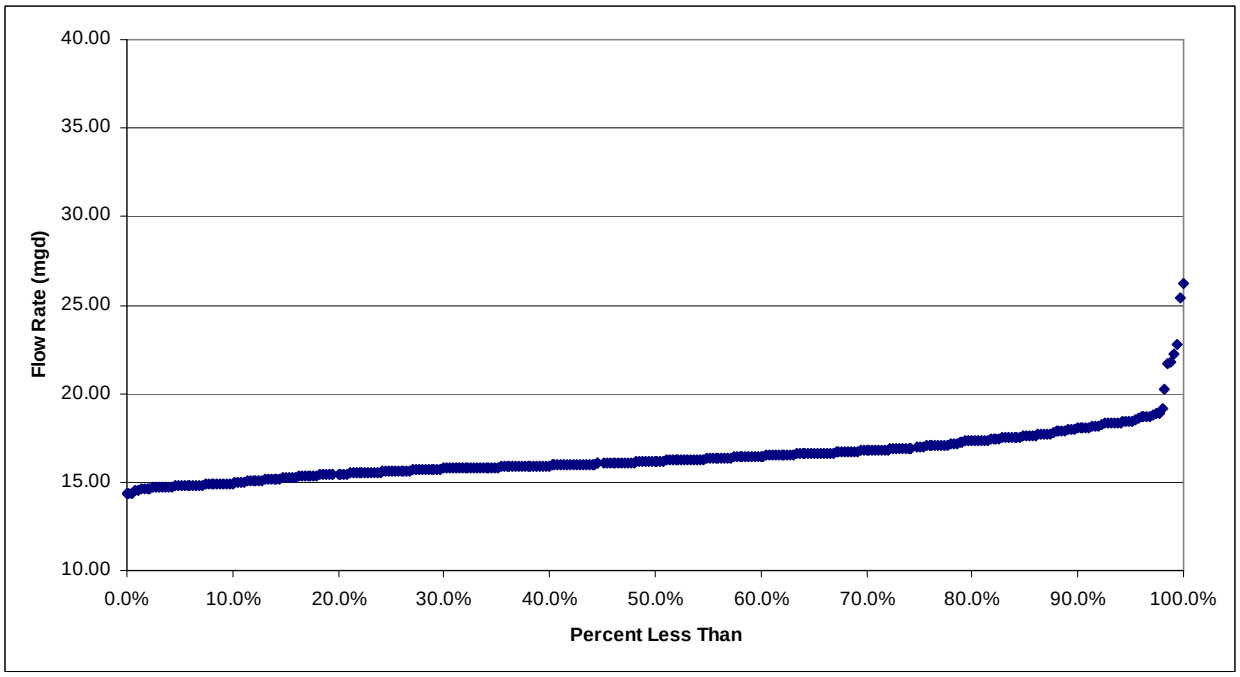


Figure SRC-1-5 Historical Percentile Values of Flow Rate (site: SRC-1).

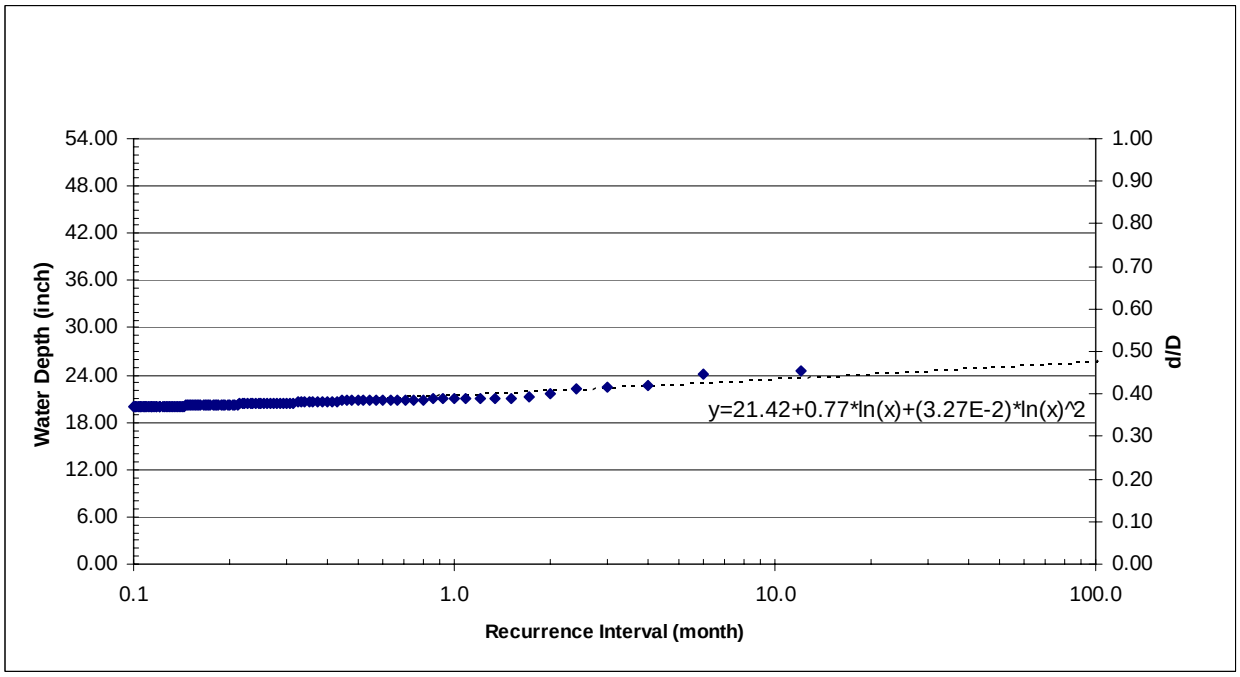


Figure SRC-1-6 Water Depths at Different Recurrence Intervals (site: SRC-1).

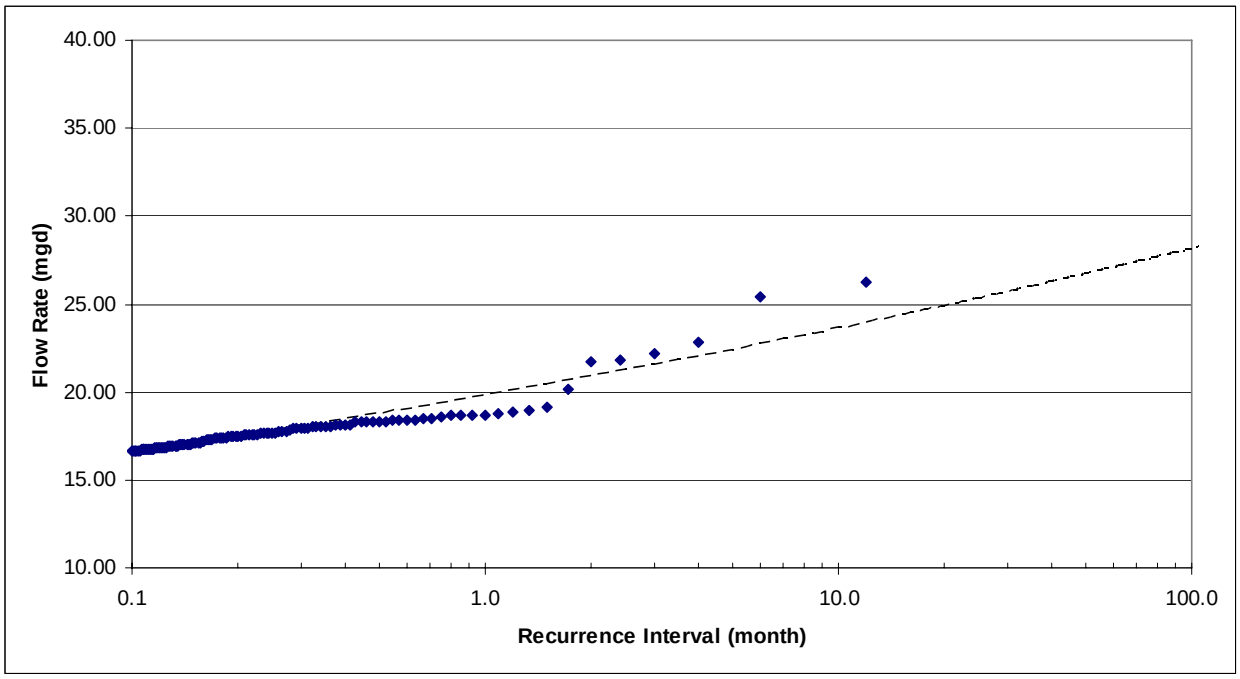


Figure SRC-1-7 Flow Rates at Different Recurrence Intervals (site: SRC-1).

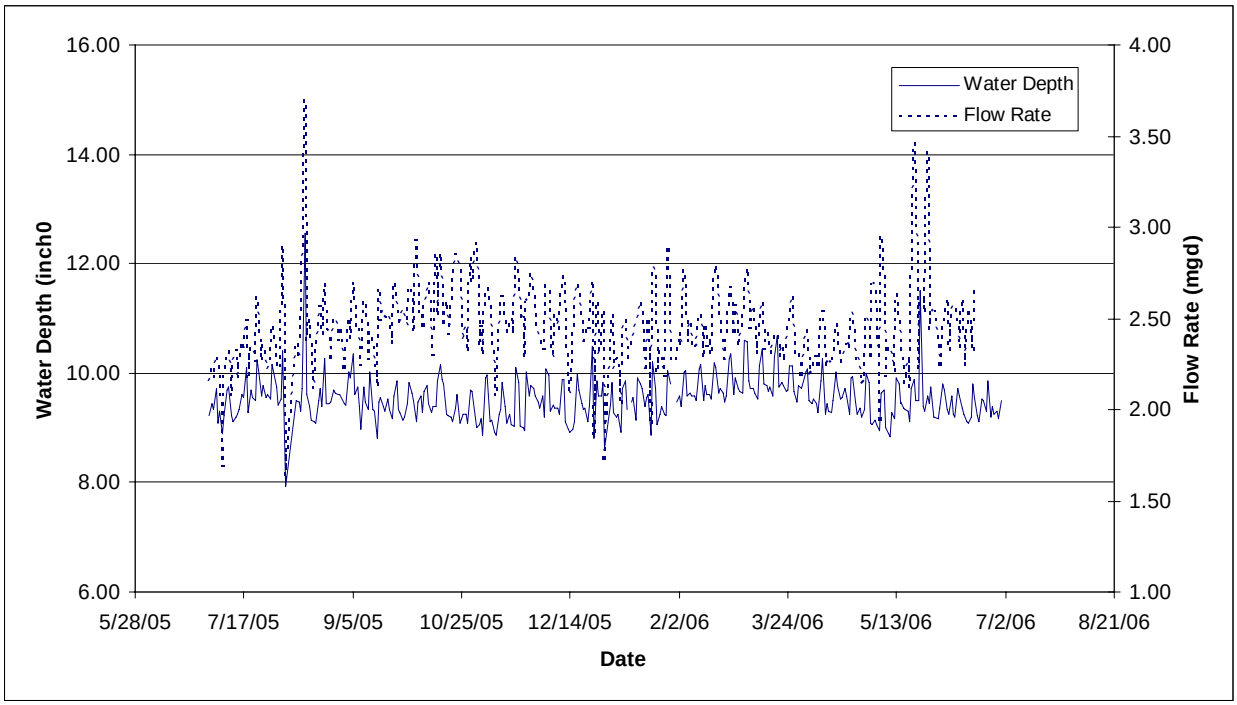


Figure SRW-1-1 Daily Peak Water Depths and Flow Rates (site: SRW-1).

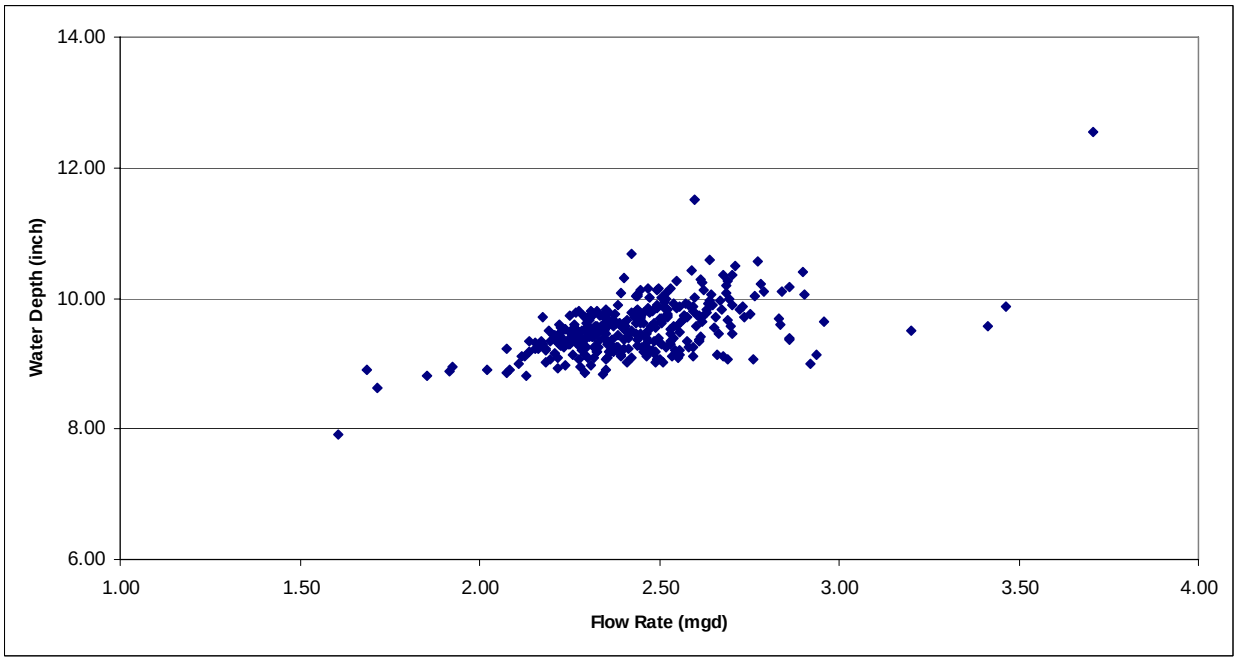


Figure SRW-1-1 Correlation between Daily Peak Water Depths and Flow Rates (site: SRW-1).

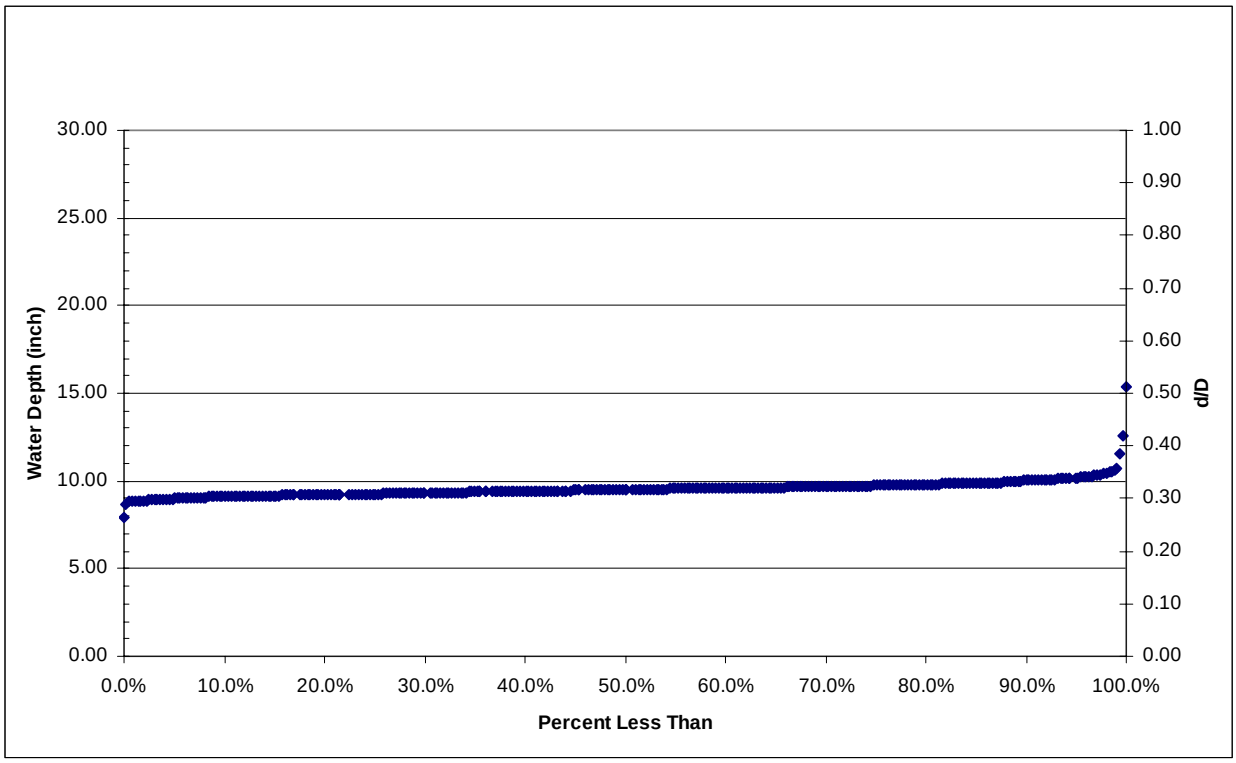


Figure SRW-1-3 Historical Percentile Values of Water Depth (site: SRW-1).

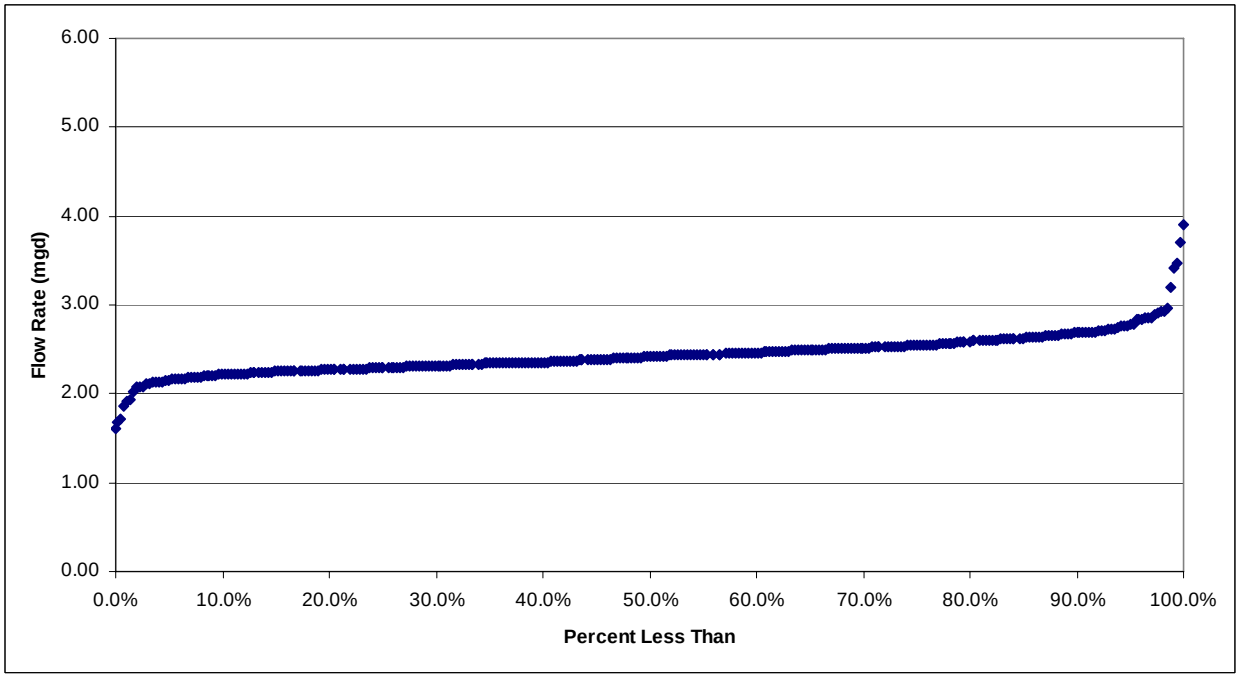


Figure SRW-1-4 Historical Percentile Values of Flow Rates (site: SRW-1).

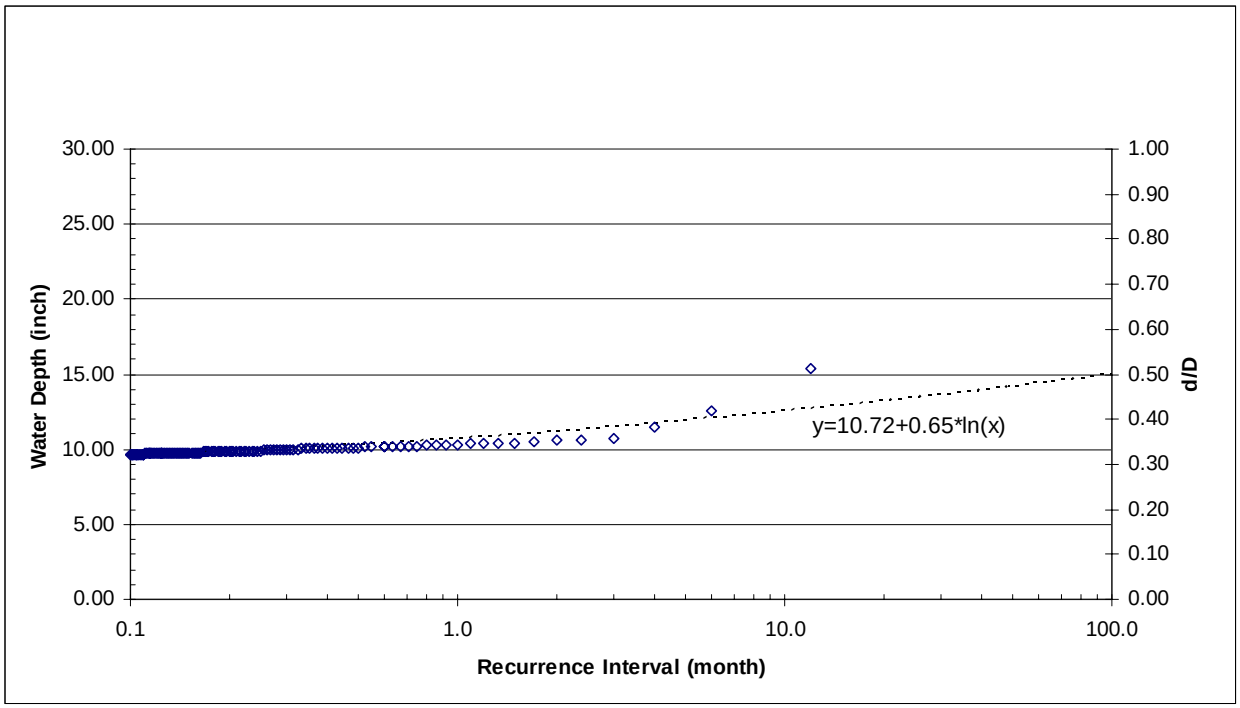


Figure SRW-1-5 Water Depths at Different Recurrence Intervals (site: SRW-1).

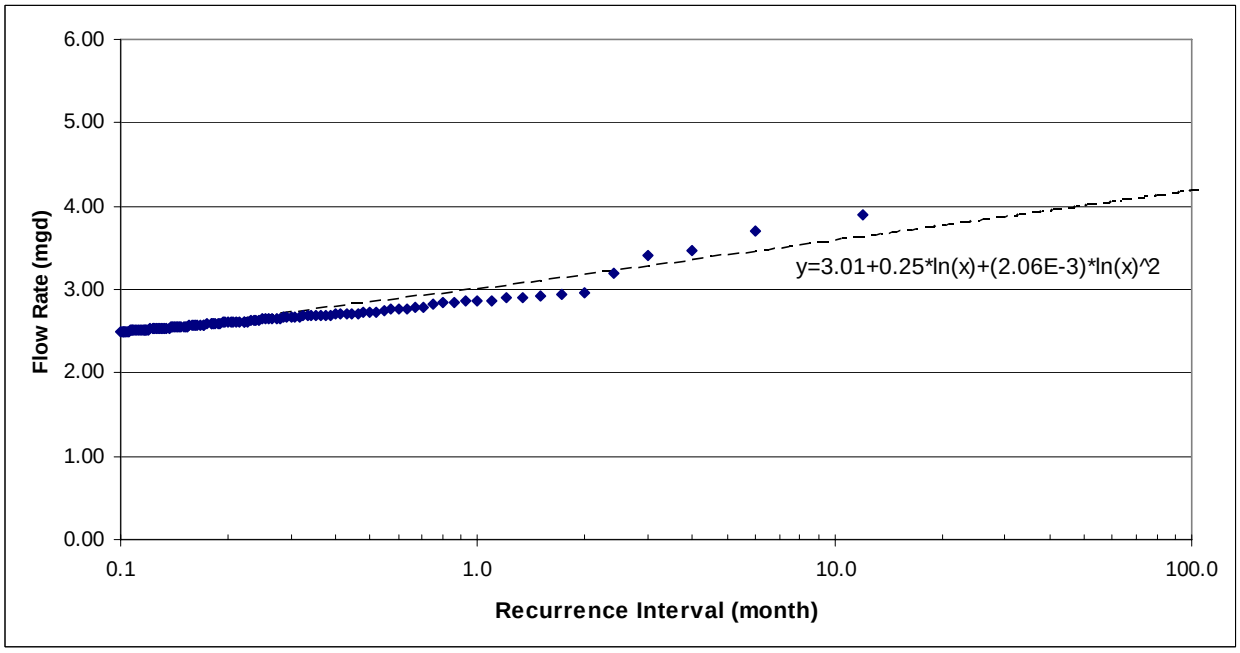


Figure SRW-1-6 Flow Rates at Different Recurrence Intervals (site: SRW-1).

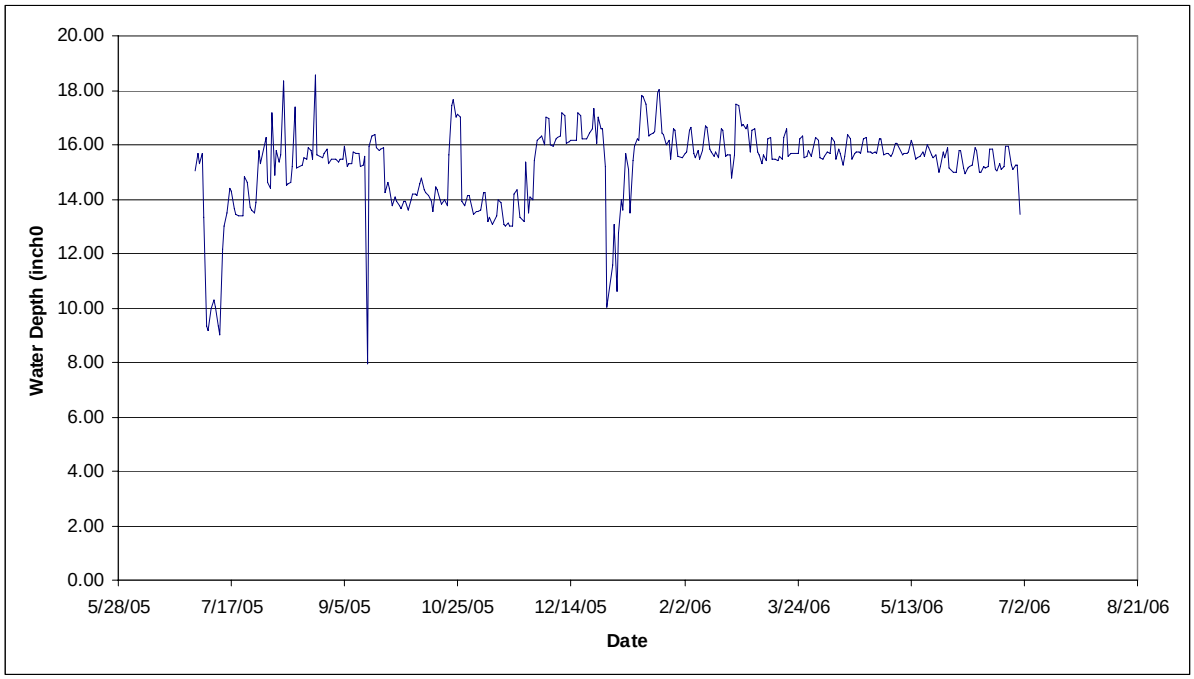


Figure SRWN-1-1 Daily Peak Water Depths (site: SRWN-1).

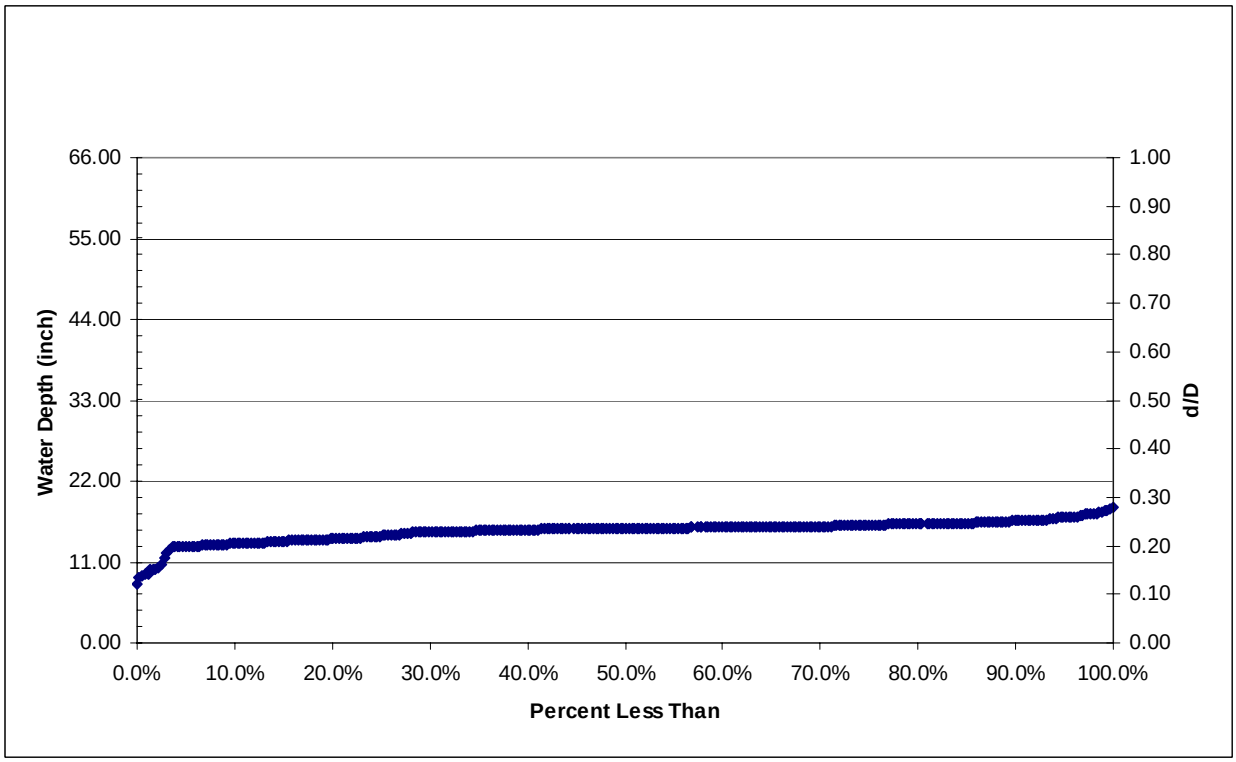


Figure SRWn-1-2 Historical Percentile Values of Water Depth (site: SRWN-1).

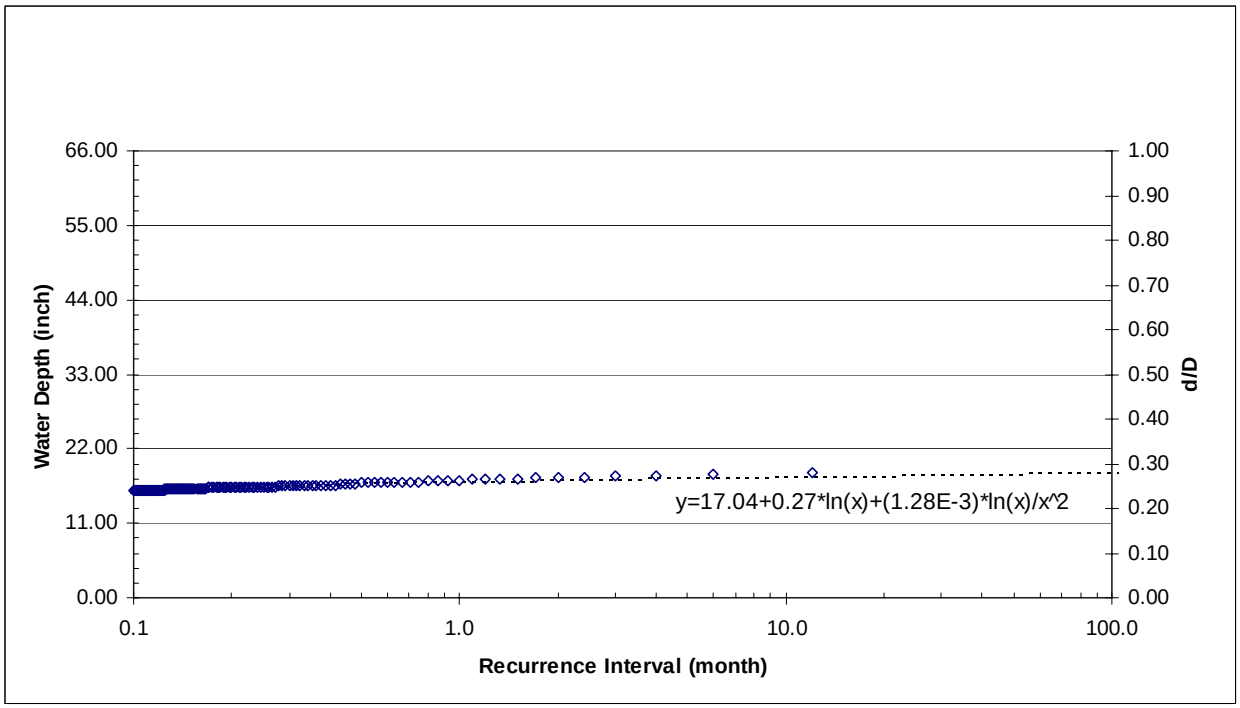


Figure SRWN-1-3 Water Depths at Different Recurrence Intervals (site: SRWN-1).

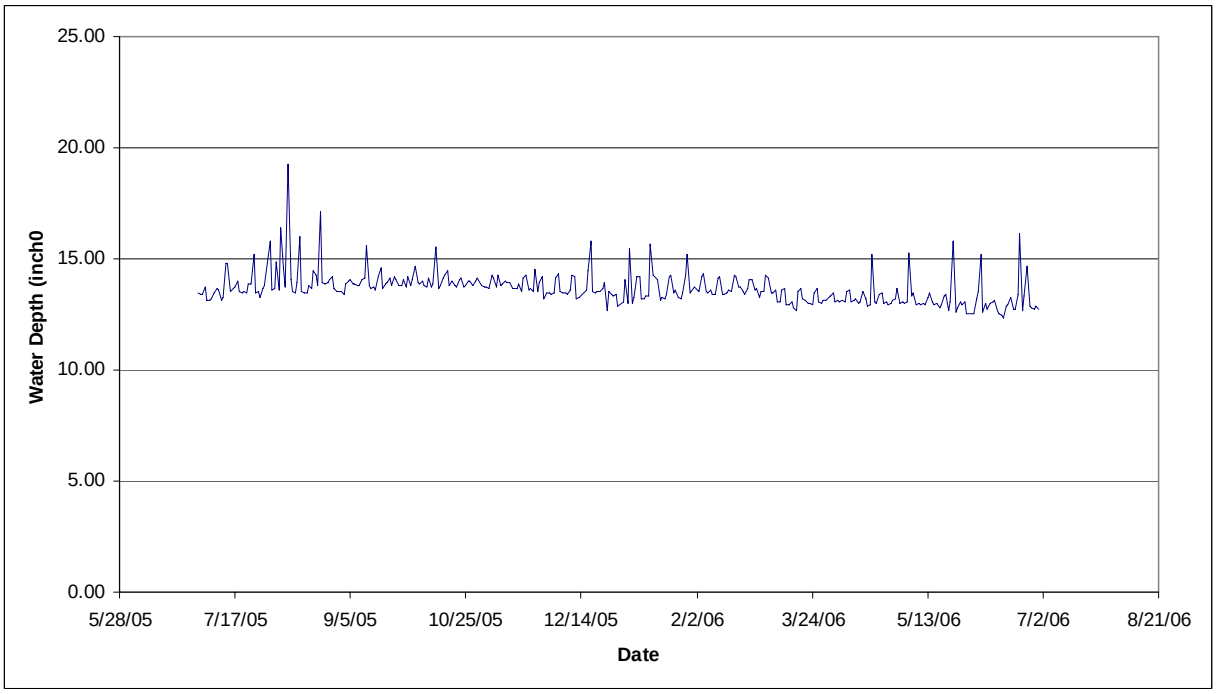


Figure SRWS-1-1 Daily Peak Water Depths (site: SRWS-1).

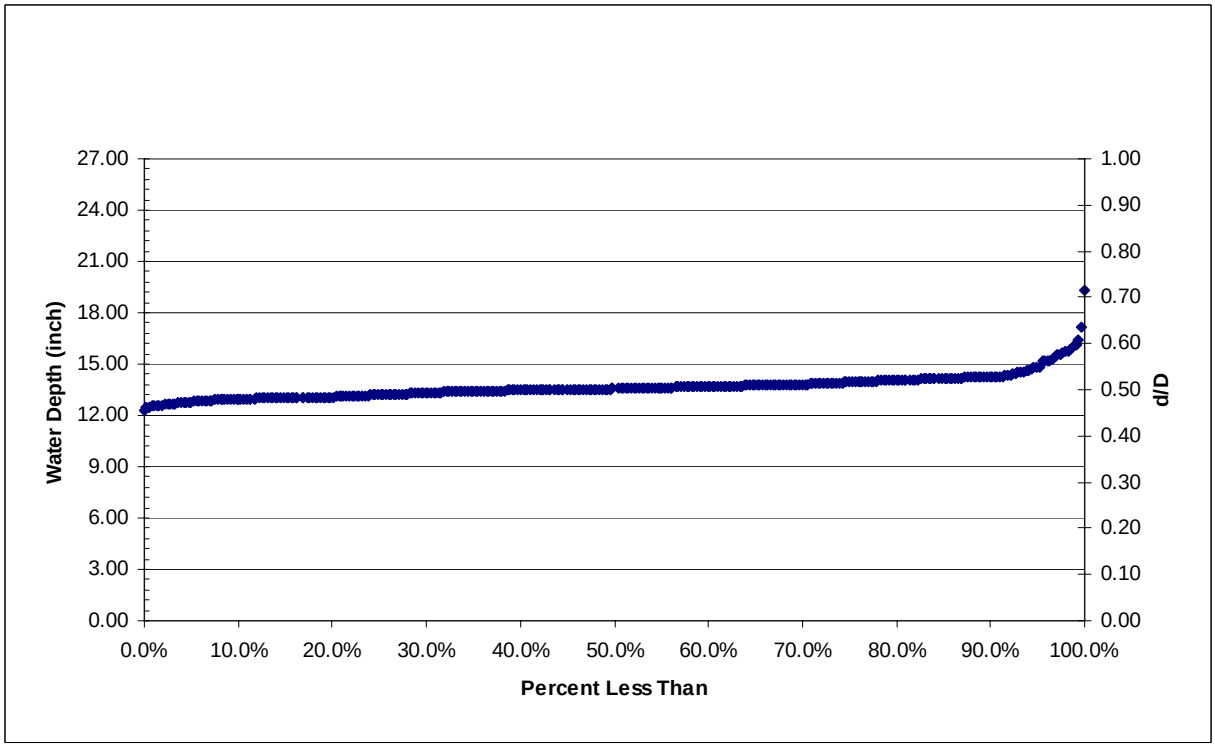


Figure SRWS-1-2 Historical Percentile Values of Water Depth (site: SRWS-1).

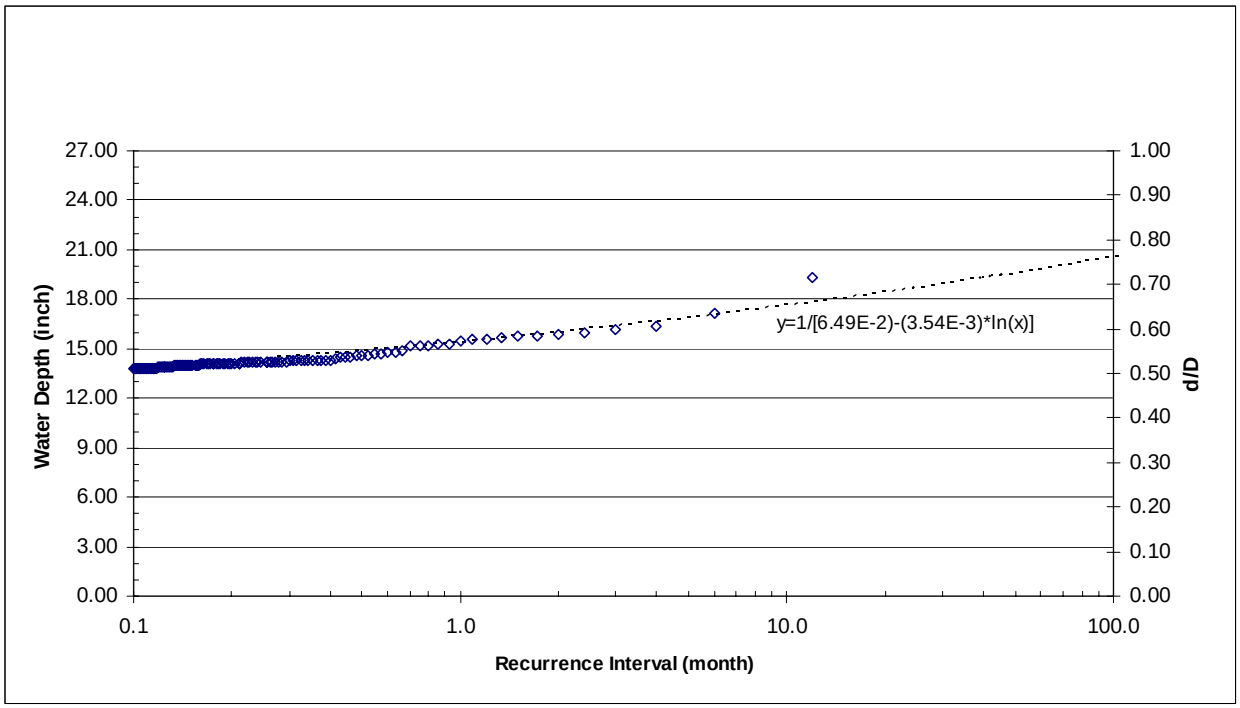


Figure SRWS-1-3 Water Depths at Different Recurrence Intervals (site: SRWS-1).

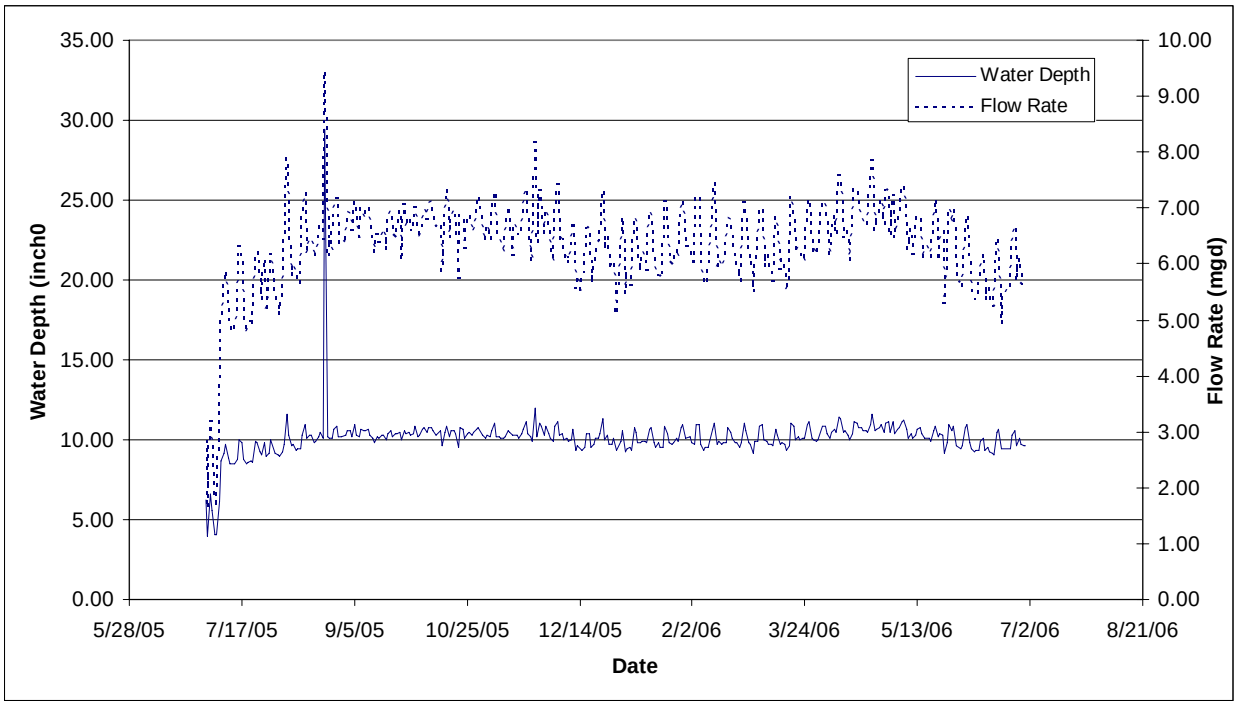


Figure SWI-1-1 Daily Peak Water Depths and Flow Rates (site: SWI-1).

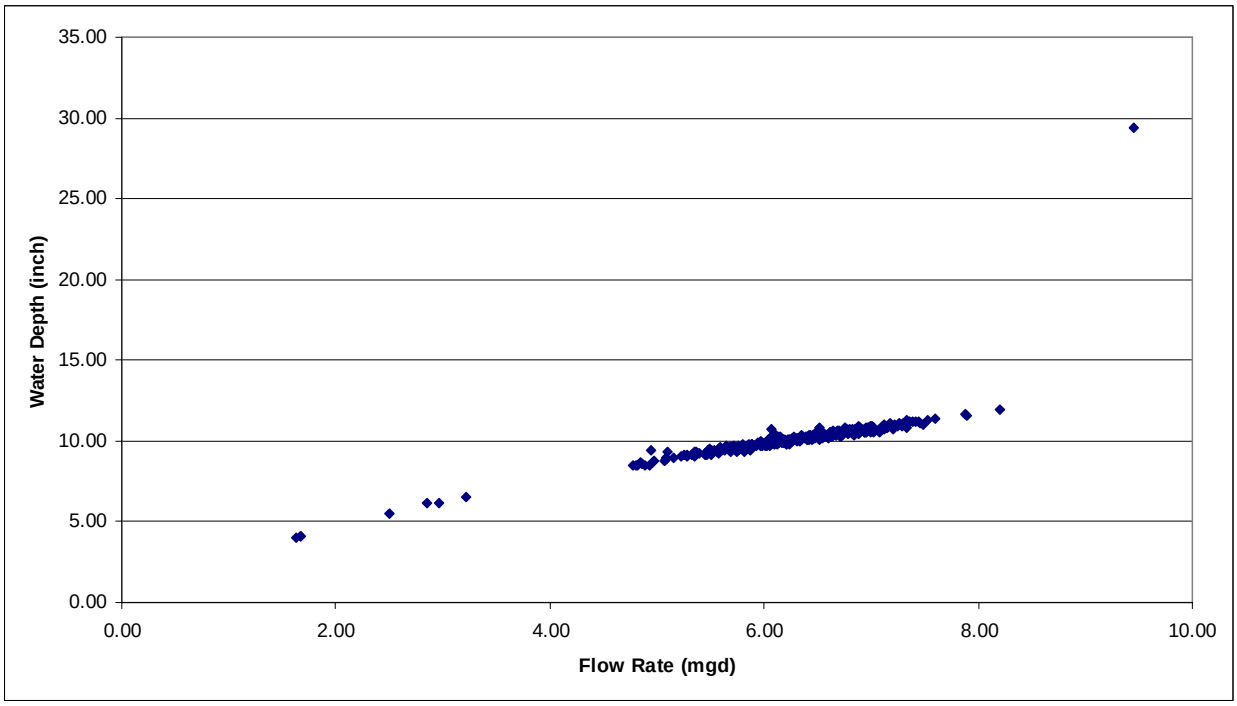


Figure SWI-1-2 Correlation between Daily Peak Water Depths and Flow Rates (site: SWI-1).

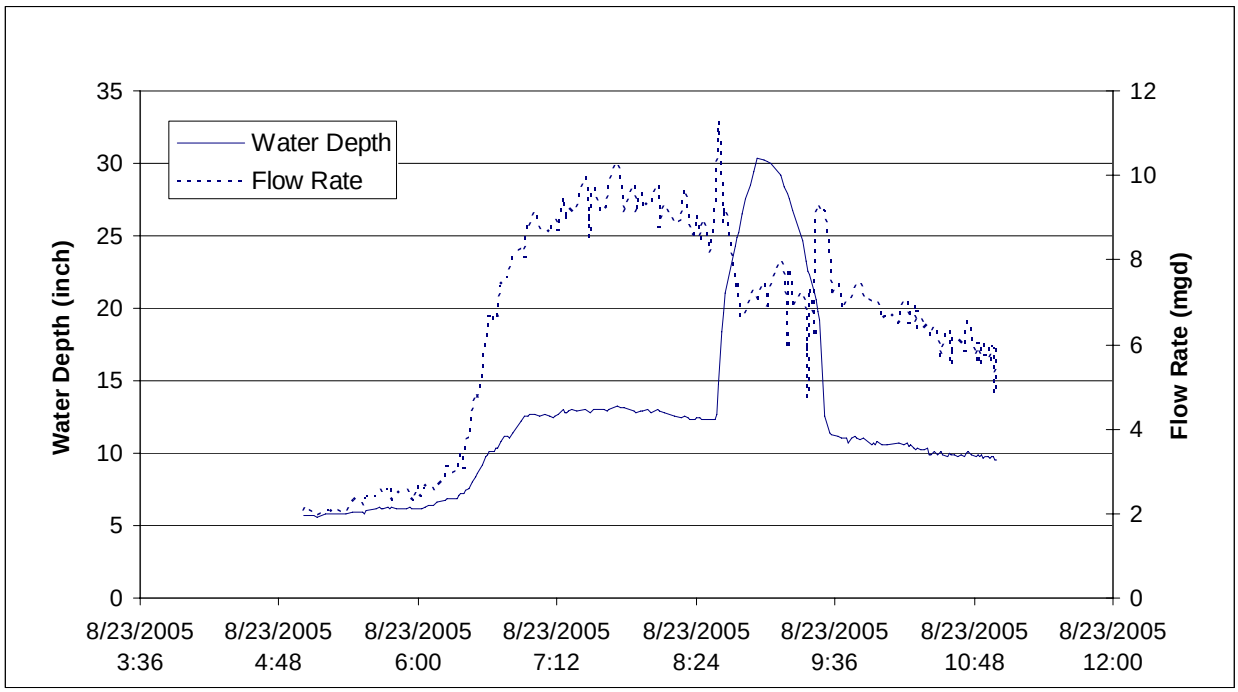


Figure SWI-1-3 One-minute Data Points with the Maximum Water Depth and Flow Rate (site: SWI-1).

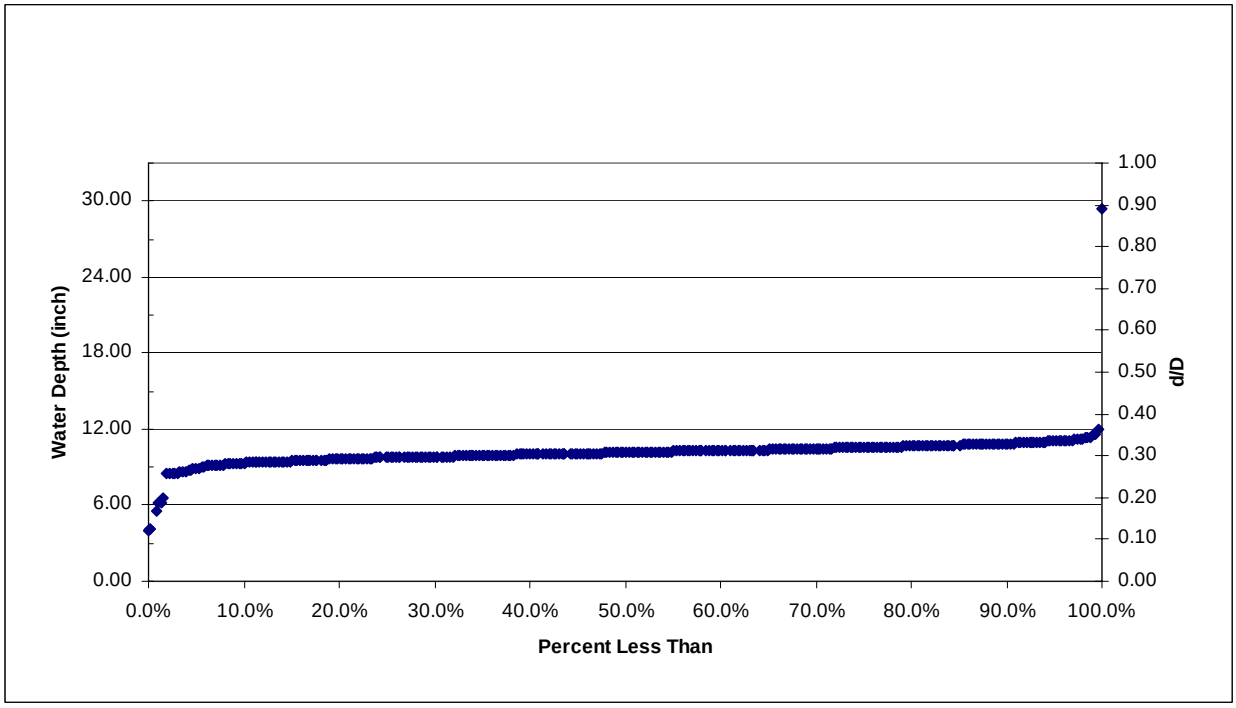


Figure SWI-1-4 Historical Percentile Values of Water Depth (site: SWI-1).

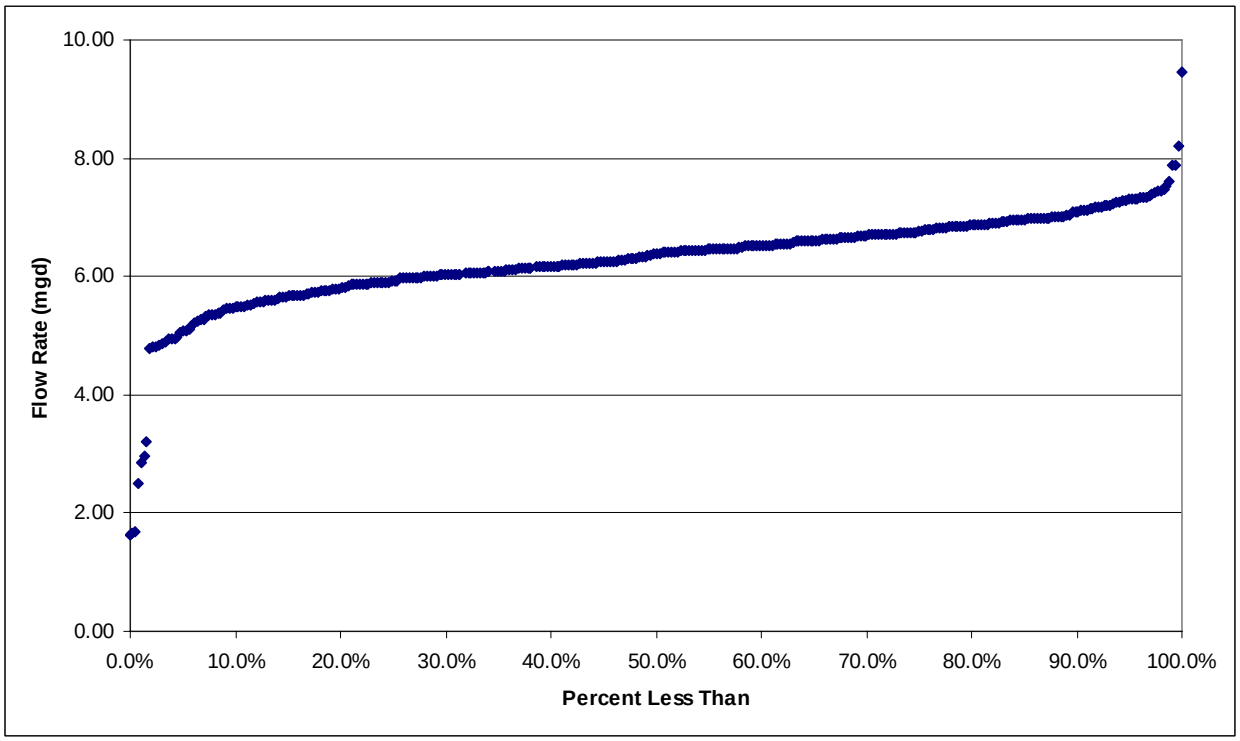


Figure SWI-1-5 Historical Percentile Values of Flow Rate (site: SWI-1).

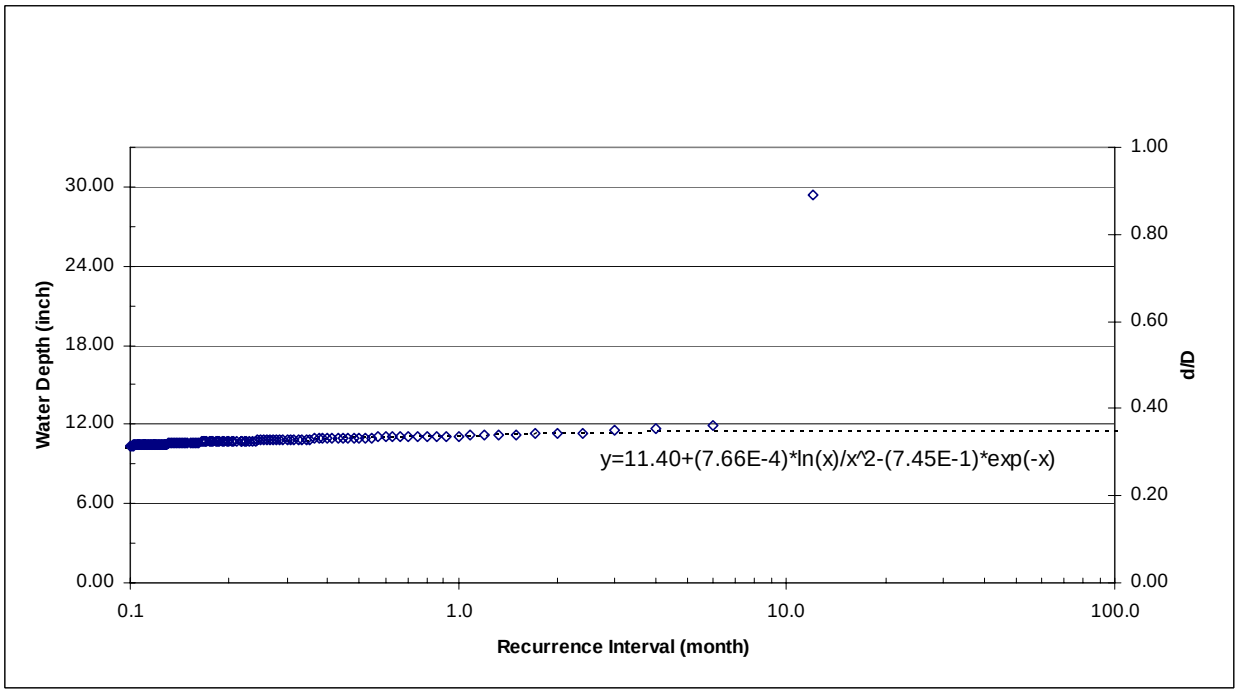


Figure SWI-1-6 Water Depths at Different Recurrence Intervals (site: SWI-1).

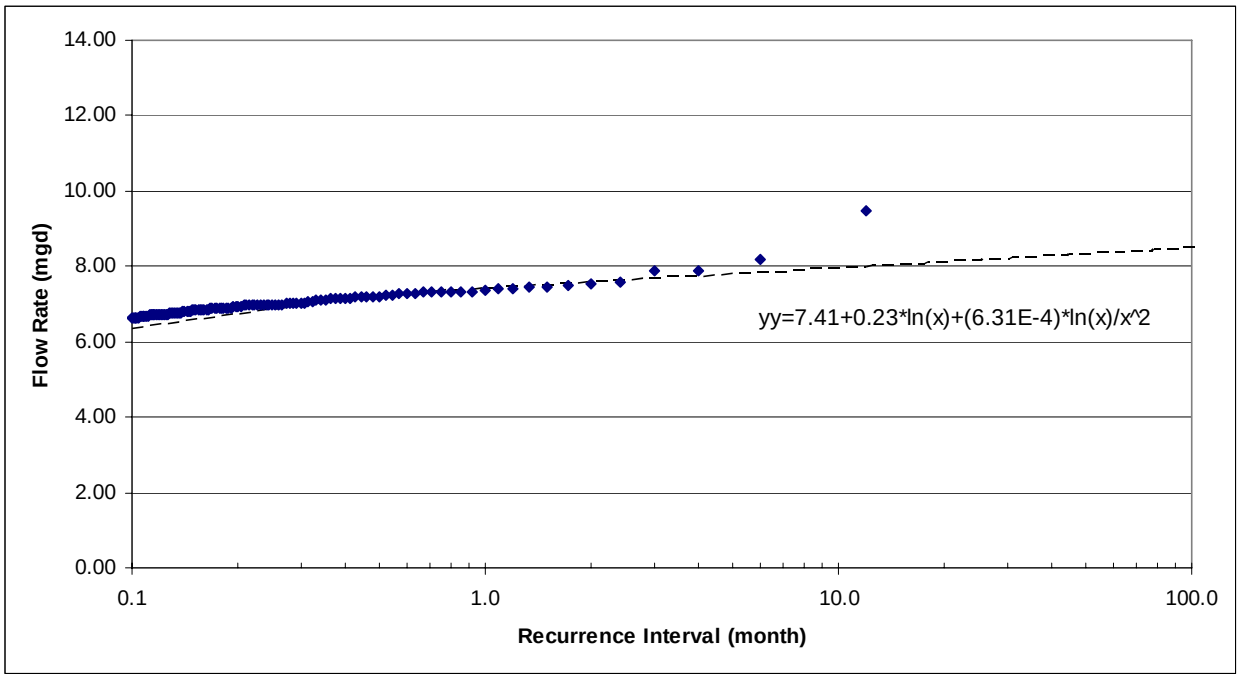


Figure SWI-1-7 Flow Rates at Different Recurrence Intervals (site: SWI-1).

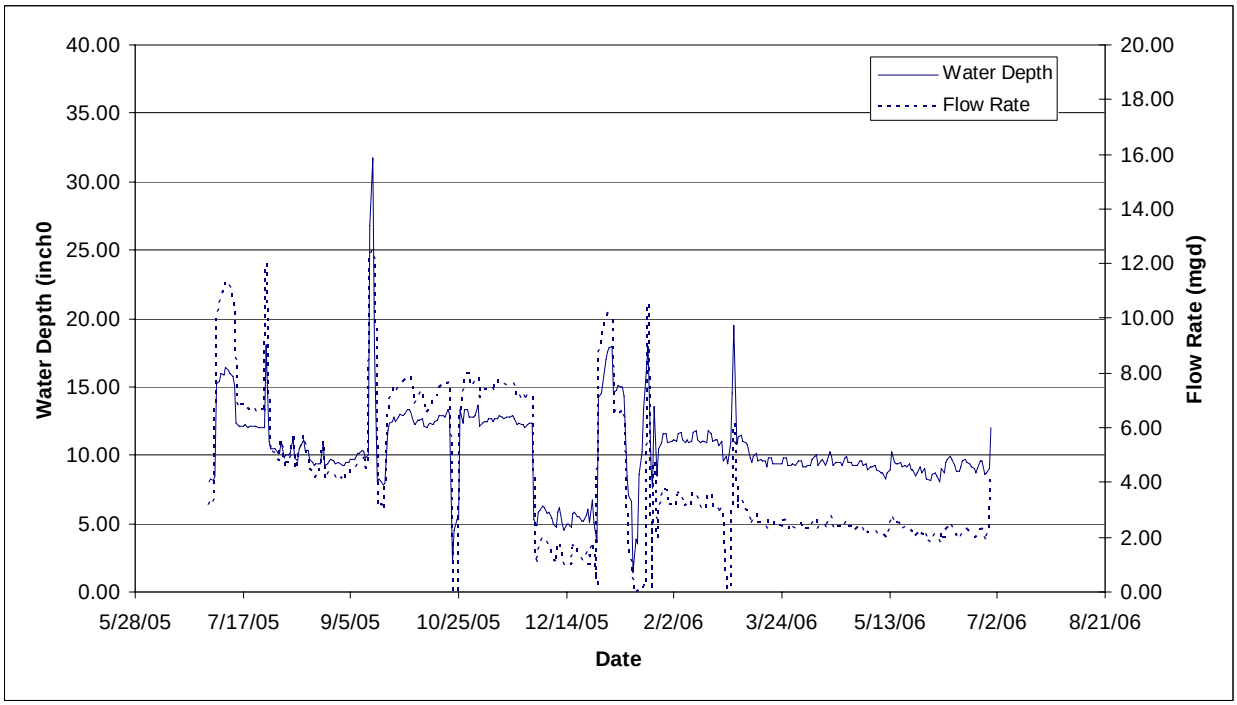


Figure TUCDIV-1 Daily Peak Water Depths and Flow Rates (site: TUCDIV).

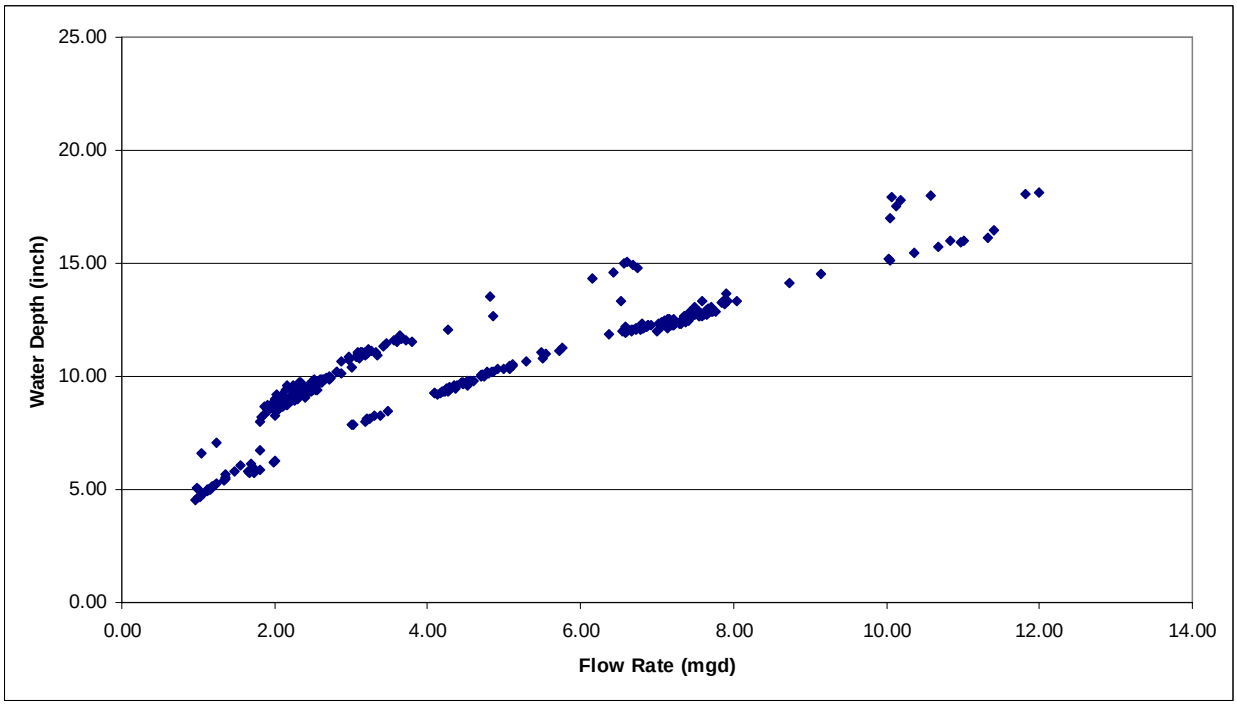


Figure TUCDIV-2 Correlation between Water Depths and flow Rates (site: TUCDIV).

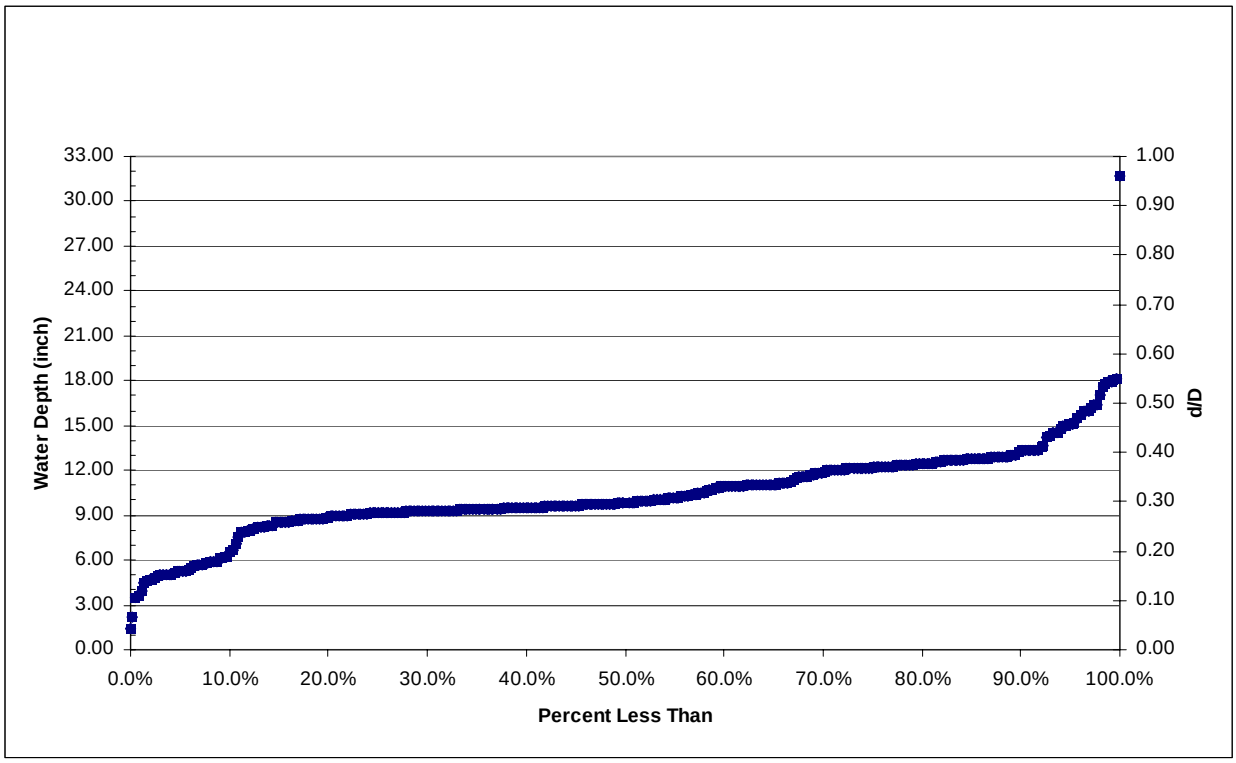


Figure TUCDIV-3 Historical Percentile Values of Water Depth (site: TUCDIV).

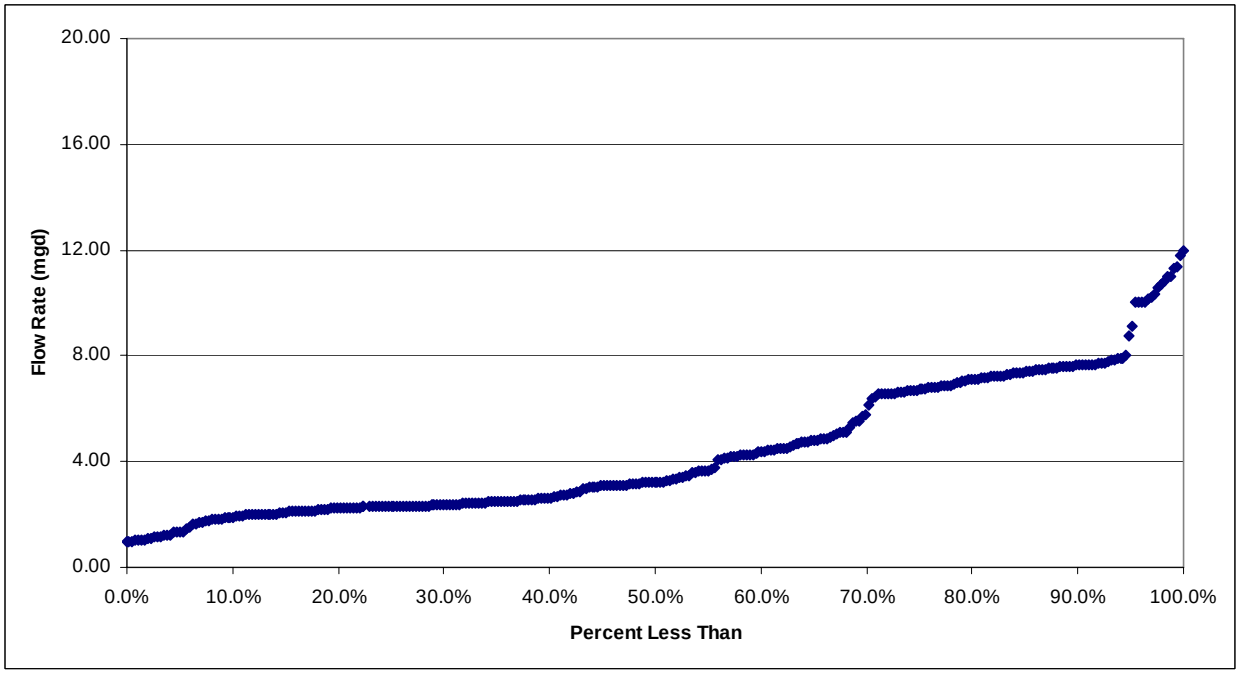


Figure TUCDIV-4 Historical Percentile Values of Flow Rate (site: TUCDIV).

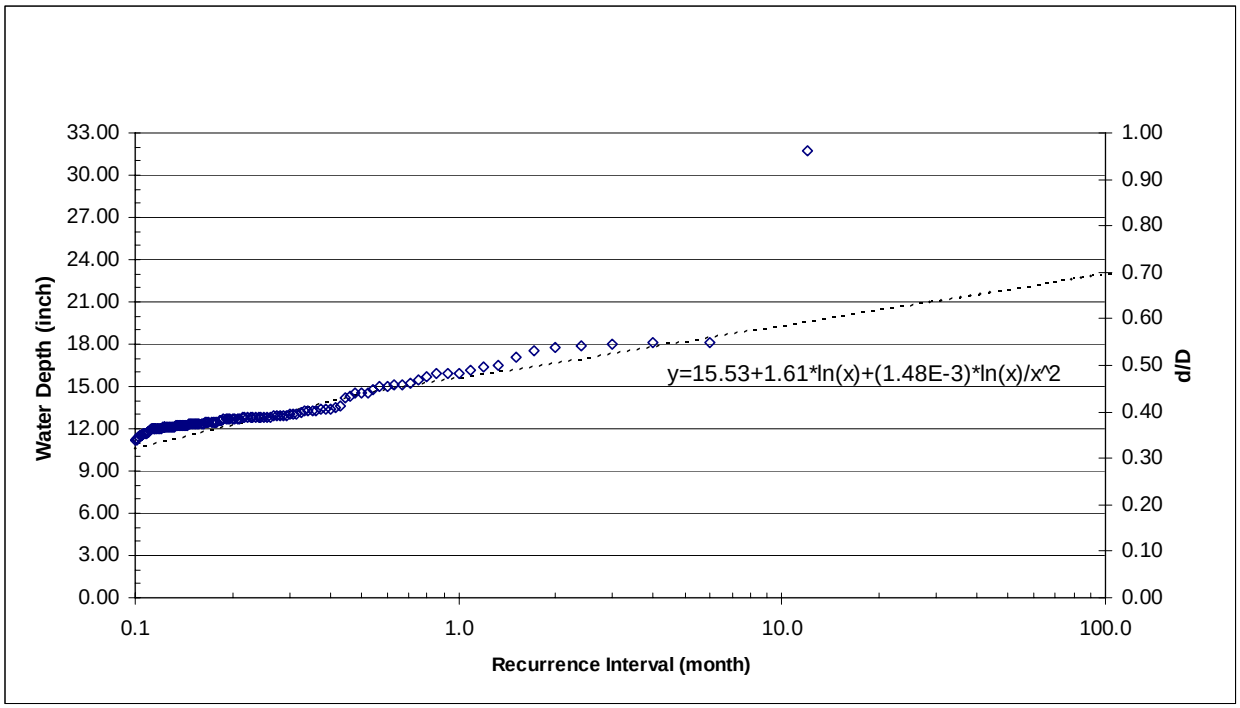


Figure TUCDIV-5 Water Depths at Different Recurrence Intervals (site: TUCDIV).

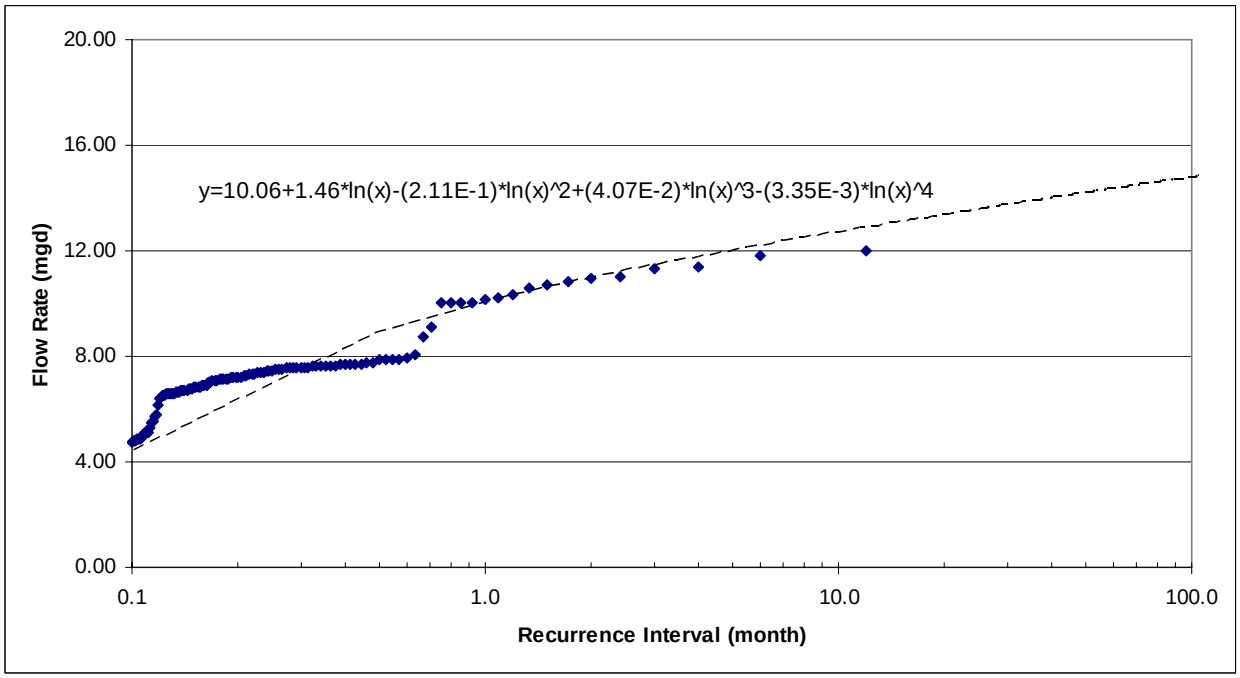


Figure TUCDIV-6 Flow Rates at Different Recurrence Intervals (site: TUCDIV).

APPENDIX I

Conceptual Basis of Design

Conceptual Basis of Design

Introduction

The overall recommended master plan includes new wastewater treatment facilities at Roger Road; upgrades and expansion at the Ina Road Wastewater Reclamation Facility; a plant interconnect pipeline; expansions and consolidation of non-metro facilities, and augmentation of the existing conveyance system for future growth. Each of these is comprised of a number of elements.

The Pima County Regional Wastewater Reclamation Department (PCRWRD) treats raw wastewater by removing undesirable constituents through a series of physical, biological, and chemical liquid stream processes. These processes produce an effluent that can be beneficially reused. Solids removed from the wastewater as sludge are stabilized to produce biosolids that can be beneficially reused.

Effluent quality objectives, discussed in Chapter 2, are established by:

- AZPDES permits, which regulate surface discharges
- State Surface Water Quality Standards and Reclaimed Water Quality Standards
- APP, which regulates discharges that ultimately reach the groundwater
- Arizona Administrative Code

The existing liquid stream processes include influent conveyance and measurement, preliminary treatment, primary treatment, secondary treatment, disinfection, and effluent conveyance. All wastewater facilities employ at least secondary biological treatment to remove conventional pollutants (biochemical oxygen demand and total suspended solids), and chlorine disinfection (with dechlorination) for pathogen reduction. The Ina Road WRC has one process train that partially removes nitrogen from the effluent.

Sludge quality objectives are currently established by federal sewage sludge regulations (*40 CFR Part 503*), which regulate land application of sludge. The existing solids stream processes include thickening, digestion, and dewatering. PCRWRD employs single-stage high-rate anaerobic digestion to meet federal requirements for Class B biosolids.

There is a potential for more stringent biosolids treatment requirements, but these are not on the immediate horizon. Future sludge quality objectives will be shaped by beneficial reuses. As new markets for biosolids are identified, it is envisioned that the specific demands of these markets could alter the form in which biosolids are delivered. At buildout biosolids could receive further treatment by temperature phased digestion, pelletization, CAMBI process or other market-driven processes.

Because the beneficial reuse markets for biosolids are largely unidentified and undeveloped, the primary function of master planning in this regard is to reserve sufficient space to accommodate future systems and a variety of processes and treatment components.

The conceptual basis of design for the major metro wastewater treatment facilities is described below.

Water Reclamation Campus - 32 MGD

Recommendations for Roger Road are to construct a new 32-mgd wastewater treatment facility using Bardenpho technology to meet the stringent standards imposed by the Arizona Department of Environmental Quality. The new facility will be located adjacent to the existing operating facility in a clear area between the plant and Sweetwater Drive or at a location north and west of the existing plant operations. The existing facilities would be demolished after commissioning the new operation. The facility will be constructed as a 32 mgd wastewater treatment facility with sludge sent to the Ina Road WRF for processing. The basic treatment system components include:

- Headworks Facilities
  - Influent Pump Station
  - Influent Screening Facilities
  - Influent Grit Removal Facilities
- Odor Control Facilities
- Aeration Tanks (Bardenpho Process)
- Blower Facilities
- Secondary Sedimentation Facilities
- Disinfection
- Sludge Thickening
- Sludge Transfer Pump Station

The conceptual basis of design for the new Water Reclamation Campus at Roger Road is attached.

Ina Road WRF Expansion and Upgrades

Ina Road WPCF will have onsite facilities upgraded and expanded to meet the regulatory and growth needs of Pima County over the next 25-years. The wastewater treatment process will be based on Bardenpho technology to meet the stringent standards imposed by the Arizona Department of Environmental Quality. The plant will handle and treat the solids from both the Roger Road WRF and the Ina Road WRF. In the near-term Pima County wastewater treatment operations will produce a Class B biosolids. These biosolids will be distributed from the Ina Road WRF. In the future the plant may produce a Class A biosolids .which also would be centrally distributed from Ina Road. Cost and space requirements for Class A biosolids is based on the temperature phased anaerobic digestion technology. The basic treatment system components include:

- New Influent Pump
- New Influent Grit Removal Facilities
- Odor Control
- Primary Clarifiers
- Aeration Tanks (Bardenpho Process)
- Blower Facilities
- Secondary Sedimentation Facilities

- Disinfection
- Sludge Thickening Facilities
- Sludge Digestion Facilities
- Sludge Dewatering Facilities
- Sludge Transfer Pump Station

The conceptual basis of design for the expanded and upgraded Ina Road WRF is attached.

Water Reclamation Campus – 32-mgd

Description and Detail	Quantity
Wastewater Quantities	
Gallons Per Capita per Day	85
Annual Average Flow, mgd	24
Monthly Peak (1.1 x an. avg. flow), mgd	26
Daily Peak (1.4 x an. avg. flow), mgd	33
Hourly Peak (2.0 x an. avg. flow), mgd	48
Raw Influent Wastewater Characteristics	
Total Suspended Solids – mg/L	286
lbs/day	57,000
Chemical Oxygen Demand - mg/L	648
lbs/day	130,000
5-day Biochemical Oxygen Demand - mg/L	294
lbs/day	59,000
Soluble 5-day Biochemical Oxygen Demand - mg/L	121
lbs/day	24,000
Volatile Suspended Solids - mg/L	225
lbs/day	45,000
Total Kjeldahl Nitrogen - mg/L	47
lbs/day	9,400
Total Phosphorus - mg/L	10
lbs/day	2,000
Influent Screening Facilities	
Bar Screen Type	Mechanically cleaned
Coarse, number of units	2
Clear opening, in.	2.5
Fine, number of units	3
Clear opening, mm	3

Water Reclamation Campus – 32-mgd

Description and Detail	Quantity
Screenings Removal	
Screenings Removed	
cu ft/MG	10
cu ft/day (an. avg.)	240
Screenings removal support equipment	
Screen Belt Conveyors	
Screenings Compactor	
Influent Grit Facilities	
Type	Vortex
Number of units	2
Capacity per unit, mgd	24
Grit Removal	
Grit Removed	
cu ft/MG	6
cu ft/day (an. avg.)	144
System Performance	95% of 65 mesh grit
Odor Control	
At preliminary treatment, wastewater treatment, and sludge thickening facilities	

Water Reclamation Campus – 32-mgd

Description and Detail	Quantity
Treatment Wastewater Characteristics[1]	
Total Suspended Solids, mg/L	310
lbs/day	62,000
Chemical Oxygen Demand, mg/L	659
lbs/day	131,800
5-day Biochemical Oxygen Demand, mg/L	301
lbs/day	60,200
Soluble 5-day Biochemical Oxygen Demand, mg/L	121
lbs/day	24,200
Volatile Suspended Solids, mg/L	243
lbs/day	48,600
Total Kjeldahl Nitrogen, mg/L	47
lbs/day	9,400
Total Phosphorus, mg/L	10
lbs/day	2,000
Aeration Tanks[2]	
Number of tanks	4
Volume per tank (new)	702,000 cu. ft
Number of Stages per Tank	5
Return sludge, %	50
Internal recycle,%	400

[1] Includes plant recycle
[2] Include future biological phosphorus removal provisions (based on Bardenpho process)

Water Reclamation Campus – 32-mgd

Description and Detail	Quantity
Final Clarifiers	
Type	Circular
Number of Tanks	4
Clarifier diameter. ft.	150
Sidewater Depth, ft.	12
Total Surface Area of Tanks, sf	53,000
Surface Loading	
An. Avg., gal/sf/day	450
Peak, gal/sf/day	900
Final Clarifier Tank Effluent	
Suspended Solids, mg/L	7
BOD, mg/L	7
NH_3-N, mg/L	< 1
TN, mg/L	< 8
Disinfection (Chlorine Technology)	
Number of Basins	4
Detention Time @ an. avg. flow, min.	90
Sodium Hypochlorite Dosage, @ max. capacity, mg/L	15
Bisulfite (De-chlorinate), @ max. capacity, mg/L	22

Water Reclamation Campus – 32-mgd

Description and Detail	Quantity
Sludge Thickening Facilities	
Waste Activated Sludge to Thickening, Avg. Values	
Flow, mgd	1.72
Mass, lbs/day	100,600
Conc., mg/L	7,000
Gravity Belt Thickeners	
Thickener Effective Width, m	2
Design Sludge Flow per Thickener, gpm	500
Number of Existing Units (relocated)	1
Number of new units	3
Number of Thickeners Operating	3
Number of Thickeners Installed	4
Future Provision	2 units
Capture Efficiency, %	90
Polymer systems, number	2
Thickened Sludge Pumped to Ina Road	
Flow, mgd	0.26
Mass, lbs/day	65,600
Conc., % solids	3
Sludge Transfer Pump Station	
Thickened Waste Activated Sludge to Ina Road	
Number of pumps	2
Rate, gpm	400

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Wastewater Quantities	
Gallons Per Capita per Day	85
Annual Average Flow, mgd	50
Monthly Peak (1.1 x an. avg. flow), mgd	55
Daily Peak (1.4 x an. avg. flow), mgd	70
Hourly Peak (2.0 x an. avg. flow), mgd	100
Raw Influent Wastewater Characteristics	
Total Suspended Solids, mg/L	286
lbs/day	120,000
Chemical Oxygen Demand. mg/L	663
lbs/day	278,000
5-day Biochemical Oxygen Demand, mg/L	318
lbs/day	133,000
Soluble 5-day Biochemical Oxygen Demand, mg/L	123
lbs/day	52,000
Volatile Suspended Solids, mg/L	254
lbs/day	107,000
Total Kjeldahl Nitrogen, mg/L	55
lbs/day	23,000
Total Phosphorus, mg/L	11
lbs/day	4,600
Influent Screening Facilities	
Bar Screen Type	Mechanically cleaned
Coarse, number of existing units	2
Clear opening, in.	2.5
Fine, number of existing units	3
Clear opening, mm	3
Screenings Removal	
Screenings Removed	
cu ft/MG	10
cu ft/day (an. avg.)	500
Screenings removal support equipment	
Screenings Belt Conveyors	
Screenings Compactor	

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Influent Grit Facilities	Aerated Grit Channels
Type	
Number of units	
Existing	3
New	1
Grit Removal	
Grit Removed	
cu ft/MG	6
cu ft/day (an. avg.)	300
System Performance	95% of 65 mesh grit
Odor Control[1]	
At primary treatment, wastewater treatment, sludge dewatering, sludge thickening, and sludge loading station facilities	
Raw Sewage Pumping Station	
Pumps, type	Archimedes screw
Existing units	3
New	1
Capacity, mgd	35

[1] Preliminary treatment odor control exists.

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Primary Influent Wastewater Characteristics[2]	
Total Suspended Solids – mg/L	358
lbs/day	149,000
Chemical Oxygen Demand - mg/L	689
lbs/day	287,000
5-day Biochemical Oxygen Demand - mg/L	324
lbs/day	135,000
Soluble 5-day Biochemical Oxygen Demand - mg/L	123
lbs/day	51,000
Volatile Suspended Solids - mg/L	282
lbs/day	118,000
Total Kjeldahl Nitrogen - mg/L	63
lbs/day	26,000
Total Phosphorus - mg/L	15
lbs/day	6,300
Primary Clarifiers	
Type	Rectangular
Existing	6
New	2
Clarifier Length, ft	216
Clarifier Width, ft	40
Sidewater Depth at influent end, ft	12
Total surface area, sf	69,000
Surface Loading @ an. avg. flow, gal/sf/day	725

[2] Includes plant recycle

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Primary Effluent Wastewater Characteristics	
Total Suspended Solids, mg/L	146
lbs/day	61,000
Chemical Oxygen Demand, mg/L	456
lbs/day	190,000
5-day Biochemical Oxygen Demand, mg/L	229
lbs/day	96,000
Soluble 5-day Biochemical Oxygen Demand, mg/L	126
lbs/day	53,000
Volatile Suspended Solids, mg/L	123
lbs/day	51,000
Total Kjeldahl Nitrogen, mg/L	61
lbs/day	26,000
Total Phosphorus, mg/L	14
lbs/day	5,900
Aeration Tanks[3]	
Number of tanks	
Existing (with modified stages)	2
New	6
Volume per tank	752,000 cu. ft.
Number of Stages per Tank	5
Return sludge, %	50
Internal recycle, %	400

[3] Includes future biological phosphorus removal provisions (based on Bardenpho process)

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Final Clarifiers	
Type	Circular
Number of Tanks	7
Existing (4 @ 115 ft dia., 3 @ 135 ft. dia.)	3
New (2 @ 115 ft. dia., 1 @ 135 ft. dia.)	12
Sidewater Depth, ft.	119,600
Total Surface Area of Tanks, sq. ft.	
Surface Loading	420
An. Avg., gal/sf/day	840
Peak, gal/sf/day	
Final Clarifier Tank Effluent	
Suspended Solids, mg/L	7
BOD, mg/L	7
NH_3-N, mg/L	< 1
TN, mg/L	< 8
Disinfection (Chlorine Technology)	
Number of Basins	
Existing	2
New	2
Detention Time @ an. avg. flow, min.	90
Sodium Hypochlorite Dosage, @ max. capacity, mg/L	15
Bisulfite (De-chlorinate), @ max. capacity, mg/L	22

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Primary Sludge Thickening Facilities	
Primary Sludge, Avg.	
Flow, mgd	1.14
Mass, lbs/day	94,700
Conc., %	1
Gravity Thickeners for Raw Primary Sludge	
Number of Units	4
Diameter, ft.	40
Sidewater Depth, ft	10
Area per Tank, sf	1,260
Total Area	5,040
Active Volume per tank, MG	0.094
Volume, MG	0.38
Overflow Rate, gpd/sf	
Solids Only	225
Solids Only (1 out of service)	300
Solids and Max. Dilution Water	500
Maximum Dilution Water, mgd	1.38
Detention Time (@ max. dilution water, hr	3.6
Solids Capture Efficiency, %	90
Thickened Primary Sludge, Avg.	
Flow, mgd	0.23
Mass, lbs/day	85,300
Conc., %	4.5

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Waste Activated Sludge Thickening Facilities	
Waste Activated Sludge, Avg.	
Flow, mgd	1.35
Mass, lbs/day	78,700
Conc., mg/L	7,000
Gravity Belt Thickeners	
Thickener Effective Width, m	2
Design Sludge Flow per Thickener, gpm	500
Number of Thickeners Operating	2
Number of Thickeners Installed	3
Capture Efficiency	90%
Polymer systems, number	2
Thickened Waste Activated Sludge	
Flow, mgd	0.19
Mass, lbs/day	70,800
Conc., % solids	4.5
Sludge Digesters, type	Mesophilic
Ina Road Thickened Primary Sludge	
Flow, mgd	0.23
Mass, lbs/day	85,300
Conc., % solids	4.5
Ina Road Thickened Waste Activated Sludge	
Flow, mgd	0.19
Mass, lbs/day	70,800
Conc., % solids	4.5

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
WRC Thickened Waste Activated Sludge	
Flow, mgd	0.36
Mass, lbs/day	90,500
Conc., % solids	3
Total Influent Sludge	
Flow, mgd	0.78
Mass, lbs/day	247,100
Conc., % solids	3.8
Percent Volatile Solids	76
Volatile Solids, lbs/day	187,800
Total Number of Digesters	10
HRT, days	17.0
HRT (one unit out of service), days	15.3
Volatile Solids Loading, lb/d/1,000cf	105
Volatile Solids Loading (one unit out of service), lb/d/1,000cf	117
Volatile Solids Destruction, %	50
Digested Sludge	
Flow, mgd	0.78
Mass, lbs/day	153,200
Conc., % solids	2.4
Volatile Solids, lbs/day	93,900
Gas Production	
cf/lb Volatile Solids Destroyed	12
Total cf/day produced	1,100.000

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Sludge Centrifuge Thickening/Dewatering Facilities	
Influent Digested Sludge	
Flow, mgd	0.68
Mass, lbs/day	153,200
Conc., % solids	2.4
Centrifuges	
Operate for Thickening or Dewatering	
Number of Existing Units	3
Number of New Units	4
Future Provision	1 unit
Flow rate per Unit (24/7 operation), gpm	80
Flow rate per Unit (24/7 operation)	
one unit out of service, gpm	95
Flow rate per Unit (24/5 operation), gpm	110
Flow rate per Unit (24/5 operation)	
one unit out of service, gpm	132
Flow rate per Unit (8/5 operation), gpm	400
Flow rate per Unit (8/5 operation)	
one unit out of service, gpm	495
Capture Efficiency, %	95
Polymer systems, number	2
Thickened Sludge	
Flow, mgd	0.20
Mass, lbs/day	130,600
Conc., % solids	8
Dewatered Sludge	
Mass, lbs/day	130,600
Conc., % solids	20

Ina Road Water Pollution Control Facility (50-mgd)

Description and Detail	Quantity
Thickened or Pre-thickening Sludge Storage	
Digested Sludge (Unthickened)	
Flow, mgd	0.78
Mass, lbs/day	153,200
Conc., % solids	2.4
Thickened Sludge	
Flow, mgd	0.20
Mass, lbs/day	130,600
Conc., % solids	8
Storage Capacity, MG	2.5
Detention Time for Unthickened Digested Sludge, days	3.2
Detention Time for Thickened Digested Sludge, days	12.5
Sludge Loading Station	
Sludge pump, gpm	300
Units	2

APPENDIX J

Request for Expressions of Interest

Appendix J

Expressions of Interest

Request for Expressions of Interest

Pima County Metropolitan Wastewater Treatment System Capital Improvement Program

Alternative Project Delivery and Private Project Financing

Request for Expressions of Interest

***Issued by*:**
Pima County Wastewater Management Department
201 North Stone Avenue, 8th Floor
Tucson, Arizona 85701

April 2007

PIMA COUNTY
WASTEWATER MANAGEMENT DEPARTMENT
201 NORTH STONE AVENUE
TUCSON, ARIZONA 85701-1207

MICHAEL GRITZUK, P.E.
DIRECTOR

PH: (520) 740-6500
FAX: (520) 620-0135

April 23, 2007

To All Interested Parties:

The mission of the Pima County Wastewater Management Department (PCWMD) is to protect public health and safety by providing world-class service and sound environmental stewardship through the efficient conveyance, treatment and reclamation of wastewater. To achieve that mission PCWMD recognizes the value of engaging the "market" to explore alternative, optimal solutions and delivery methods as a means of implementing portions of the County's Capital Improvement Program. The County further recognizes that it is through collaboration with those entities that can make available to PCWMD "world class" innovative solutions that may result in the real cost and timesavings while implementing the Capital Improvement Program. Accordingly, in advance of those responding to this request for expressions of interest (RFEI), PCWMD expresses a debt of gratitude for those providing information that will help the County implement its mission.

For those responding to the RFEI, the County's hope is that certain knowledge may accrue to the County that will provide long-term benefits and value to the customers and citizens of Pima County. By responding to the RFEI, your effect will be contributing to that goal. In addition, your contribution may also lead to a better understanding of how public-private partnership can be used to meet long-term community benefits.

Pima County (County) is issuing this request for expressions of interest (RFEI) to solicit information from interested parties concerning the implementation of a proposed capital improvement program (Program) for its wastewater treatment system (System). Based on an extensive study of the System conducted over the past year by the Pima County Wastewater Management Department (Department) and a team of consultants led by Greeley and Hansen, the proposed Program has been developed. The County intends to expeditiously implement major portions of the Program. The scale of the program is substantial, with budget estimates ranging in excess of $500 million (basis 2006 dollars) over a multi-year period, depending upon financing availability and other factors.

The Program has been developed in close conjunction with internal and external stakeholders including the City of Tucson (City), which has independent responsibility for potable water production, treatment and distribution in the metropolitan region. The City has rights with respect to a large portion of the effluent produced by the County's wastewater system. A portion of the System effluent is currently further treated by the City and used for water reclamation purposes. The City has assisted in the preparation of this RFEI and may use relevant information

developed under this RFEI for its own water system capital improvement program planning purposes.

Through the issuance of this RFEI, the County is seeking input from respondents as to their potential interest in participating in the implementation of the Program and as to the project delivery method that they would recommend the County to employ. Input concerning the scope, extent, nature and schedule for the Program is also being sought.

The County expects that, through the issuance of this RFEI and the associated exchanges of information between the County and potentially interested firms, prior to the commencement of any formal procurement process, it will be able to obtain useful information regarding private sector participation in the Program in an organized and systematic fashion. The County also intends to utilize the RFEI process to familiarize the market with the contracting opportunities, which are expected to emerge from the Program, and to invite comment as to the private sector's requirements and preferences regarding potential participation in the Program. As a result, the structuring of the planned project procurements should be improved through greater understanding of the objectives and requirements of the companies participating in the market for these services.

Arizona law, in addition to traditional design-bid-build contracting, authorizes the County to utilize several alternative project delivery methods for carrying out the Program. These include design-build contracting and several variants, such as design-build-operate, design-build-finance-operate, and design-build-finance-own-operate. Construction-manager-at-risk contracts are also permitted. Each alternative method must commence with a request-for-qualifications process. RFEI responses will help the County gauge the level of market interest in particular delivery methods and determine the extent to which the Program will be implemented on a traditional or alternative basis.

The County is also aware of the heightened interest of financial firms in providing private financing for public infrastructure. Given the extent of the capital needs of the Program, as well as the projected $2 billion cost of the County's capital improvement program outside the wastewater sector, this RFEI is also intended to invite input from financial institutions as to potential private project financing approaches that the County may wish to consider in today's marketplace.

The County, accordingly, invites participation in this RFEI process by all private sector firms that may wish to participate in any aspect of the Program, whether for any or all of the particular projects under consideration. Such firms are expected to include companies with expertise in the design, construction, operation, maintenance, repair, management, and financing of wastewater and power infrastructure facilities, as well as biosolids residuals management services.

This RFEI does not constitute the formal commencement of any procurement process under applicable State law. Participation by interested firms is strictly voluntary, and any information obtained by the County may be freely used in any manner the County deems appropriate. An election not to respond to this RFEI will not disqualify or disadvantage any firm in the procurement process for any planned project once the County formally commences the process.

A pre-submittal meeting will be held on May 23 2007, between 9:30 AM and 12:00 PM at the following location:

Joel D. Valdez Main Library
Basement Meeting Room
101 North Stone Street
Tucson, Arizona

If requested, tours of Roger Road and Ina Road Facilities will be conducted between 1:00 PM and 5:00 PM on May 22 2007. Please advise via e-mail to ROMPEOI@wwm.pima.gov with number of visitors by May 18 2007.

Attendance at the pre-submittal meeting is encouraged but not a requirement for making a submittal in response to this RFEI.

This RFEI does not obligate the County in any manner with respect to the Program. Respondents shall bear all costs relating to their participation in the RFEI process, without any reimbursement by the County.

The County requests that responses to the RFEI be submitted by no later than 5:00 PM Arizona time on June 22, 2007.

We look forward to your participation and thank you for your interest.

Sincerely,

Michael Gritzuk
Director
Pima County Wastewater
Management Department

Enclosure: Request for Expressions of Interest

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Section 1 Introduction

1.1 Overview

The Wastewater Management Department (Department) of Pima County, Arizona (County) is nearing completion of its Regional Optimization Management Plan (ROMP). The ROMP is the culmination of a year-long intensive study of the capital improvements required to be made to the County's wastewater treatment system (System) through 2030. The County expects to commence procurement of major elements of the ROMP later this year. These elements consist of facility replacements, expansions and upgrades that must be built to meet expected capacity and effluent quality requirements, including reductions of ammonia and nitrogen concentrations discharged into the Santa Cruz River. Cost projections for planned near term capital improvements exceed $500 million. Priority capital improvement projects (Projects) included in the ROMP consist of:

- ***New 24 Million Gallons per Day (mgd) Wastewater Treatment Plant***. At the Roger Road site, a new facility will replace the existing Roger Road wastewater treatment facility (Roger Road WWTP).
- ***Major Upgrade/Expansion of the Ina Road Water Pollution Control Facility***. The upgrade will include nitrogen (ammonia) removal and the expansion will increase the plant's capacity from 37.5 mgd to 50 mgd (Ina Road WPCF).
- ***Power Generation Facilities***. At the Ina Road WPCF, retrofitted or new facilities will recover digester gas (methane) to generate power and heat for plant utilization (Power Facilities).
- ***Biosolids Services***. Treatment, production and disposal facilities or services will be developed and implemented at the Ina Road WPCF (Biosolids Services).
- ***Outlying (Smaller) Treatment Facilities***. Several small wastewater treatment facilities are owned and operated by the County which will require expansion to accommodate rapid population growth near those facilities.

The ROMP also includes a major transmission pipeline for the two-way conveyance of untreated wastewater between the existing Roger Road WWTP/proposed new Roger Road WRF and the Ina Road WPCF (Plant Interconnect Transmission Pipeline). Procurement of the Transmission Pipeline has commenced on a construction-manger-at-risk basis.

The ROMP concludes that there are several benefits that may accrue to Pima County through the exploration of creative public-private partnerships. For those initial areas under consideration, these benefits may include:

- ***Private Financing and Innovative Public Financing Options for ROMP Capital Improvements***. If private financing proves feasible, a key benefit to the County would be a reduction in the amount of debt needed to be raised by the County.

- ***Green Power Generation from Department Facilities***. Benefits from "green" power generation include a reduction in long-term operation and maintenance costs for power, as well as the potential to generate revenue for the County.

- ***Innovative Biosolids Disposal***. Has the potential to avoid the County's reliance on a single or limited number of providers for biosolids disposal. In addition, it could provide an offset for long-term operation and maintenance costs, as well as create confidence in a sustainable long-term biosolids disposal program.

- ***Methods for CIP Project Delivery***. Offers the County the potential to achieve greater efficiency in the implementation of capital projects through alternative project delivery methods that may provide cost savings over the traditional method of project implementation. The County is in the process of investigating alternative project delivery methods to the traditional bid-build method and is interested in receiving information from interested parties, including the private sector, which will help in determining the appropriate project implementation approach for each Project. Upon the completion of this review, the County will decide whether to proceed with an alternative project delivery method, or methods, for the implementation of the Projects or proceed using the traditional bid-build approach. Regardless of the method or methods chosen, it is anticipated that procurement of some of the Projects will commence in late 2007.

With respect to financing options for the Projects, the County is exploring all public and private innovative options that are available to the County. Questions relating to various private financing options are set forth below in Section 5.6.

1.2 RFEI Objectives

Through the issuance of this RFEI, the County is soliciting information from respondents on possible project delivery methods and related matters for the development of the Projects. The information requested in response to this RFEI is strictly voluntary on behalf of the respondent and may be used by the County in selecting project delivery methods and structuring the procurements. The following project delivery methods are permissible in Arizona, and are being considered as potentially viable procurement approaches to the implementation of the Projects:

- Traditional Design-Bid-Build;
- Design-Build;
- Design-Build-Finance (Turn-Key);
- Design-Build-Operate;
- Design-Build-Finance-Operate;
- Design-Build-Finance-Own-Operate; and
- Construction Manager at Risk.

The information provided in response to this RFEI will be used as part of the overall evaluation process for selecting the ultimate delivery method or methods. The County seeks particularly to receive information from parties that have had actual experience using one or more of the implementation approaches being contemplated, and that are potentially interested in submitting a proposal for a particular Project. Several firms have already made general inquiries of the County concerning contract opportunities that might arise from the ROMP. The County is issuing this RFEI in part to provide a

structured means by which to receive private sector comment in order to inform its public policy decisions, and to gauge the interest of qualified firms to enter into contracts using alternative project delivery methods.

It is requested that responses to this RFEI be in compliance with the schedule and requirements set forth in this RFEI. The County may elect to:

- Supplement, amend, otherwise modify or cancel this RFEI
- Postpone or change the date for receipt of responses to the RFEI
- Cancel or modify the Projects at any time

This RFEI is issued by the County solely for the purpose of gathering information regarding interested parties' perspectives on project delivery methods, private project financing, and related matters concerning Projects. The purpose of this RFEI is to simply solicit information and expressions of interest for the County's information and use and does not constitute a solicitation or procurement document for the development of the Projects, nor will it be a factor in determining to whom the Projects are awarded. A response to the RFEI is not mandatory for future participation in any procurement process. Failure to submit a response to this document will not disqualify any firm from submitting a response to any formal procurement process for the Projects. The submittals received may be made available to the public if requested. No response can be kept confidential.

1.3 Pima County Wastewater System

The Pima County wastewater system consists of two major wastewater treatment plants, a water reclamation plant, and eight outlying wastewater treatment facilities. The associated conveyance systems operate by gravity with some pump stations and force mains. The existing System components and recommendations for future improvements and modifications are discussed in greater detail below in Sections 2 and 3.

1.4 Regional Optimization Master Plan (ROMP) Study

The purpose of the ROMP has been twofold. The first purpose was to determine an optimal strategy for:

- Select treatment process to comply with regulatory agency effluent quality requirements;
- Addressing long-term flow/capacity management;
- Treating additional wastewater loading within current/future service basins;
- Evaluating existing facility rehabilitation needs;
- Optimizing solids handling; and
- Integrating reclaimed water program needs.

The second purpose was to develop a coordinated capital improvement design and construction program, including, at a minimum, cost estimates, schedules and a recommended project delivery and funding strategy for implementation of all resulting projects and integration with the Program. The current estimated cost of the ROMP Program is $536 million in 2006 dollars.

The ROMP identifies the optimal strategy for the treatment of current and projected wastewater flows to the existing Roger Road WWTP/new Roger Road WRF and the Ina Road WPCF, including the reduction of the amounts of ammonia and nitrogen concentrations discharged into the Santa Cruz River to comply with current and future environmental regulatory requirements. In addition, the County seeks to optimize biosolids treatment and disposal, and consider and evaluate updating the level of biosolids treatment to produce Class A biosolids.

The optimal strategy for long-term flow/capacity management, treatment of additional loading of metro basin wastewater, existing facility rehabilitation, optimized solids handling and optimal methods to provide reclaimed water are identified in the ROMP strategy. In addition a coordinated capital improvement design and construction program, including construction cost estimates, schedules and a recommended project delivery and funding strategy for implementation of all resulting projects is developed. Various hydraulic and process modeling were used in the evaluation of alternatives and development of the final recommendations.

The goal of the master plan is to serve as a broad road map. The plan is based on current and potential future regulatory and Department customer requirements. This master plan forecast needs for wastewater treatment capacity throughout the Department service area and the facilities required to meet those needs through the year 2030. The master plan builds upon several planning and engineering efforts previously performed for and by the Department. The plan identifies how and when wastewater treatment facilities are upgraded and expanded, as well as how existing facilities are integrated into future expansions or decommissions through the year 2030.

The plan recommends necessary wastewater treatment components and systems, phasing schedules and cost apportionments for future implementation of Department wastewater facilities.

1.5 ROMP Capital Improvement Plan

The ROMP identifies specific needs throughout the System, and operations that are necessary to meet its current and future regulatory obligations and comply with good practices for fully functional and efficient operations capable of 24-hour 7-day per week service. The areas of need will require new or rehabilitated facilities in the near future. These facilities are:

- ***New 24-mgd Roger Road WRF***. At the Roger Road site a brand new facility will be constructed along side of the existing wastewater treatment operations. The new facilities will have the operating capacity to treat 24 million gallons of wastewater per day (additional capacity of 8 mgd may be added to the new facilities in the future). The facility will be designed around the Bardenpho process with the treatment capacity to achieve an ammonia limit of less than 2 mg/L. The existing Roger Road WWTP will be decommissioned and demolished to make room for economic development at that site.

- ***Major Upgrade of the Ina Road WPCF***. The existing wastewater treatment facilities at Ina Road consist of two treatment process trains designed to meet different effluent criteria. The future treatment process will integrate the two existing wastewater processes to provide a system to remove high levels of nitrogen with the Bardenpho process. In addition the combined capacity of the existing systems will be expanded from a capacity of 37.5 mgd to 50 mgd.

- ***Power Generation Facilities***. There is an existing power generation facility at the Ina Road WPCF that generates power and heat for internal use at the plant. In the future biosolids from the existing Roger Road WWTP will be transferred to the centralized solids processing center at Ina Road WPCF which will increase the amount of biogas available for power and heat production. The biosolids will be anaerobically digested and the gas made available for power and heat generation. The existing power generation facilities are scheduled to be upgraded or replaced with modern, efficient systems with the capacity to utilize the entire biogas production. Currently, the plant supplements the biogas production with purchased natural gas to achieve its power production goals.

- ***Biosolids Services***. The current biosolids practice is to generate Class B biosolids and to contract out the disposal for land application. Biosolids at the two major treatment plants are treated on site with mesophilic digesters. Digested biosolids at Roger Road are pumped to Ina Road for thickening with the Ina Road digested biosolids. The combined thickened biosolids are discharged to a storage facility prior to loading tanker trucks for land application. In the future digestion will be discontinued at Roger Road and all solids will be digested at Ina Road. The County is seeking alternative treatment and/or disposal options to broaden its flexibility to meet the changing regulatory and marketing demands and its reliability on a single source of disposal.

- ***Outlying (Smaller) Treatment Facilities***. Several small wastewater treatment facilities are owned and operated by the County which will require expansion to accommodate rapid population growth near those facilities. The County currently operates nine outlying wastewater treatment facilities. Seven of the nine facilities are located in areas of rapid population growth. The future plan is to expand four of these facilities and combine three with the other existing facilities through interconnecting gravity sewers. The remaining two facilities will remain at their current size because of buildout or growth restrictions in the service areas. The four plant expansions will increase capacities from less than one million gallons per day to approximately 4 to 6 million gallons per day. One facility is expected to increase to over 10 mgd in the 25-year planning period.

1.6 County Retained Responsibilities

In general, under any procurement approach to the Projects, the County will retain responsibility for policy, planning, regulatory enforcement, permitting, capital improvements, setting rates, billing and collection, and overall administrative and financial management of the utility enterprise funds. Ownership, financing and operational responsibility shall also remain with the County with respect to the entire System, except to the extent that the County considers using the design-build-finance, design-build-operate, design-build-finance-operate, or design-build-finance-own-operate procurement models to implement particular Projects.

1.7 Timetable

Following issuance of this RFEI, respondents may submit written questions to the County to assist them in preparing their responses. The deadline for receipt of questions concerning this RFEI is June 13, 2007. The County may, but is not be obligated to, respond to such questions. All responses to these questions and requests for additional information which the County determines to warrant a response will be

addressed at the Pre-Submittal Meeting, if respondent's questions are received prior to such meeting, or issued in the form of addenda to this RFEI.

The County will hold a meeting (Pre-Submittal Meeting) to present the Projects and the goals and objectives of this RFEI to potential respondents and to provide them with the opportunity to ask pertinent questions. The Pre-Submittal Meeting will take place at 9:30 AM on May 23, 2007 at Joel D. Valdez Main Library, 101 North Stone Street, Tucson, Arizona 85701.

For planning purposes, the County requests that each potential respondent planning to attend the Pre-Submittal Meeting notify the County by e-mail to ROMPEOI@wwm.pima.gov by May 18 2007 of the total number of individuals representing such potential respondent that will be in attendance at the Pre-Submittal Meeting.

The County requests that responses be submitted no later than 5:00 PM Arizona time on June 22, 2007 (RFEI Response Due Date). Responses should be reasonably succinct. The County further requests that responses include a letter of transmittal that identifies the name, address, title, telephone number, and email address of the contact person who will serve as the interface between the County and the respondent.

One original and ten (10) hard copies as well as one electronic copy of respondent's response should be submitted on or before the RFEI Response Due Date to:

Mr. Michael Gritzuk, Director,
Pima County Wastewater Management Department
201 N. Stone Avenue, 8th Floor,
Tucson, AZ 85701

1.8 Communications

Inquiries, questions and correspondence relating to this RFEI should be submitted by e-mail to ROMPEOI@wwm.pima.gov .

1.9 Costs

The costs and expenses associated with the preparation of a response, attendance at the Pre-Submittal Meeting, and preparation of all other information required pursuant to this RFEI will be borne by the respondent. In no event will a respondent have a claim against the County, its staff, or its consultants or agents for reimbursement of any such costs or expenses.

1.10 Respondents

The County is seeking responses from private firms, or teams of private firms, with expertise in developing, designing, building, operating and maintaining, managing, or financing wastewater treatment facilities and systems, or any combination of the foregoing.

Particularly, the County is interested in receiving useful input from private firms who may be planning to participate in any or all of the particular Projects that are being considered under the following viable

procurement approaches: traditional bid-build; design-build; design-build-finance (turn-key); design-build-operate; design-build-finance-operate; design-build-finance-own-operate; or construction-manager-at-risk.

Stakeholders not in the private sector are also invited to make submittals as to matters addressed in this RFEI if such stakeholders have information they believe the County should consider in making its ROMP implementation decisions.

1.11 County Website

Additional documents and information may be available for use by the Respondent. Additional information, if and when available, will be posted on the Internet at http://www.pima.gov/procure/ifbrfp-dc.htm. Respondents are advised that the documents posted on the website will have been prepared in the course of the County's development of the Projects, as well as other County projects.

1.12 County Team

The information received in response to this RFEI will be reviewed and analyzed by representatives of the Pima County Wastewater Management Department, the Pima County Attorney's Office, the Pima County Finance and Risk Management Department, the City of Tucson, Greeley and Hansen (consulting engineers), Hawkins Delafield & Wood LLP (special counsel), and Raftelis Financial Consultants (financial advisors).

Section 2 Facilities, Operations and Budget

2.1 Description of the Department and Its Responsibilities

Department operations are authorized by state legislative authority (Arizona Revised Statutes, Title 11, Chapter 2, Article 4). The Department's primary responsibilities are to effectively manage, operate, and maintain a regional public sanitary sewer system serving the residents of the County. Currently, the Department provides service to customers in several unincorporated areas of eastern Pima County, the Cities of Tucson and South Tucson, the Towns of Oro Valley and Marana, a portion of the Town of Sahuarita, and a portion of Pinal County. The Department is governed by the Pima County Board of supervisors (Board) and the Pima County Wastewater Management Advisory Committee (WMAC). The WMAC was established by the Board in 1986 to ensure adequate public oversight of all Department activities.

The Department is operated as an enterprise fund and is not dependent on property or sales taxes levied by the County. The Department is authorized to assess and collect fees and charges to recover its costs of operation and, through voter approval, can issue revenue bonds for the rehabilitation, construction, acquisition, and improvement of the sanitary sewer system.

2.2 Existing Facilities

The existing wastewater treatment facilities owned and operated by the County include two major treatment works and nine smaller facilities.

2.2.1 Roger Road Wastewater Treatment Plant

The existing Roger Road WWTP is the older of the two major treatment facilities. The plant is the result of several past expansions, and currently has a permitted capacity of 41 million gallons per day. The facility is located at 2600 W. Sweetwater Drive, Tucson, Arizona 85705, just north of Prince Road between Interstate 10 and the Santa Cruz River. The existing Roger Road WWTP was first operated in 1951 as a 12-mgd activated sludge facility and was expanded with a separate 13-mgd trickling filter plant in 1960. A 13-mgd activated sludge/contract stabilization facility was added in 1967. In 1979, the facility was consolidated into a single facility with the major biological treatment process consisting of two, 165-foot diameter by 26-foot deep, plastic media, biofilters with return activated sludge capability. Digested biosolids are conveyed via force main to the Ina Road WPCF, combined with digested biosolids from the Ina Road WPCF, and thickened and applied to agricultural land as a soil amendment. Methane produced at the facility is used to generate electrical power and power on-site equipment.

As flow and influent loadings have increased at the facility, the activated sludge tanks have been placed into continuous service. The facility is currently required to meet secondary treatment limits. It is anticipated that process modification or changes will be required to lower nitrogen discharge levels from this facility. Rehabilitation is needed to repair corroded process units, replace equipment that is beyond its service life, address odor control issues, and upgrade the facility to be compliant with current environmental regulatory code requirements.

Investigations and evaluations performed under the ROMP concluded that the existing Roger Road WWTP is aging and is difficult to retrofit with new facilities that are capable of meeting future effluent goals, while meeting environmental requirements and odor control. The Roger Road site has available space sufficient to accommodate all new treatment facilities on the existing plant site. Therefore, the ROMP concludes that a new treatment plant on the available space referred to as a Roger Road Water Reclamation Facility (WRF) option is the preferred alternative to the modification/expansion of the existing plant for Roger Road WWTP.

2.2.2 Ina Road Water Pollution Control Facility

The existing Ina Road WPCF was designed in 1973 and constructed from 1975 to 1977. The facility is located at 7101 N. Casa Grande Highway, Tucson, Arizona 85743, just south of Ina Road, between Interstate 10 and the Santa Cruz River. The facility was designed to produce a treated effluent meeting existing regulatory secondary treatment quality requirements. The existing Ina Road WPCF uses a 25-mgd high-purity oxygen activated sludge process, a sludge digestion and centrifuge thickening/dewatering facility for solids-handling (to meet Class B agricultural land application disposal criteria), and a complete energy-recovery system for heating, cooling and on-site generation of electrical power for plant operation from methane generated as part of the treatment process. Modifications to the original design to enhance equipment performance and reliability were completed in 1990. Average winter influent flow (peak season) is currently 23.8 mgd.

The headworks serving this facility, along with appropriate odor control facilities, were recently expanded. A Biological Nutrient Removal Activated Sludge (BNRAS) treatment works with average daily flow of 12.5 mgd has recently been constructed and placed into service. Effluent from the existing 25-mgd treatment process and the new 12.5-mgd BNRAS treatment process is combined prior to dechlorination and discharge into the Santa Cruz River.

Process modifications will also be required at this facility to lower nitrogen discharge levels. Rehabilitation is needed to repair existing corroded facilities, replace equipment that is beyond its service life, and upgrade the facility to be compliant with current environmental regulatory code requirements. Any modifications will need to consider back-up power provisions and existing/expanded need of laboratory facilities.

Investigations and evaluations performed under the ROMP concluded that most of the existing treatment facilities at the Ina Road WPCF are both viable and functional for conversion to meet the effluent goals, while meeting environmental requirements and odor control through the planning period. Additional facilities will need to be constructed to treat projected additional flows and loads.

2.2.3 Other Existing Facilities and Practices

Other existing facilities owned and operated by the County include:

- Randolph Park Water Reclamation Facility;
- Arivaca Junction Wastewater Treatment Facility;
- Avra Valley Wastewater Treatment Facility;
- Corona de Tucson Wastewater Treatment Facility;
- Green Valley Wastewater Treatment Facility;

- Marana Wastewater Treatment Facility;
- Mt. Lemmon Wastewater Treatment Facility;
- Pima County Fairgrounds Wastewater Treatment Facility; and
- Rillito Vista Wastewater Treatment Facility.

The Randolph Park Water Reclamation Facility (WRF) is a 3-mgd Membrane Bioreactor facility capable of producing Class A+ reuse water for discharge into the Tucson Water Reclaimed Water System. There are no plans under the ROMP to modify the Randolph Park WRF.

Additional details on the eight (8) other existing facilities owned and operated by the County are set forth below in Section 3.5 of this document.

2.3 Recent Improvements and Optimization Efforts

Over the course of time, facilities and equipment at wastewater treatment plants reach the end of their useful life, become obsolete or need to be replaced or upgraded, or both, to meet more stringent regulatory requirements.

Recently completed significant improvements and optimization efforts for the existing Roger Road WWTP and the Ina Road WPCF include the following:

- Roger Road WWTP
  - Headworks – new screenings washing and compaction equipment;
  - Headworks – new grit washing and separation equipment; and
  - Sludge Handling Facilities – new gravity belt thickener (GBT) for thickening waste activated sludge (WAS).

- Ina Road WPCF
  - Secondary Treatment Process – Construction and startup of the new 12.5-mgd BNRAS plant.

Improvement and optimization efforts which are currently in progress or planned for the existing Roger Road WWTP and the Ina Road WPCF include the following:

- Roger Road WWTP
  - Sludge Thickening Facilities – Improvements to existing odor control scrubber to improve performance;
  - Plant Headworks – Addition of enclosure and odor control facilities to reduce off site odor emissions;
  - Primary Clarifiers – Addition of covers over the effluent troughs to collect air for odor control;
  - Bio Towers – Reversal of air flow, collection of air and addition of odor control facilities to reduce off site odor emissions; and
  - Electrical Power Distribution – improvements and replacements to increase reliability of electrical power supply and distribution.

- Ina Road WPCF
  - Existing Odor Control Scrubbers - Improvements to existing odor control scrubbers to improve performance.

2.4 Interface with City of Tucson Water Department

The City of Tucson operates the majority of the reclaimed water distribution system in the region. Construction of the interconnect pipeline between Roger Road WWTF and the Ina Road WPCF will impact available water to the existing Tucson Water Reclaimed system for existing and future customers.

Tucson Water will, therefore, need additional capture and treatment facilities at the Ina Road WPCF. Those facilities (the Tucson Regional Reclamation Facility – TRRF) will be constructed on 10-acres +/- at the Ina Road WPCF provided for in an existing inter-governmental agreement.

The TRRF will initially be designed for a capacity of 20 mgd, expandable to 40 mgd, with allowance for additional, advanced water treatment. Construction is planned to coincide with the Ina Road WPCF expansion.

2.5 Economic and Financial Matters

2.5.1 Rates and Charges

The Department provides wastewater collection, treatment, and disposal services for residential, commercial, and industrial customers. All customers are assessed a monthly service fee of $5.72 and a monthly user fee of $1.33 per one hundred cubic feet based on metered water consumption. Certain customers that contribute wastewater to the County's system that is above residential strength are surcharged for the additional cost of treatment. New residential customers are assessed an average connection fee of $4,700 to recover the cost of capacity available in the County's system.

2.5.2 Financial Summary

The Department's primary sources of revenue are from user fees and connection charges, which represent approximately 96% of annual cash receipts. As of March 2006, the Department's forecast of revenues for fiscal year (FY) 2007, excluding capital contributions, is approximately $100.4 million. The Department's forecast of operating expenditures for FY 2007 is approximately $70.0 million. Non-operating expenditures, which include departmental capital outlays, revenue financed capital and debt service, are projected to be approximately $30.4 million.

Based on the County's FY 2006 Comprehensive Annual Financial Report, the Department has total assets of $657.9 million. Total current assets are $68.7 million and include $42.3 million in unrestricted cash and cash equivalents. Total liabilities are $152.2 million; and total net assets, which primarily include funds invested in capital assets net of related debt, are $505.7 million.

The Department's long-term debt obligations include principal and interest payments on a number of revenue bond issues and a loan from the Water Infrastructure Finance Authority of Arizona. The Department's percentage of long-term debt to total assets of 19.1% and ratio of long-term debt to equity of 0.25 are both favorable compared to similar utilities. Moody's Investor Service assigned an underlying

rating of A1 to the Department's Series 2007 Revenue Bonds, while Standard & Poor's assigned an underlying rating of A+. Both ratings represent above average creditworthiness relative to other municipal or tax-exempt issuers.

2.5.3 Financial Planning Considerations

All of the Department's capital costs, including ROMP project costs, are presently being evaluated in a 15-year Capital Improvements Plan (CIP) currently under preparation by the Department. Funding sources were identified as part of a Baseline Financing Plan that used traditional public financing vehicles including revenue bonds, connection charges, and revenue financed capital. A projection of operating and maintenance costs was also developed that considered the effects of inflation, increased operating costs, increased demand, and the operational impact of the Department's CIP. Total revenue requirements, both operating and capital, were projected over the forecast period to assess the potential impacts on user rates and charges. The forecast of revenue requirements also considered the Department's liquidity objectives and debt service coverage requirements.

2.6 Effluent Quality Requirements

Current Arizona Pollutant Discharge Elimination System (AZPDES) permit requirements for the existing Roger Road WWTP and the Ina Road WPCF are summarized in the following table:

Table 2-1
Current Permit Requirements

Parameter	Roger Road WWTP Monthly Average Limit	Ina Road WPCF Monthly Average Limit
Effluent Flow, mgd	41	37.5
BOD (5 day), mg/L	30	30
Total Suspended Solids, mg/L	30	30
Total Nitrogen, mg/L	No Permit Requirement	No Permit Requirement
Parameter	Roger Road WWTP – Monthly Average Limit	Ina Road WPCF – Monthly Average Limit
Ammonia, mg/L	No Permit Requirement	No Permit Requirement
Total Phosphorous, mg/L	No Permit Requirement	No Permit Requirement
Fecal Coliform Bacteria	200 cfu/100ml	200 cfu/100ml
e-coli Bacteria	126 cfu/100ml	126 cfu/100ml
Settleable Solids, mg/L	1	No Permit Requirement
pH	>6.5,<9.0	>6.5,<9.0
Total Residual Chlorine	0.011 mg/L	0.011 mg/L
Copper (as CU)	No Permit Requirement	38 mg/L

Projections of wastewater flows and characteristics for the year 2030 were made during development of the ROMP and are summarized as follows:

Table 2-2
Year 2030 Wastewater Influent Flows and Characteristics

Parameter	Roger Road WWTP Raw Wastewater Influent (with in-plant recycles) Characteristics	Ina Road WPCF Raw Wastewater Influent (with in-plant recycles) Characteristics
Flow, mgd	33.2	52.6
COD, mg/L	659	689
BOD (5 day), mg/L	301	324
sBOD (soluble), mg/L	121	123
Total Suspended Solids, mg/L	310	358
Volatile Suspended Solids, mg/L	243	282
TKN, mg/L	47	63
TP	10	15

Future AZPDES permit requirements for Roger Road WRF and Ina Road WPCF are anticipated to be as summarized in the following table:

Table 2-3
Future AZPDES Permit Requirements

Parameter	Roger Road WRF Monthly Average Limit	Ina Road WPCF Monthly Average Limit
Effluent Flow, mgd	32	50
BOD (5 day), mg/L	5	5
Total Suspended Solids, mg/L	10	10
Total Nitrogen, mg/L	8	8
Ammonia, mg/L	2	2
Total Phosphorous, mg/L	No Permit Requirement	No Permit Requirement
Fecal Coliform Bacteria	No Fecal Coliform organisms detected in 4 of 7 samples collected during the week base on seven daily samples per week, no single sample with >23 cfu/100ml	No Fecal Coliform organisms detected in 4 of 7 samples collected during the week base on seven daily samples per week, no single sample with >23 cfu/100ml
e-coli Bacteria	No e-coli organisms detected in 4 of 7 samples collected during the week base on seven daily samples per week, no single sample with >15 cfu/100ml	No e-coli organisms detected in 4 of 7 samples collected during the week base on seven daily samples per week, no single sample with >15 cfu/100ml
Settleable Solids, mg/L	1	No Permit Requirement
pH	>6.5,<9.0	>6.5, <9.0
Total Residual Chlorine	4 ug/L	4 ug/L
Copper (as CU)	25 ug/L	30 ug/L

2.7 Regulatory Matters

The County's Roger Road WWTP and Ina Road WPCF operate under AZPDES permit numbers AZ0020923 and AZ0020001, respectively, issued by the Arizona Department of Environmental Quality (ADEQ). ADEQ operates the AZPDES program under a delegation agreement with U.S. EPA. Pursuant to state law, ADEQ also issues permits under a state-wide aquifer protection permit (APP) program. See Arizona Administrative Code Title 18, Chap. 9. The Roger Road WWTP and Ina Road WPCF operate under APP permit numbers P-100655 and P-100630, respectively.

The AZPDES operating permits for the Roger Road WWTP and Ina Road WPCF require the facilities to comply with ammonia removal standards by January 30, 2014 and January 30, 2015, respectively. The ammonia removal requirements are the impetus for the ROMP process.

The AZPDES permits also include the standard array of effluent discharge concentration limitations as well as whole effluent testing standards and biosolids quality standards. In addition, the APP permits currently in place require compliance with discharge limitations for a substantially greater list of organic and inorganic compounds plus fecal coliform. Once the two facilities are expanded or replaced, new source best available demonstrated control technology will apply. These include more stringent limits for a number of parameters including fecal coliform.

In addition to these permitting constraints, the County has an existing agreement with the City regarding ownership of wastewater facility effluent. The City currently uses a significant amount of the Roger Road effluent for irrigation and aquifer recharge purposes. It operates its own filtration plant to prepare the effluent for re-use. The City will continue to need effluent from the Roger Road WWTP and plans to begin using effluent from the Ina Road WPCF once the expansion is complete.

Section 3 Proposed Projects

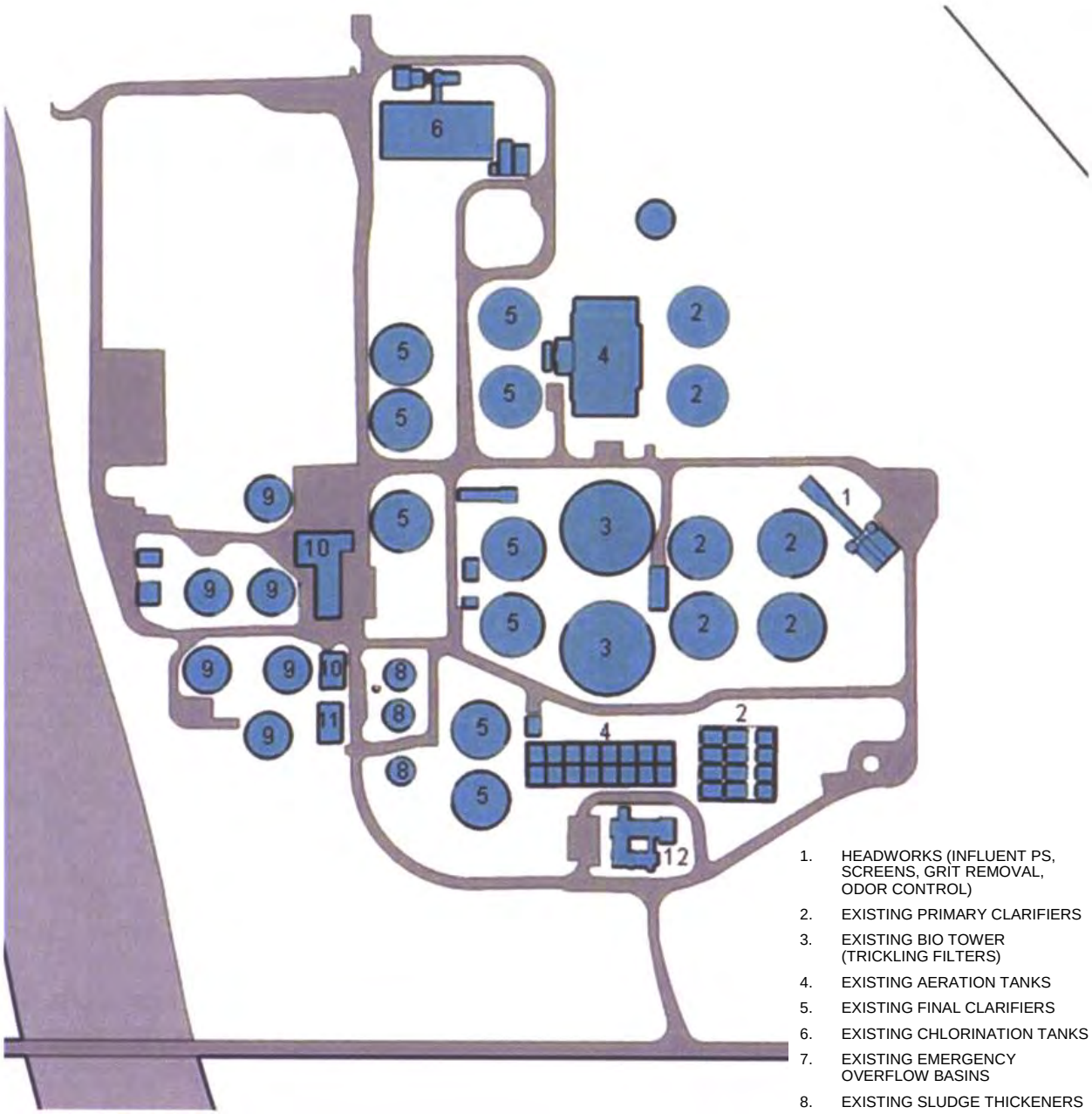
3.1 Roger Road Facilities

A new Roger Road WRF plant without primary treatment is planned. The existing treatment facilities will be decommissioned and demolished once the new plant is operational. Major elements of the new Roger Road WRF include:

- New Influent Pump Station;
- New Screenings and Grit Removal Facility;
- New Aeration Tanks (configured in the Bardenpho Process);
- New Final Clarifiers;
- New Rapid Sand Effluent Filters (Optional);
- New Disinfection Facilities;
- New administration and ancillary facilities
- New WAS Thickening/Pumping Facility; and
- Demolish and Remove existing Roger Road WWTP after new GF Plant is operational.

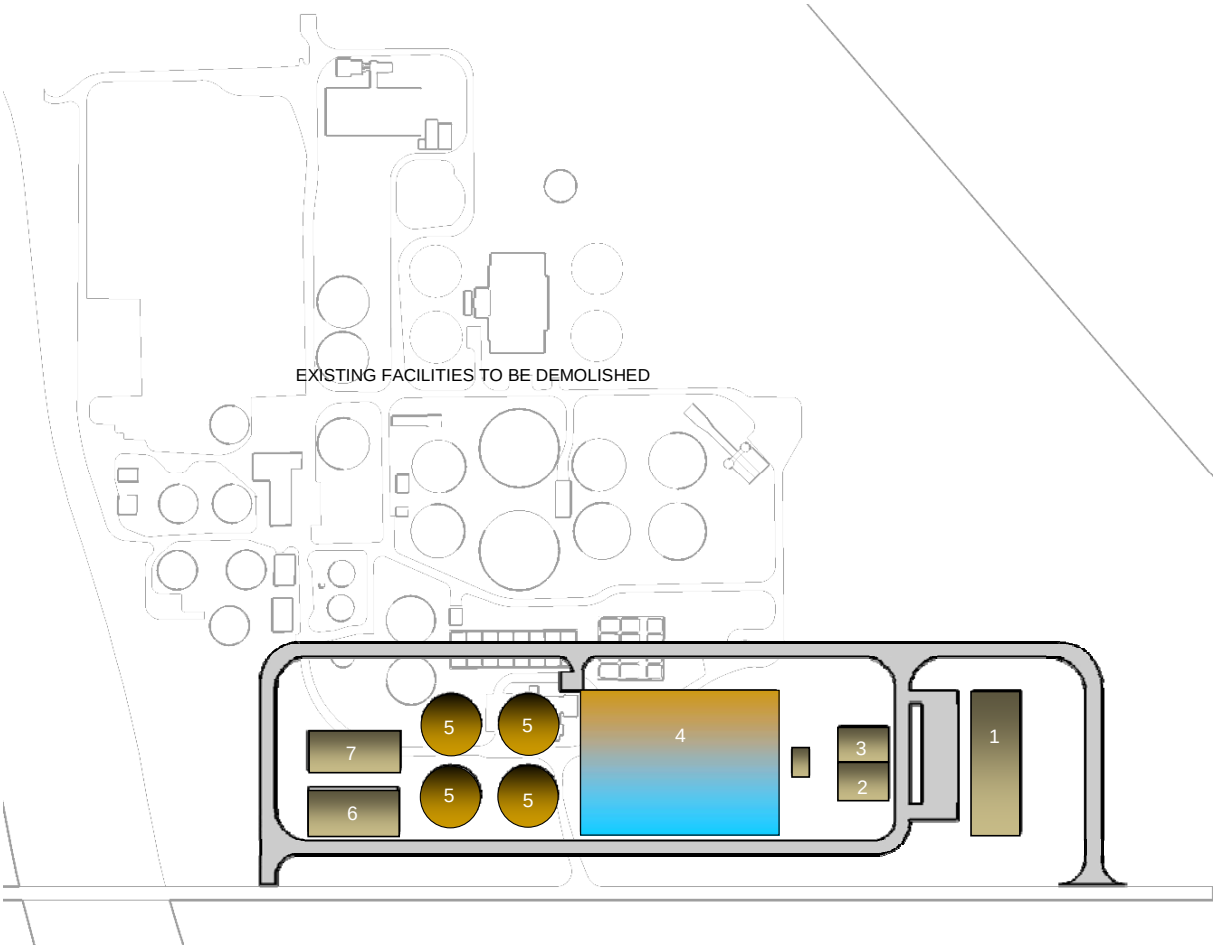
There is a “green space” on the south side of the existing Roger Road WWTP that is available to site a new facility to treat 24 mgd of wastewater. The recommended plan for future Roger Road WRF is to locate the facilities along Sweetwater Drive on the south side of the existing treatment facilities and west of the existing Tucson water reclaimed water filtration plant, reservoir and pumping station operations. The plan maximizes the availability of public land for alternative uses, such as a new sports complex, enables upstream discharge to the Santa Cruz River to sustain riparian habitat, and locates operations adjacent to the existing and future reclaimed water operation. The existing facilities will continue operations until the new facilities are commissioned and then the existing facilities will be demolished. A site plan of the existing Roger Road WWTP and the proposed new Roger Road WRF plant is presented on **Figure 3-1** and **Figure 3-2**.

Figure 3-1
Existing Roger Road WWTP Site Plan



1. HEADWORKS (INFLUENT PS, SCREENS, GRIT REMOVAL, ODOR CONTROL)
2. EXISTING PRIMARY CLARIFIERS
3. EXISTING BIO TOWER (TRICKLING FILTERS)
4. EXISTING AERATION TANKS
5. EXISTING FINAL CLARIFIERS
6. EXISTING CHLORINATION TANKS
7. EXISTING EMERGENCY OVERFLOW BASINS
8. EXISTING SLUDGE THICKENERS
9. EXISTING ANAEROBIC DIGESTION
10. EXISTING SLUDGE DEWATERING/DISPOSAL FACILITY
11. EXISTING POWER GENERATION FACILITY
12. EXISTING ADMINISTRATION/ LABORATORY

Figure 3-2
Proposed Roger Road WRF Site Plan



1. PROPOSED ADMINISTRATION FACILITY
2. PROPOSED HEADWORKS (INFLUENT PS, SCREENS)
3. PROPOSED GRIT REMOVAL FACILITY
4. PROPOSED BARDENPHO AERATION TANKS
5. PROPOSED FINAL CLARIFIERS
6. PROPOSED EFFLUENT FILTERS/DISINFECTION FACILITIES
7. PROPOSED SLUDGE THICKENING/TRANSFER FACILITY

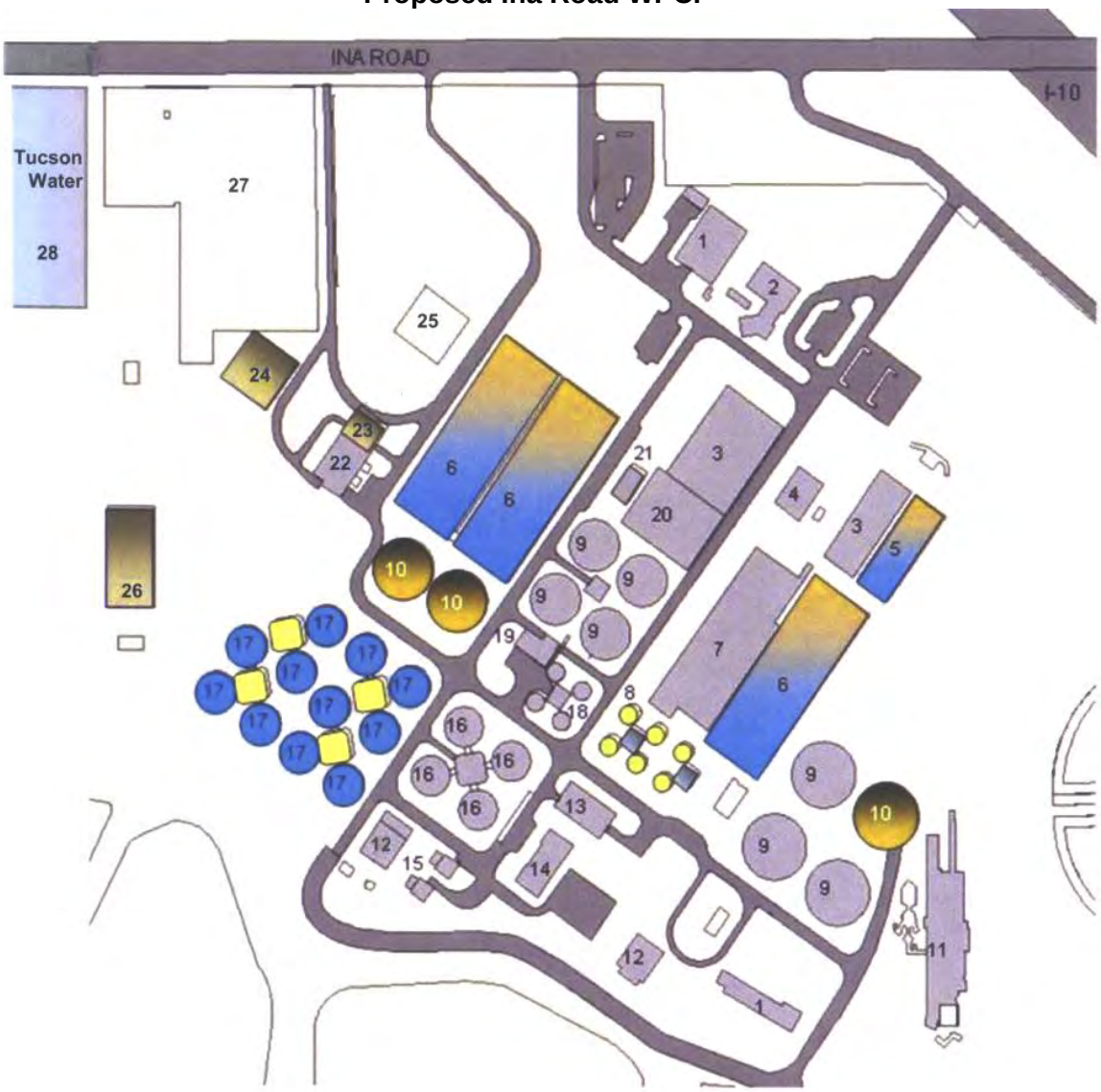
3.2 Ina Road Facilities

The draft ROMP recommends that the Ina Road WPCF facilities be expanded to accommodate the treatment of 50 mgd on the existing site. Major elements of the expanded Ina Road WPCF include:

- Additions to the existing headworks (pump station, screen and grit) facility;
- New Primary Clarifiers;
- Modifications to existing BNRAS (12.5 mgd) plant (reconfigured to the Bardenpho Process);
- New Aeration Tanks (configured in the Bardenpho Process);
- New Final Clarifiers;
- New Rapid Sand Effluent Filters (Optional);
- New Disinfection Facilities;
- Upgrade existing power plant or construct new facilities
- New Sludge Thickening, Anaerobic Digestion and Sludge Disposal Facilities; and
- Demolish and Remove portions of the existing High Purity Oxygen Plant after the new plant is operational.

At the Ina Road WPCF, there is sufficient space on the existing plant site to accommodate expansion to treat 50 mgd of wastewater. A site plan of the existing and proposed new facilities at the Ina Road WPCF is presented on **Figure 3-3**.

Figure 3-3
Proposed Ina Road WPCF



1. WAREHOUSE
2. ADMINISTRATION BUILDING
3. EXISTING PRIMARY CLARIFIERS
4. NEW BLOWER BUILDING
5. NEW PRIMARY CLARIFIERS
6. NEW AERATION TANKS
7. EXISTING AERATION TANKS
8. NEW SLUDGE THICKENERS
9. EXISTING SECONDARY CLARIFIERS
10. NEW SECONDARY CLARIFIER
11. HEADWORKS
12. CHLORINE CONTACT BASIN
13. ENERGY RECOVERY BUILDING
14. TRAINING CENTER
15. CHLORINATION BUILDINGS
16. EXISTING DIGESTORS
17. NEW DIGESTORS
18. EXISTING SLUDGE THICKENERS
19. EXISTING VACUUM FILTRATION BUILDING
20. EXISTING ACTIVATED SLUDGE REACTOR
21. OXYGEN PRODUCTION
22. EXISTING CENTRIFUGE BUILDING
23. EXTENSION TO CENTRIFUGE BUILDING
24. NEW GBT THICKENING BUILDING
25. SLUDGE STORAGE BASIN
26. FILTER / DISINFECTION
27. PIMA COUNTY INDUSTRIAL WASTE
28. TUCSON WATER

3.3 Power Facilities

The plant power generation system at Ina Road WPCF consists of seven 650 kW, 4160 volts, 3-phase generators connected in parallel to 4.16 kV Switchgear "A/B". The power generators utilize biogas (primarily methane) generated on-site by anaerobic digestion of organic solids and natural gas supplied by the local utility. The production of methane gas will be increased in the future as the plant is expanded and the Ina Road WPCF becomes the centralized solids processing center. Switchgear feeder breakers distribute power to six outdoor unit substations and three 400 horsepower Oxygen Compressors. The unit substations are connected delta-wye with their secondaries rated 480-volts, 3-phase. The secondary of each unit substation serves a close coupled walk-in aisle 480-volt switchboard with the exception of the two at the Centrifuge Building. The Centrifuge Building unit substations serves a motor control center directly from the secondaries of the substation transformers. Those configured with secondary switchboards distribute power to motor control centers and other utilization equipment.

Since digester gas (methane) will not be available at the new Roger Road facility, it is expected that engine generators will be provided as backup power in the event of power outage in the power grid servicing the plant. This is forecast to be intermittent service. The fuel source would be fuel oil, natural gas or liquid propane.

3.4 Biosolids Services

3.4.1 Existing Biosolids Processing

Stabilized Class B biosolids from both the existing Roger Road WWTP and the Ina Road WPCF are currently thickened to approximately 8 percent solids using centrifuges and are disposed of through an existing contract for agricultural land application. This disposal option is suited to thickened rather than dewatered solids as the water in the biosolids is beneficial in the region and the existing contractor's equipment is consistent with this product up to 10 percent solids.

The current land application option has been successful for the County and provides a beneficial use of its biosolids. It is expected that land application will continue to be an option for biosolids disposal in the area in the future. However, some issues of concern with this disposal method have arisen. Currently, hauling distances for disposal are approximately 25 miles round trip and are through a single disposal contractor that controls the majority of available land in the area. It is expected that this hauling distance could increase to 40 miles at some point in the future as development pushes available land further out from the existing Ina Road WPCF. Concerns over the quality of Class B biosolids have arisen in other areas of the U.S. If similar concerns arise in the area, disposal of Class B biosolids by land application could become difficult or unacceptable, requiring Class A processing. As a result, the County is seeking additional options for disposal.

3.4.2 Future Biosolids Processing

In order to provide reliable biosolids processing and disposal through the planning period, the following recommendations for biosolids processing improvements are made in the ROMP:

- ***Roger Road WWTP*** (after construction and startup of new Roger Road WRF plant)
  - Decommission existing gravity thickeners and dissolved air flotation thickeners;
  - Provide waste activated sludge gravity belt thickening facilities with 4 gravity belt thickeners to produce a minimum of 3 percent solids;
  - Decommission existing digesters;
  - Improve transfer pump station facilities to transfer 3 percent waste activated sludge to Ina Road WPCF through the existing transfer forcemain; and
  - Consider providing redundancy to the single sludge forcemain through construction of a parallel forcemain.

- ***Ina Road WPCF*** (as part of the improvements and expansion to 50-mgd capacity)
  - Expand existing gravity thickening facilities for primary sludge at the same size as existing for a total of 4 gravity thickeners to produce 5 percent solids;
  - Provide waste activated sludge gravity belt thickening facilities with 3 gravity belt thickeners to produce a minimum of 5 percent solids;
  - Expand existing mesophilic digestion capacity with 5 additional digesters at the same size as existing;
  - Expand centrifuge facility to have 6 units (for 5 days per week operation) or 4 units (for 7 days per week operation) that can be operated to produce either thickened or dewatered solids;
  - Replace and expand centrate and cake pumping systems at the centrifuge facility;
  - If 5 days per week operation is desired for dewatering, provide digested sludge storage upstream of centrifuges;
  - Provide thickened/dewatered solids storage with storage capacity to hold 10 days of solids production; and
  - Replace existing solids transfer station.

Thus, it is recommended that the County continue to produce Class B biosolids using consolidated mesophilic digestion facilities at Ina Road. This stabilization process will provide digester gas for use at the plant. Additionally, thermophliic anaerobic digestion (TPAD), heat drying, or possibly the Cambi process (when and if approved by U.S. EPA for producing Class A biosolids) could be added in the future to produce Class A biosolids, if necessary. An arrangement has been determined for the required Class A TPAD facilities on the Ina Road site based on the conceptual sizing. Finally, the centrifuges will be designed to operate in either a thickening or dewatering mode that will permit the use of landfilling as a backup or contingency plan for biosolids handling.

3.5 Outlying (Smaller) Treatment Facilities

Areas outside the metropolitan Tucson region are served by what are called the outlying facilities. These outlying areas are experiencing a rapid population expansion. An evaluation to determine the optimal strategy for long-term flow/capacity management, wastewater treatment and facility expansion was performed.

The outlying region includes facilities operated by the Department and by others. Existing Department operated facilities include:

- Arivaca Junction Wastewater Treatment Facility;
- Avra Valley Wastewater Treatment Facility;
- Corona de Tucson Wastewater Treatment Facility;
- Pima County Fairgrounds Wastewater Treatment Facility;
- Green Valley Wastewater Treatment Facility;
- Marana Wastewater Treatment Facility;
- Mt. Lemmon Wastewater Treatment Facility;
- Rillito Vista Wastewater Treatment Facility; and
- Randolph Park Water Reclamation Facility.

Treatment facilities for the outlying area must accommodate future projected average daily flows that are 250 – 3,000% greater than 2006 average daily flows. The following table shows current and future projected wastewater flows for the outlying facilities.

Table 3-1
Current/Projected Outlying Facility Wastewater Influent Flows

Outlying Facility Name	2006	2030	Approximate Increase
Arivaca Junction	0.06	0	-
Avra Valley	1.08	3.0	300%
Corona de Tucson	0.14	2.1	1500%
Green Valley	1.76	4.4	250%
Marana	0.15	4.4	3000%
Mt. Lemmon	0.002	0.002	0
Pima County Fairgrounds	0	0	-
Rillito Vista	0.01	0	-
Southlands (excludes Corona)	0	10.5	-

The existing non-Department operated facilities include Arizona Sonoran Desert Museum, Sahuarita, and others.

The existing outlying facilities vary in capacity and treatment process employed. The ROMP investigated and evaluated outlying service areas and facilities with two major objectives:

- Opportunities to decommission smaller facilities and consolidate wastewater flows into area regional plants; and
- Opportunities to incorporate a single, or perhaps two, treatment processes as a standard for the outlying regional plants.

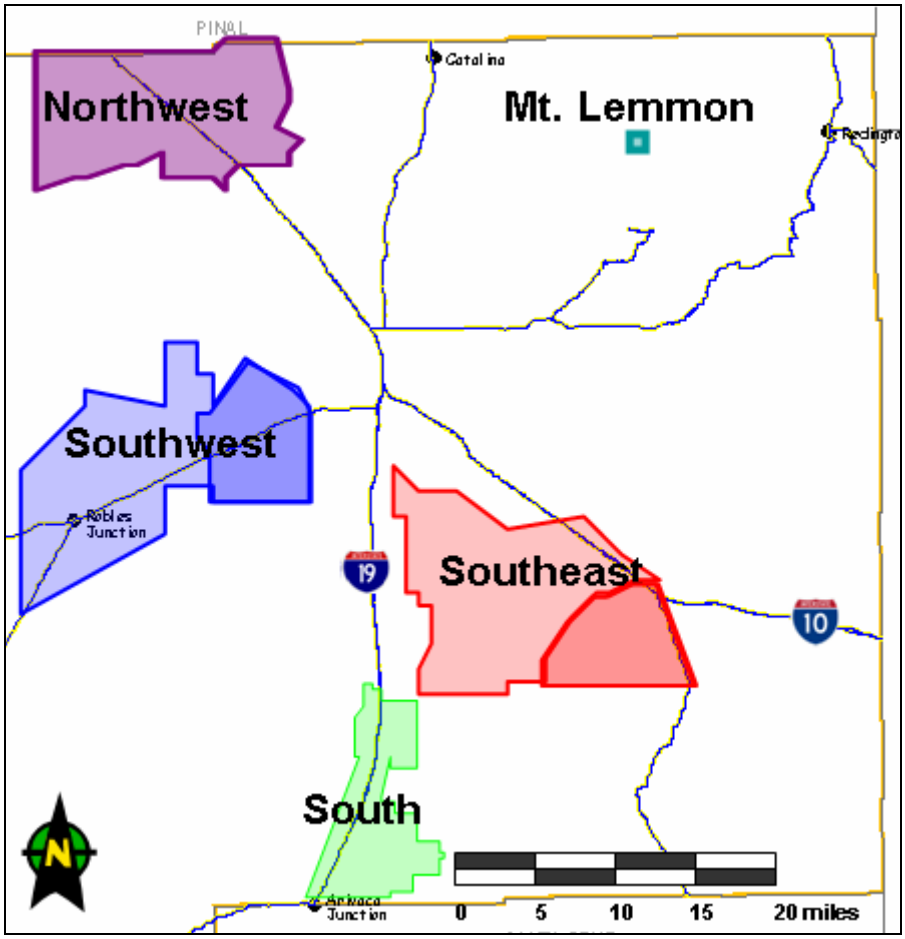
Outlying regions were developed to meet the following list of objectives:

- Separate topographically confined areas;
- Convey wastewater via gravity;

- Limit conveyance line distances;
- Avoid conveyance line construction in areas of sparse population; and
- Consolidate facilities to sub-regional treatment facilities.

Application of the above objectives to the planning area yields five regions, the Northwest, Southwest, South, Southeast, and Mountain Regions. The graphic below shows the five conceptual regions.

Figure 3-4
Non-Metro Service Area Regions Year 2030



Construction of sub-regional facilities includes the option of locating, designing, and building new sub-regional facilities. This option would require construction of a new facility and subsequent decommissioning of the satellite facilities as their useful life expires. Conveyance structures would need to be constructed to include flows associated with new development as well as taking over decommissioned facility flows. Thus, all flows for the region would be treated at the new sub-regional facilities. Construction of a new sub-regional facility could potentially decrease construction operations and maintenance costs due to economies of scale. A new sub-regional facility would reduce the

opportunity for areas near the existing outlying facilities to obtain water for water reuse by relocating the treated effluent at a distant area. This option would require all or some of the following steps listed:

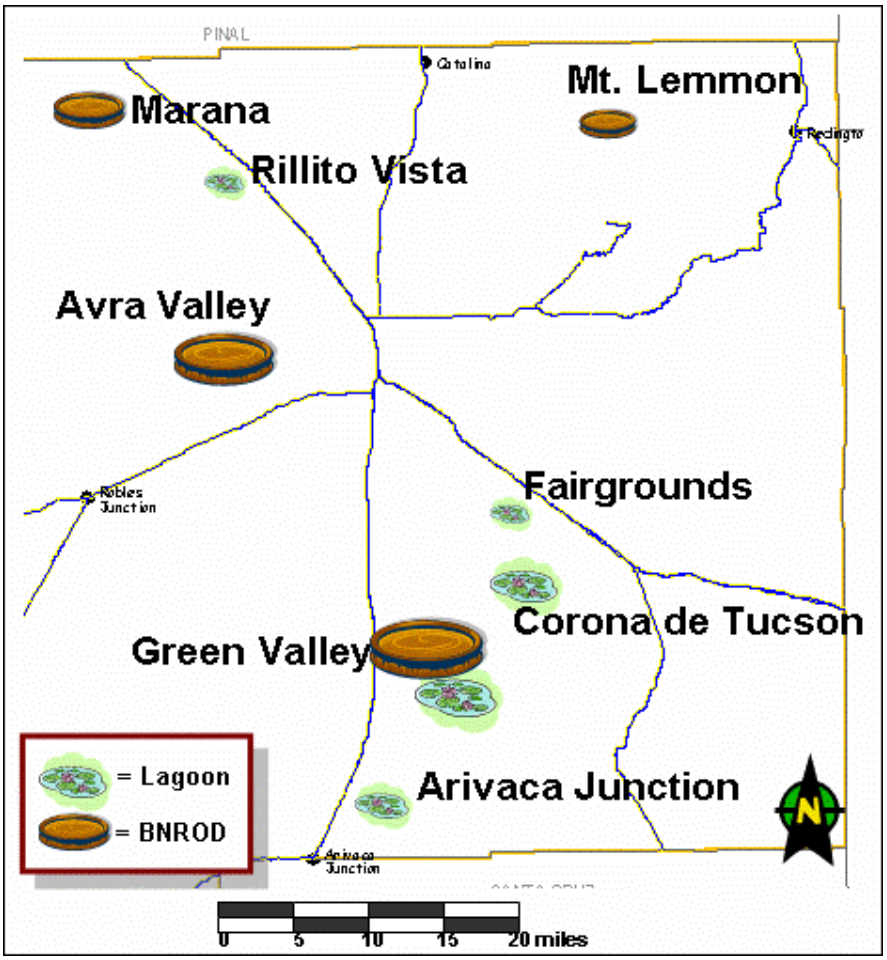
- Land procurement;
- New facility design and construction;
- Conveyance structure design and construction to convey flow from satellite facilities to the sub-regional facility; and/or
- Decommissioning of existing satellite facilities.

The ROMP includes evaluations for existing outlying facilities located within each region. The ROMP also provides recommendations regarding expansion, new construction and decommissioning of existing outlying facilities located within each region.

The evaluation for each Department operated outlying facility is set forth in **Appendix A**.

Figure 3-5 shows the general location of Department's outlying facilities.

Figure 3-5
Department's Outlying Facilities



Section 4 Alternative Project Delivery Methods

4.1 Overview

Traditionally in Arizona, design-bid-build has been the generally used and legally required procurement method for public works. This project delivery method consists of two phases: a design phase and a bidding and construction phase. In the first phase, a design professional is hired, usually on a qualifications-based competitive selection process, to assist the County in planning and designing the project, and supervising (or managing) the bidding and construction processes. In the second phase, bids are solicited by the County from construction companies in accordance with a request for bids and the lowest responsible bidder is selected to construct the project. The County is responsible for managing the contracts of both the design professional and construction contractor throughout the entire process.

The State enacted omnibus legislation in 2000 that greatly expanded permissible project delivery methods. The Arizona public works procurement code is now among the most flexible in the country. Accordingly, Arizona law permits the County to consider the following project delivery methods:

- Traditional Design-Bid-Build;
- Design-Build;
- Design-Build-Finance (Turn-Key);
- Design-Build-Operate;
- Design-Build-Finance-Operate;
- Design-Build-Finance-Own-Operate; and
- Construction Manager at Risk.

The sections below summarize the primary alternative delivery methods that are presently allowed.

The County, to date, has for the most part employed the design-bid-build approach. It has recently begun to use construction-manager-at-risk contracting and, for smaller, job order projects, some design-build procurement. The County does not, however, have significant experience with design-build, design-build-finance, design-build-operate, design-build-finance-operate, or design-build-finance-own-operate procurements. This RFEI process has been undertaken as part of the County's effort to familiarize itself with how these other methods would work in Arizona as a practical matter, and to assess market interest.

In conjunction with the County's effort to familiarize itself with various alternative project delivery methods available for the Projects, the County is also exploring all public and private innovative options that are allowed and feasible under each of the alternative project delivery methods provided below. Questions relating to financing options and each of the alternative project delivery methods are provided below in Section 5.6.

4.2 Requests for Qualifications

Requests for qualifications are required to be issued by the County to commence an alternative project delivery process in Arizona. A selection committee reviews the qualifications submittals, and may elect to conduct interviews. Fee, price and cost information may not be solicited at the RFQ stage. The

selection committee, applying the qualifications criteria, must select the three (and only three) most qualified firms to be interviewed for the specific project.

Arizona law permits the County, without conducting a subsequent RFP process, to enter into contract negotiations with the highest qualified firm from among the three firms selected through the RFQ process. The contract may encompass not only design services but also resident engineer and construction management / inspection services. Price, as well as terms and conditions, can be negotiated notwithstanding the absence of competing price proposals. If a reasonable agreement is reached, the County may execute it without further procedural steps. If agreement cannot be reached, the County can turn to the next highest ranked firm identified through the RFQ process.

4.3 Requests for Proposals

The County may elect, following the RFQ process, to conduct a competitive request for proposals process. The RFP must be issued to the three pre-qualified firms. Technical and price proposals are opened and scored separately, with the highest scored proposal selected. Clarifying discussions are permitted prior to the submittal of final technical and price proposals. A stipend must be paid to responsive but unsuccessful proposers in an amount at least equal to 2/10ths of one percent of the County's final budget for the project.

4.4 Design-Build and Related Project Delivery Methods

The State procurement code defines "design-build" as a project delivery method in which (1) there is a single contract for design and construction services; (2) design and construction may be in sequential phases or concurrent phases; and (3) finance services, maintenance services, operations services, preconstruction services, and other related services may be included. Thus the County has general legal authority to use the design-build, design-build-finance, design-build-operate, design-build-finance-operate and design-build-finance-own-operate project delivery methods.

Design-build and related procurements operate to create one point of responsibility for multiple services. They also operate to transfer design liability from the owner to the private contractor assuming full responsibility for construction and other services. These alternative project delivery methods are generally believed to have the potential to shorten the project schedule by allowing design and construction work to proceed in parallel. Cost savings and risk transfer are also generally regarded as achievable using design-build and related procurements, potentially at the loss of some degree of municipal control over design details.

4.5 Construction-Manager-at-Risk

Construction-manager-at-risk procurements are also authorized in Arizona. These are defined as a project delivery method in which there is a separate contract for design services and construction services (including preconstruction and design services). A contract for design services and a contract for construction services may be entered into and performed at the same or different times under this delivery method.

Construction-manager-at-risk procurements do not generally operate to transfer design liability from the owner and its design engineer to the construction firm and other companies that are party to the transaction. Nor does this form of contracting work to transfer operating performance cost or risk to a private company. It does, however, permit the selection of a construction services firm on a qualifications basis and allow the construction firm to be involved in project design. Guaranteed maximum pricing is also possible, to be negotiated once the design is sufficiently advanced.

Section 5 Questions and Comments

The County is interested in respondent's answers to the questions set forth below as it formulates its approach to project implementation. The County recognizes that not all questions set forth below are relevant to each of the project delivery methods identified herein as potentially viable delivery methods. Please answer those questions that pertain to the particular delivery method or methods you are interested in or with which you have particular experience.

While we have attempted to group the following questions under general, topical section headings, please note that many of these topics will overlap. For example, many of the questions relating to the design-build method of project delivery apply equally to the design-build-finance, design-build-operate, design-build-finance-operate and design-build-finance-own-operate methods of project delivery. Accordingly, please review all of the following questions carefully and answer each of the questions that pertain to your preferred method or methods of project delivery.

Section 5.6 poses questions with respect to how innovative financing options may be incorporated into these project delivery methods.

5.1 Preferred Project Delivery Method and Procurement Process

- In which projects are you interested?
- Which projects are appropriate for using the traditional bid-build method, and why?
- Which projects are appropriate for using alternative project delivery methods, and why?
- What is your preferred project delivery method for such projects, and why?
- Would you be interested in proposing on such projects under other delivery methods?
- Please give examples of the successful use of the preferred project delivery method in other projects within the industry.
- Are there delivery methods that you would caution the County against using for particular projects, and why?
- Based on your knowledge, how interested are contractors in breaking up large projects set forth herein into smaller project packages?
- Please comment generally on any particular issues of concern relating to the procurement processes to be employed under your preferred project delivery method or methods.
- What do you believe are the best means of obtaining the input of potential respondents as to the details of the process, terms and conditions of a County procurement? To what extent would the County benefit from issuing draft procurement documents to potential respondents for review and comment prior to the commencement of a formal solicitation?
- Arizona law authorizes a request for qualifications process that provides for the selection of a firm based solely on qualifications followed by negotiations with the firm to arrive at a fixed price or guaranteed maximum price. Alternatively, Arizona law authorizes the more common request for qualifications and request for proposals process enabling a short-listing of firms followed by a competition that includes price consideration. Please comment on the relative merits of the two alternatives based on your experience.
- Under the request for qualifications/request for proposals process authorized under Arizona law, the County would be required to pay a stipend or honorarium to "each final list offer or who provides a responsive, but unsuccessful, proposal." The statute provides that the amount of the honorarium or stipend shall be not less than two-tenths of one percent of the County's estimated

final design and construction budget for the project. Please comment on the importance of such an honorarium or stipend in terms of your determination as to whether to submit a proposal for a project. What factors should guide the County in determining the amount of an honorarium or stipend?

- Please provide any recommendations you may have concerning the amount of time to be stipulated in a procurement schedule for preparation of statements of qualifications and proposals, review and discussions concerning statements of qualifications and proposals and for negotiating contracts.

5.2 Business Terms and Conditions Generally

- Please comment on the particular risks and business terms and conditions that you feel are, and are not, appropriate to assign to the private sector under various project delivery methods.
- Please comment generally on how the various project delivery methods might impact the amount of time that can reasonably be expected to be required for the design and construction of the particular projects under consideration.
- Please comment generally on how the various project delivery methods might impact the price estimates for the Projects included in the ROMP. What price estimate info will be provided ?
- Please comment on the issue of the “loss of control” by the County that is commonly asserted to be associated with alternative project delivery methods.

5.3 Construction-Manager-At-Risk

- How long after engaging the design-engineer should the County engage the construction manager?
- How can the construction manager best add design value to the project?
- What do you believe is optimal scope of work for the construction manager?
- Based on your knowledge, are construction managers willing to provide a guaranteed maximum price for the project? When? Under what conditions?
- To what extent, if any, do you believe that design liability (i.e., full responsibility for the facility’s ability to meet the performance standards following construction of the project in accordance with the design) can be transferred under the construction-manager-at-risk method of contracting?
- To what extent can the construction-manager-at-risk method of contracting reasonably be expected to shorten the project delivery schedule, reduce the project cost, or transfer risk with respect to the projects under consideration?
- What advantages do you believe that construction-manager-at-risk contracting have over traditional bid-build contracting?

5.4 Design-Build

- Are there wastewater treatment processes or technologies that you believe the County should consider for the projects, other than those identified in the ROMP?
- How can the County best strike the balance between the competing goals of assuring a well-built, high quality project that meets the performance standards and providing the potential contractors with the opportunity to develop competitive and innovative proposals that will provide the best value to the County? What would you recommend as to the extent of the design requirements to be included in a request for proposals for a design-build contract?

- Please comment on the particular challenges posed by an upgrade to an existing facility, as opposed to a greenfield project, in the design-build context.
- Based upon your knowledge, how willing are contractors to assume permitting risk based on a project design that they have furnished (e.g., delays; terms and conditions, etc.)?
- Can design-build reasonably be expected to shorten the project delivery schedule, reduce the project cost, or transfer risk with respect to the projects under consideration?
- Based upon your knowledge, to what extent are contractors willing to propose, and for how long would they be willing to hold, a fixed price for a design-build project?
- Please outline your preferred approach to addressing risks associated with fluctuations in the prices of commodities and other materials in the context of a design-build contract.
- Please comment on the importance of including a limit of liability in a design-build contract and the nature and extent of any such limit.
- Please comment on today's surety market and how current surety bond procedures and practices could be expected to affect a procurement carried out using alternative project delivery.
- Based on your knowledge, are contractors willing to take any responsibility for the short-term operations after acceptance of the design-build project? How can the County be protected against the performance or cost issues that arise in the first two years of operations once the design-build work is completed?
- Please comment generally on the appropriate mechanisms for security for performance under a design-build contract, including parent company guarantees, performance bonds and letters of credit.

5.5 Design-Build-Operate

- Based upon your knowledge, to what extent are contractors willing to assume the "as-is" or "condition" risk in terms of operating and upgrading an existing facility?
- Is private operation of a project that is part of the System viable from the standpoint of the operational interface between the County and the design-build-operate contractor?
- Please describe how the County can best assure that, with a long-term contract, its facilities will be properly maintained and their value preserved. What approaches to facility maintenance have you found most effective in the context of the design-build-operate method of contracting?
- Please provide any recommendations you may have with respect to the structure of a fixed service fee for a long-term design-build-operate contract. What is the appropriate adjustment mechanism to account for inflation over the term of a design-build-operate contract? Are there particular operating and maintenance costs that you would recommend as "pass-through" costs for the County?
- Is the traditional "single guarantor" structure, whereby the operator or another single firm, guarantees performance of the entire design-build-operate contract viable in today's market place? Based upon your knowledge, how willing are contractors to consider participating in a procurement structure in this manner?
- Please provide any recommendations you may have with respect to alternatives to the "single guarantor" structure. One possibility might be to establish a "successor guarantor" structure, which would enable a "successor guarantor" (the operating company member of the proposer team) to assume all obligations and liabilities of an "initial guarantor" (the design-build entity) at a point following acceptance of the facility. Based upon your knowledge, how willing are contractors to consider participating in a procurement structure in this manner?

- Based on your knowledge, how are the interests of the County's existing operations and maintenance staff protected in the context of a design-build-operate contract?

5.6 Private Financing

- Please describe generally any extent to which you would recommend that private financing be incorporated into these transactions.
- Based upon your knowledge, how willing are contractors to undertake a private financing without having a federal tax beneficial ownership interest in the project?
- Is there any reason the County should consider having the project privately owned, as well as privately financed?
- Is private financing likely to advance, or delay, project completion?
- Based upon your knowledge, how willing are contractors to consider providing turnkey construction financing (where the County would "take-out" the financing upon project completion and acceptance), rather than permanent financing?
- Should the County allow proposals incorporating private project financing to be submitted by teams led by financial institutions (who subcontract the performance of the work to design, construction and operating services firms), or limit proposals to those led by design, construction or operating services firms who provide such services directly or arrange for project financing?
- If private project financing is provided by teams led by financial institutions, and equity is provided (with or without private ownership):
  - What would secure the project company's contract performance to the County?
  - Would the County have any direct recourse to the operating services company in the event of non-performance?
  - How would the operational interface between the County and the project company work?
- Private project financing would generally be taxable (unless tax-exempt bond "volume cap" is obtained), resulting in a higher borrowing cost for the project, when compared to traditional tax-exempt municipal revenue bond financing. What other factors should cause the County to consider private project financing despite its probable higher cost?
- How would you suggest that the request for proposals and the service contract deal with the issue of interest rate uncertainty between the date the proposal is submitted and the date financing actually occurs, which will be sometime following execution of the service contract?
- Based upon your knowledge, how willing are contractors to "guarantee" that the financing will actually occur (in the sense of a guaranteed date for completion of financing) at a guaranteed interest rate, or a guaranteed "spread" over an interest rate index, with damages payable if the financing does not occur?
- Based upon your knowledge, if a contractor would not be willing to "guarantee" the occurrence of a financing, how could the County be assured that a "best efforts" financing would actually occur, and on what terms?
- If the County were to allow proposers full discretion to propose any type of financing plan, how would you suggest the financing elements of the proposals be compared?

Section 6 RFEI Submittals

6.1 RFEI Response Format

Respondents are requested to provide information that they believe will help the County in determining the optimal procurement approach for implementing each of the Projects. The response should focus primarily on input relative to the delivery methods being contemplated. Responses shall not be prepared as a statement of qualifications or a proposal for the Projects.

Respondents are requested to address the following, as detailed below:

- Respondent Information;
- Projects of Interest;
- Project Delivery Methods Commentary;
- Institutional, Contractual and Legal Considerations; and
- Economic and Financial Considerations.

6.2 Respondent Information

The respondents should provide pertinent information about their company, including: name; address; business description; relevant experience; reference project information; brief organizational and financial profile; contact person or persons; contact information, including phone and fax numbers and email address; and website address.

Respondents may submit information individually or jointly with other interested parties or firms. Joint submissions will not be considered by the County to constitute any formal teaming arrangement.

6.3 Projects of Interest

Respondents are requested to identify one or more of the Projects they may be potentially interested in pursuing, and the delivery method or methods they believe should be considered by the County to be most advantageous in implementing the particular Project.

6.4 Project Delivery Method Commentary

Respondents are asked to comment on each of the project delivery methods of particular interest to them, and discuss the basis of their interest. Specific suggestions as to how these procurements should be carried out in practice under State procurement law are welcome. The advantages and disadvantages of the available procurement models, as they may be applied to the different Projects, should be discussed. Case studies, both of U.S. and international projects, can be usefully cited. The County is also interested in suggestions as to variants on the particular procurement models discussed in this RFEI.

6.5 Institutional, Contractual and Legal Considerations

The County wishes to receive input on institutional, contractual and legal considerations bearing upon the development of the Projects. This input may include commentary on alternative project delivery practice

in Pima County and Arizona generally; regulatory agency issues, such as the approach of permitting agencies to alternative project delivery and regulatory standards; intermunicipal matters, including reclaimed water allocation issues; the role of other institutions or organizations in implementing the ROMP using alternative project delivery; approaches to establishing a fair, equitable and efficient procurement process; and contract structuring issues, such as the allocation of risk and responsibility that would best serve the County's interests.

6.6 Economic and Financial Considerations

The County also is requesting input on economic and financial considerations. Economic considerations include how and why the cost of a Project may differ among the contemplated delivery methods, and information relative to "risk costing". Supporting information from specific case studies and references would be of particular value. Financial considerations should focus primarily on possible private financing approaches for the Projects and may include suggestions on innovative public financing approaches. Information regarding taxable versus tax exempt debt; equity; financing guarantees; revenue and collateral pledges; project ownership; and comparisons with traditional municipal bond issuance would be helpful.

6.7 Answers to Questions

Respondents are requested to answer the specific questions set forth in Section 5.0 of this RFEI, to the extent the questions relate to the respondent's experience and projects of interest. In lieu of answering such questions sequentially as presented, respondents may incorporate answers in the text provided in response to the general subjects raised in Sections 6.3, 6.4, 6.5, and 6.6 above. The County is interested in receiving commentary and suggestions in the manner each respondent determines will most effectively communicate its response to the matters raised in this RFEI and assist the County in its decision-making process.

Appendix A Outlying Facilities

Arivaca Junction Wastewater Treatment Facility (AJWWTF)

AJWWTF is located 3,080 feet above sea level (FASL) on the southern border of Pima County approximately 30 miles south of Tucson just east of Interstate 19. The facility has a permitted treatment capacity of 0.1 mgd (maximum daily flow average of 60,000 gallons per day) and treated an average daily influent flow of 0.059 mgd in 2006 (59% capacity). Treatment consists of a single 3.2-acre, 13-ft deep, unlined aerated facultative stabilization pond (side slope of 3:1) with two surface aspirating aerators/mixers. Effluent disposal for AJWWTF is through percolation, evaporation, and reuse. A reuse agreement for delivery of the Class C effluent for restricted agriculture use is in place with nearby Reventone Ranch. Prior to effluent being delivered to the adjacent ranch it is disinfected through the addition of sodium hypochlorite. Biosolids are scraped from one lagoon when necessary and hauled to a landfill.

AJWWTF is expected to close once construction of the gravity sewer line between AJWWTF and Green Valley WWTF is completed. Wastewater flow from AJWWTF will then be transported to Green Valley's facility for treatment. Completion of the gravity sewer line is scheduled for 2007/2008.

Avra Valley Wastewater Treatment Facility (AVWWTF)

AVWWTF is located 2,382-FASL in a rapidly growing area about 20 miles southwest of Tucson in southern Avra Valley, north of Hwy 86 (Ajo Way) and east of Three Points. AVWWTF treated an average daily influent flow of 1.079 mgd in 2006 (90% Current BNROD capacity, 67% of the expansion to 1.6 mgd total). Treatment consists of a Biological Nutrient Removal Oxidation Ditch (BNROD) and consists of a flow equalization basin, an oxidation ditch, two secondary clarifiers, four sludge-drying beds, and four percolation basins. Sewage enters the facility through a lift station where it is discharged to a screening channel. Influent is then equalized in a 0.37 million gallon basin and flows to a 1.33 million gallon oxidation ditch (1.2 mgd permitted treatment capacity). Effluent is disposed of through percolation, evaporation, plant irrigation reuse, and spraying into the Black Wash. Disposal of effluent to the Black Wash is only done when emergency flow conditions exceed percolation and evaporation capabilities. Waste activated sludge mixed liquors flow into the secondary clarifiers from the oxidation ditches via a distribution box where the sludge settles and further processes produce Class B+ effluent. The sludge from the clarifiers is then sent to two gravity thickeners and then to Roger Road WWTP. Four sludge drying beds are available for emergency use.

The Department's Avra Valley Expansion Plan recommends two concurrent expansion projects, the first is to increase current 1.2-mgd BNROD capacity to 2.2 mgd through interim improvements and the second is to have a dual oxidation ditch online and permitted to treat 4.0 mgd by 2009. Avra Valley also plans on treating effluent to Class A+ treatment requirements prior to discharge to percolation ponds.

Corona de Tucson Wastewater Treatment Facility (CdTWWTF)

CdTWWTF is located 3,090-FASL and is located approximately 15 miles south of Tucson in an area that is currently rural but facing very rapid population growth. The facility has a permitted treatment capacity

of 0.300 mgd and average daily influent flows for 2006 were 0.135 mgd (45% capacity). Sewage enters CdTWWTF through a gravity interceptor, then through a Parshall flume flow-metering chamber. The sewage then flows into a series of "splitter manholes" dividing the flow between the two concrete-lined stabilization ponds of 3.3- and 3.7-acres with an average operating depth of 4-feet. Ponds can be operated in series or parallel. The treated water overflows from the stabilization ponds into the 10.2-acre evaporation pond with a 6.1-acre unlined soil aquifer transfer (SAT) pond used as a recharge basin. Effluent is discharged to the plastic lined evaporation pond. Biosolids are removed from the plastic lined evaporation ponds when needed.

Corona de Tucson WWTF will be placing a new, 1.0 mgd permitted, closed loop reactor online in 2007 to eventually replace the existing lagoons. The new facility will include new headworks, Parshall flume, RAS/WAS station, polymer storage, sludge holding tank, sludge pump, and mechanical/electrical/administration complex. Effluent will be disposed of via the SAT basins regulated by the facility's APP. Biosolids will be pumped to the facility's sludge holding tanks before being hauled and discharged into the South East Interceptor for processing and disposal at the Ina Road biosolids processing facility.

Green Valley Wastewater Treatment Facility (GVWWTF)

GVWWTF is located 2,790-FASL south of Tucson along the east side of the Santa Cruz River. The facility's 2004 expansion included the addition of a 2.0 mgd treatment train utilizing Biological Nutrient Removal Oxidation Ditch (BNROD) and increased the total permitted treatment capacity to 4.1 mgd (average dry weather flow). The facility treated an average daily influent flow of 1.764 mgd in 2006 (43% capacity). GVWWTF is split into two processes. The first, a 2.1 mgd Class B effluent producing process, consists of two trains of primary and secondary aerated lagoons followed by two effluent maturation/settling lagoons and four percolation basins. The second process, a 2.0 mgd BNROD Class A+ effluent producing process, operates on an extended aeration, nitrification, and denitrification process within the oxidation ditch by cycling the aeration on and off. Flows greater than BNROD's capacity are directed to the aerated lagoons and polishing ponds. Effluent is disposed of through percolation, reuse, and delivery. Department has a contract to deliver up to 1 mgd of Class A+ and B effluent to Robson/Quail Creek Inc. GVWWTF is the only Outlying facility with biosolids treatment and disposal capacity. The sludge is thickened, digested, and dried (Class A biosolids) before being utilized as a mine tailing reclamation product at the ASARCO Mines.

GVWWTF will be treating flow from the Arivaca Junction WWTF once the gravity sewer main is completed (completion is expected in 2007/2008). Department is planning on decommissioning the aerated lagoon system and replacing the capacity with a similar 2.0 mgd BNROD process by 2010.

Marana Wastewater Treatment Facility (MWWTF)

MWWTF is located 1,910-FASL one-half mile north of Marana Road, one mile west of Luckett Road, and one-half mile east of the Santa Cruz River. The facility has a permitted treatment capacity of 0.5 mgd and treated an average daily influent flow of 0.149 mgd in 2006 (30% capacity). The current wastewater treatment system includes a headworks and a 3-inch Parshall flume with a maximum capacity of 1.1 mgd (currently capacity is 0.7 mgd). To provide wastewater treatment for the accelerated development, three 0.05 mgd biological nutrient removal package plants began operation at the end of 2001 and a fourth was added in 2005 providing a treatment capacity of 0.2 mgd. The four package plants will be soon

supplemented with a 0.5-mgd "Biolac" activated sludge treatment system, as an interim treatment process. Effluent is discharged into a 60 mil high density polyethylene (HDPE) lined effluent storage pond and disinfected with chlorine. The eastern facultative evaporation pond has been converted into a soil cement lined emergency influent storage basin. An in-ground biofilter is located onsite for odor control purposes. Effluent is reused onsite through landscape irrigation or for a riparian habitat restoration project. Class B+ effluent is produced through a Biological Nutrient Removal process and a chlorination and de-chlorination disinfection process. MWWTF collects sludge in sludge storage tanks before transporting to Ina Road for processing.

MWWTF's service area is expanding to match the area's growth and eventually the facility will require expansion to provide capacity for the increased wastewater flow. Possible flows for inclusion to Marana's future capacity are the Rillito Vista WWTF and the Continental Ranch Pumping Station. Marana WWTF has finished design of a new 1.5 mgd Biological Nutrient Removal Oxidation Ditch facility. Construction should begin at a date allowing enough time for completion and startup/testing. Once construction is complete, the existing package plants will require evaluation to determine their remaining life and application for future projects. Plans have been mentioned to relocate existing package plants to a proposed Canoa Ranch Water Reclamation Facility south of Green Valley WWTF or as a provisional treatment for the Southlands area (Southlands area is discussed later).

Mount Lemmon Wastewater Treatment Facility (MLWWTF)

MLWWTF is located 8,310-FASL near the small community of Summerhaven on Mount Lemmon, north of Tucson. The facility treats an average of 12,500 gallons per day and treated an average daily influent flow of 1,900 gallons per day in 2006 (average flow is just over 15% of capacity). MLWWTF consists of a circular oxidation ditch followed by chlorination-dechlorination units. The facility is the only treatment plant in the County experiencing freezing temperatures and is entirely enclosed. Treated effluent from the MLWWTF is disposed of via sprayfield irrigation onto forest vegetation, or is disposed of using underground pipelines leading to three combined outfalls; both are regulated by the facility's AZPDES permit. Sludge is deposited into the County collection system (manhole 8716-03) for treatment at the Ina Road WPCF and further processing at the Regional Biosolids Facility.

Department, the County Department of Environmental Quality and the USFS are working together to develop the Mt. Lemmon Service Area Watershed Study and Wastewater Management Plan. This plan hopes to identify the conditions and circumstances existing in and around the Mt. Lemmon community, and the significant issues and challenges involved in planning wastewater systems for the future. Due to its location and limited service, MLWWTF will most likely continue to be a stand alone facility in the future.

Pima County Fairgrounds Wastewater Treatment Facility (PCFWWTF)

The PCFWWTF is located 3,010-FASL approximately 18 miles southeast of Tucson at the county fairgrounds south of Interstate 10 and west of Houghton Road. The Fairgrounds has only measurable flow in the month of April when the Pima County Fair is held. The facility has a permitted treatment capacity of 0.035 mgd. PCFWWTF consists of two primary stabilization ponds and an overflow pond. Flow is split or directed into a stabilization pond via a manual splitter device. PCFWWTF does not discharge effluent. Biosolids are dried, scraped, and hauled to a landfill when necessary.

PCFWWTF can be decommissioned once a conveyance structure connecting the facility to the South East Interceptor, Corona de Tucson WWTF, or other location is completed.

Rillito Vista Wastewater Treatment Facility (RVWWTF)

RVWWTF is located 2,130-FASL on land owned by Arizona Portland Cement, northwest of Tucson, between Avra Valley Road and Tangerine Road, and between Interstate 10 and the Santa Cruz River. The facility has a permitted treatment capacity of 0.02 mgd and treated an average daily influent flow of 0.012 mgd in 2006 (60% capacity). The treatment method for this facility consists of two stabilization/evaporation/percolation ponds. One pond is in use while the adjacent pond is dried and scraped before returning to service. The facility does not discharge effluent. Biosolids are dried, scraped, and hauled for disposal via landfill when necessary.

RVWWTF is operated by the Department on land leased from the Arizona Portland Cement Company and the facility decommissioning of the facility will be considered as soon as a conveyance structure connecting the service area to a facility for treatment is completed (Marana WWTF or Ina Road WPCF).

Appendix J

Expressions of Interest

Summary of Responses to Request for Expressions of Interest

Pima County Wastewater Management Department

Pima County
Wastewater Management Department
Regional Optimization Master Plan

Summary of Responses to Request for Expressions of Interest

October 2007

GREELEY AND HANSEN

In association with:
Hawkins, Delafield and Wood
Raftelis Financial Consultants, Inc.

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1. Introduction

The County received an overwhelming response to its Request for Expressions of Interest (RFEI) concerning the Metropolitan Wastewater Treatment System Capital Improvement Program (CIP). Twenty-seven firms submitted responses addressing the issues raised in the RFEI, including the method of project delivery, private financing, biosolids disposal, biogas and bio-power and additional technical considerations. Generally, the responses are very well thought-out, offer valuable information for the County to consider as it begins to implement the CIP, and indicate a strong interest on the part of the engineering and construction contracting industry to participate in the Pima County CIP.

2. Respondents

Respondents are grouped into categories solely for ease of reference and discussion of the comments offered. Placement of a firm into a particular category should not be viewed as limiting the scope of that firm. In actually many firms can fit into more than one category and their responses crossover into various other issues addressed in the Request for Expressions of Interest. The seven categories used for classifying the respondents are:

1) Engineering Design Firms,
2) Construction Firms,
3) Design/Build Firms
4) Design/Build/Operate Firms
5) Financial Firms
6) Biosolids Firms, and
7) Biogas/Bio-power Firms.

Specific respondents under each of these categories are:

- Engineering Design Firms include: Brown and Caldwell, Carollo Engineers, P.C., Kennedy/Jenks Consultants, and Malcolm Pirnie, Inc.
- Construction Firms include: Kiewit Western Co., McCarthy Building Companies, M.A. Mortenson Company, Sundt Construction, Inc., and Western Summit Constructors, Inc.
- Design/Build Firms include: AMEC Infrastructure, Inc., Black & Veatch, MWH Constructors, Inc. and Parsons Water & Infrastructure Inc.
- Design/Build/Operate Firms include: CH2M Hill, EPCOR Utilities Inc., GE Water and Process Technologies, PCL Construction, Inc., Severn Trent Services, and Veolia Water North America - West, LLC.
- Financial Firms include: Goldman, Sachs & Co. and Lehman Brothers Inc.
- Biosolids Firms include: Synagro-WWT, Inc., Biochem Resources (formally known as FKOS Resources, LLC), Fenton Environmental Technologies, Inc. and Sweet Ethanol, LLC.

- Biogas/Bio-power Firms include: NZ Legacy, LLC. and APS Energy Services

2.1 Comprehensive Responses

While the majority of the responses to the RFEI provided valuable information for the County's consideration, Black & Veatch, Parsons Water & Infrastructure Inc., CH2M Hill, EPCOR Utilities, Inc., Veolia Water North America – West, LLC, and Lehman Brothers Inc. provided the most comprehensive responses. These respondents offered extensive discussion concerning the wide array of issues raised in the RFEI and each indicated that they would consider proposing on one or more of the projects included in the CIP.

2.2 Certain Non-Respondents

Several noteworthy industry players did not respond to the RFEI, including American Water, Southwest Water, and the engineering firms of Metcalf & Eddy, CDM, and HDR. However, it is important to note that, as specifically indicated in the RFEI, submitting a response is not a precondition to future participation in the CIP projects. Accordingly, these firms may still propose on the projects included in the CIP when the formal procurements commence.

3. Project Delivery Considerations

Critically important information offered by the respondents with respect to the various methods of project delivery is summarized in the following.

3.1 Traditional Design-Bid-Build

Market Interest. Most of the Engineering Design Firms, Construction Firms and Design/Build Firms indicated some level of interest in pursuing projects included in the CIP on a traditional, design-bid-build basis. While a few of the respondents indicated that bid-build would be appropriate for all of the projects included in the CIP, most of the respondents suggested that it would be appropriate only for smaller, well-defined projects (e.g., projects valued at less than $10,000,000). Both PCL Construction, Inc. and Kiewit Western Co. cited the demolition of Roger Road as suitable for design-bid-build approach due to the straightforward nature of the project. Most respondents indicated that some form of alternative project delivery would be preferable for the projects included in the CIP and a few specifically cautioned against the use of the design-bid-build method for any of the projects included in the CIP.

Advantages. The primary advantages cited by respondents with respect the design-bid-build method relate to the familiarity with the approach, both from the perspective of the County and the engineering and construction contracting industry. For example, Kennedy/Jenks Consultants noted the County's "long-term experience with and well-defined procurement documents for this delivery method". AMEC Infrastructure, Inc. noted the lower risk profile associated with design-bid-build from the perspective of engineers and contractors when compared to alternative project delivery methods and suggested that most firms are primarily focused on delivering under this conventional method. Other firms emphasized the greater level of control the County would have in proceeding under the traditional design-bid-build method as compared to the alternative methods of project delivery.

Disadvantages. Most firms indicated that the design-bid-build method is not appropriate for projects of the size and complexity of the major projects included in the CIP (i.e., Roger Road new Water Reclamation Campus and Ina Road WPCF upgrade and expansion). Respondents noted that the County would assume primary responsibility for project outcomes and performance under the design-bid-build method. Specific disadvantages indicated include the lack of design phase assistance or collaboration from construction professionals, an extended project timeline, late stage establishment of price, potentially adversarial relationships and a greater risk of claims and disputes than under the alternative project delivery methods. Kiewit Western Co. highlighted the higher cost that could be expected to be incurred under the design-bid-build method. According to CH2M Hill, "If the County is concerned about the quality of hard-bid contractors or the local construction market is saturated with work, [the design-bid-build] approach may not result in the lowest cost or best quality."

Special Considerations. One Engineering Design Firm (Kennedy/Jenks Consultants) noted that the County's recent experience with design-bid-build has been less than satisfactory. The firm's recommendation was to include a contractor prequalification step in the procurement process. While Arizona State law appears to preclude such a prequalification step in the design-bid-build process, it may be possible to factor in the qualifications of the bidding companies through careful drafting of the procurement documents. More generally, the comments of the respondents suggest that design-bid-build can be successful when design documents are accurate and complete, a quality construction contractor is obtained and the County procures experienced construction oversight.

3.2 Construction Manager-at-Risk

Market Interest. The Construction Manager-at-Risk (CMAR) method of project delivery was generally favored over the bid-build method by the Design/Build Firms, Construction Firms, and Engineering Design Firms. Particularly, these firms indicated that the Ina Road project would benefit from the CMAR method due to the complexities associated with upgrading an existing facility and the need to maintain operations during the construction of the project.

Advantages - General. Respondents emphasized the ability to select a construction manager based on qualifications (rather than price) and the ability of the construction manager to collaborate with the design engineer in the development of the design as the primary advantages associated with the CMAR method. Respondents suggested that these factors combine to foster team building and collaborating, which can lead to common goals and objectives among the members of the project team. The construction manager adds value by performing constructability reviews, cost estimating and value engineering throughout the design and through project management during the procurement of subcontractors, project permitting, construction, start-up and commissioning. The construction manager assumes quality assurance control during construction and is generally responsible for all construction issues. Respondents indicated that collaboration between the construction manager and the design engineer generally results in fewer change orders over the course of construction. Respondents also noted that the CMAR method provides the owner with significant control over the design of the project, as the owner will generally have design approval rights at each development stage.

Advantages - Cost. A few respondents suggested that the CMAR method could achieve cost savings over the design-bid-build method through schedule optimization and constructability reviews by the

construction manager. According to McCarthy Building Companies, "The CMAR team reviews design documents for constructability and bidability before soliciting bids to eliminate unclear or inconsistent details, thus reducing the possibility of change orders during construction. They provide value analysis, suggesting materials or equipment that might be more cost effective." Respondents also noted that the CMAR method provides for the transfer of price risk at the point of the establishment of a guaranteed maximum price (GMP) through negotiations with the construction manager and indicated that the County could benefit from a negotiated sharing of any savings against the GMP. As compared to the design-bid-build method, respondents indicated that the CMAR method might provide for earlier price certainty depending on when the GMP is established.

Advantages - Schedule. A few respondents suggested that the CMAR method reduces the risk of schedule delays and change orders. More generally, respondents indicated that schedule efficiencies could be achieved under the CMAR method where there are identifiable portions of a project that can be phased to allow for early procurement of long-lead equipment and materials, early utility relocation and commencement of construction prior to completion of design.

Disadvantages - No Transfer of Design Liability. Respondents were uniform in stating that the CMAR method does not provide for the transfer of design liability. Under the CMAR method, the County remains ultimately responsible for process risk and has no single point of responsibility for all project issues. While the County may look to the construction manager for issues relating to the construction of the project, the County must look to the design engineer for issues relating to the design of the project and will ultimately be responsible for disputes between the construction manager and the design engineer.

Disadvantages – Cost and Schedule. Some of the respondents indicated that the CMAR method is not likely to result in significant cost savings. In fact, one Engineering Design Firm (Kennedy/Jenks Consultants) indicated that owners typically pay a premium for the CMAR method, which may only be offset through cost saving design refinements and minimal construction period claims. Another (Kiewit Western Co.) indicated that while the CMAR method may provide the best value, it would not necessarily provide the lowest cost.

Most of the respondents who offered information concerning the CMAR method emphasized that, while a GMP can be negotiated at any point from 30% design to 100% design, establishing the GMP later in the design process (i.e., from the 60% to 100% design) reduces the risk of uncertainty and enables the construction manager to obtain more competitive pricing from subcontractors. According to MWH Constructors, Inc. who advocated establishing the GMP only at the 70% to 100% design stage, "the increased certainty and detailed design allows the construction manager to pass reduced pricing risk to the subcontractors and, subsequently, a lower overall cost back to the owner." Other respondents noted that establishing the GMP at an earlier design stage increases the contingency amount that the construction manager will include in the GMP. Accordingly, the comments of the respondents suggested a tradeoff between early stage price certainty and cost savings under the CMAR method: in order to avoid paying a high contingency, the owner must wait until the design is significantly developed before negotiating the GMP. According to CH2M Hill, "One of the problems that we have seen numerous times in construction-management at-risk is that while the construction manager might provide estimating input during design, they do not typically provide a firm price until the design is at least 90 percent complete. There can then be 'sticker shock' when this firm price finally appears." Black & Veatch further noted

that the need to have a significantly developed design prior to negotiating the GMP means that the CMAR method currently offers little schedule relief.

Special Considerations – Early Engagement. Nearly all of the respondents who discussed the CMAR method emphasized the need to engage the construction manager as early as possible in the process, with some suggesting concurrent engagement with the design engineer and others indicating that the construction manager should be engaged at no later than 60% design. According to Carollo Engineers, P.C., "By engaging the CMAR early in the project, the Owner is able to take advantage of what the CMAR process promises to deliver. Early understanding of the project elements allows contractors to develop accurate cost models and schedules that provide for cost control throughout the design phase of the project." Other respondents indicated that the construction manager's ability to influence the final design and cost drastically reduces beyond the 30% design stage.

Special Considerations – Negotiating the GMP. In addition to the timing issues discussed above with respect to the negotiation and establishment of the GMP, a few respondents emphasized the need to establish a list of assumptions and clarifications defining the scope of the GMP. Kiewit Western Co. suggested that contingencies should be based on a detailed set of unknowns rather than a percentage of the GMP. Parsons Water & Infrastructure Inc. noted that the GMP contingency must be controlled by the construction manager and emphasized that the construction manager's contingency should not be viewed to cover risks that the owner contractually assumes, such as project scope or differing site conditions. Parsons also indicated that a construction manager may seek contractual protection from such risks as aberrations in the price of construction materials and supplies if the length of time between GMP and construction is such that the construction manager's contingency could not adequately address the risk.

3.3 Design/Build

Market Interest. Respondents indicated significant interest in pursuing the projects included in the CIP on a design/build basis. As a general matter, the Design/Build and Design/Build/Operate Firms suggested that this method would be superior to either design-bid-build or the CMAR method, as design/build can be expected to shorten the project delivery schedule, reduce project costs and transfer the basic risks associated with whether a project will work to the design/build contractor. Particular interest was expressed in pursuing the new plant at Roger Road on a design/build basis.
Implementing Design/Build. The respondents offered a great deal of commentary concerning the best means to implement a project on a design/build basis. Many firms advocated for the implementation of design/build projects on a "single step" procurement basis where the design/build contractor (either a single firm or a team comprised of an engineer and a construction contractor) is selected on a qualifications basis without consideration of price. The selected design/build contractor then works with the owner to develop the project scope and design. As under the CMAR method, the owner and the design/build contractor negotiate a lump sum price or GMP when the project scope and design are sufficiently developed. However, in contrast to the CMAR method, once the lump sum price or GMP is established through the negotiation of the design/build contract, the design/build contractor assumes full responsibility for price, schedule, and project outcome.

This implementation method (single step design/build) differs significantly from the more common "two-step" design/build implementation process involving a request for qualifications (RFQ) to pre-qualify

potential design-build contractors (up to three under Arizona State law) followed by a request for proposals (RFP), which provides for competition on price and non-price factors (including design). Under the two-step design/build process, the parties negotiate and establish a fixed price at the outset upon execution of the design/build contract based on the design/build contractor's proposal, which generally includes a 20-30% design. The advantages, disadvantages and special considerations associated with these different methods for implementing a design/build project, as indicated by the respondent comments, are addressed separately below.

Advantages and Special Considerations– Two-Step Design/Build. The respondents generally indicated that the two-step design/build process has the advantage of early price certainty, with the price known and fixed at the 20-30% design stage. Respondents indicated that this method, when compared to design-bid-build, CMAR or the single step design/build method, offers a greater opportunity for cost reduction through innovation and competition. Other advantages noted by the respondents include the fact that the design/build contractor serves as a single point of responsibility for price, schedule and performance outcomes, that the owner is removed from potential disputes between the engineer and construction contractor, and that the design liability is effectively transferred to the design/build contractor.

Generally, where the owner strikes the appropriate balance between ensuring a well-built, high quality project and providing for adequate opportunity for competition and innovation in the proposal process, innovation can result in lower capital and operating cost and improved performance. Respondents indicated that this can be achieved where the owner has a clear project definition, is comfortable with a performance-based selection and there is little chance of unforeseen circumstances or owner-directed change orders during construction. Particularly, respondents emphasized that the RFP should include performance-based requirements and minimal specific equipment or process specifications. According to Veolia Water North America - West, LLC, "For a municipality to benefit the most from design-build procurement, it must ensure it doesn't over design the initial plans prospective proposers will bid to… To develop creative proposals from DB team, the municipal entity should go out with a 10 percent or PDR (preliminary design report) level of design in order to get a spectrum of ideas from the proposer field." Similarly, Parsons Water & Infrastructure Inc. noted that "If an owner requires 30% or more design then a traditional project approach may be best suited for the project. Design build projects should be based on design that is less than 30%; more in the 10%-20% rang[e] to ensure maximum proposer flexibility and creativity." Overall, respondents indicated that opportunity for innovation and creativity, achieved through a properly structured, performance-based RFP process, can result in lower project costs for the owner.

Disadvantages and Special Considerations– Two-Step Design/Build. The primary disadvantages cited by the respondents with respect to the two-step design/build method are loss of control by the owner over design development and the cost of the procurement from the perspective of the proposing firms and, to a lesser extent, the owner. Respondents indicated that an owner under a two-step design/build process might experience some loss of control over the design of the project because, as suggested above, the design/build contractor will propose based on performance requirements and minimal specifications. This loss of control is the tradeoff associated with allowing a flexible, performance based approach, which enables proposing firms to develop innovative and creative proposals resulting in lower overall project costs to the owner. While the owner reviews design packages as the design progresses, the scope of the review is limited to whether the package complies with the parameters (design requirements) identified in the RFP and finalized in the design/build contract. The owner does not have approval rights

with respect to the design, as it does under the bid-build and CMAR method, except to the extent that design packages or suggested design changes do not comply with the specified design requirements. For this reason, it is critical that the owner establish clear design requirements in the RFP documents and subsequent design/build contract based on specific project goals and objective and measurable criteria. A few respondents suggested that the more time that the owner spends in this effort, the less risk the owner has in loss of control over design. However, some respondents suggested that this required up front effort could be costly to the owner, as the owner must generally hire consultants to assist with the project definition and the development of the procurement documents.

The primary cost concerns suggested by the respondents with respect to the two-step design/build method relate to the costs that the proposing firms incur in preparing competitive proposals. Cost concerns include not only the actual cost of preparing the proposal, but also the opportunity costs associated with committing resources to a project for an extended duration where the firm may not ultimately be successful. The actual costs of preparing a proposal are generally only partially offset by an honorarium or stipend. Respondents indicated that these cost concerns could have the effect of limiting the number of firms who will respond in the two-step design/build process. To mitigate these concerns, respondents suggested that the County should attempt to shorten the procurement process and streamline the submittal requirements. According to Parsons Water & Infrastructure Inc.:

"The amount of resources that a proposer will be asked to invest on a particular project must be taken into account. There is an alarming trend taking place in the alternative project delivery market whereby procurements are taking longer and costing more. This trend is impacting the level of competition, as proposers are making investments in business opportunities that they determine represent a commensurate level of business development dollars with the project. Procurement requirements have risen to the point of proposers asking, 'Is this really needed to make a selection?' An owner is well advised today to carefully look at schedule and proposal requirements, as it now has to develop a procurement that is attractive to the proposing community or else those proposers will look at other opportunities."

<u>Advantages and Special Considerations- Single Step Design/Build</u>. Many respondents suggested that the single step design/build method, also referred to as "progressive", "QBS", "collaborative", "negotiated" or "sole source" design/build, addresses some of the disadvantages associated with the two-step design/build method. As discussed above, the single step design/build method provides for a qualifications based selection of the design/build contractor followed by a collaborative effort by the owner and the selected firm on project scope and design. The selected firm is paid currently for its work with the owner in the development of the design. At the point where the design is sufficiently developed (50-60%), the owner and the selected firm negotiate the design/build contract. If negotiations are unsuccessful, the project can be completed on a bid-build basis. If the parties are able to negotiate a design/build contract, the design/build contractor completes the design, performs certain "general conditions" services and generally self-performs 10-20% of the construction work, with the remaining 80-90% of the construction work competitively bid.

According to many of the respondents, this process reduces the up-front procurement costs of both the owner and the design/build contractor and enables the owner to exert control over the design process through collaboration with the selected firm over the development of the design. Respondents also suggested that this process fosters a collaborative and cooperative relationship between the design/build contractor and the owner and reduces contingency pricing by the design/build contractor, since the fixed

price or GMP (including both the selected firm's fee and the competitively bid work) is negotiated based on a well-developed design (again, generally 50-60%). A few respondents noted that this process might attract more competitors due to the reduced costs associated with proposing on a qualifications-based procurement as opposed to the qualifications and price-based procurement contemplated by the two-step method.

Disadvantages and Special Considerations- Single Step Design/Build. Potential drawbacks associated with single step design/build include a lack of competition with respect to both design and price. The single step design/build method eliminates competition over the design of the project, thus limiting the opportunity for innovation and creativity that is generally associated with the proposal competition under the two-step design/build process. With respect to price, as noted above, the work involved in developing and completing the design and performing the general conditions services, as well as the work that the design/build contractor self-performs, is negotiated on a sole source basis. The owner is left without a competitive baseline with which to measure the reasonableness of the price offered by the selected firm. Moreover, the more work the design/build contractor proposes to self-perform, the less the amount of competitively bid work.
It should also be noted that the single step design/build process might not achieve the purported transfer of design liability that is considered a key benefit of design/build contracting. Under the normal, two-step design/build process, the transfer of design liability is based on the fact that the design/build contractor assumes full responsibility over the design. The single step design/build process might serve to negate this transfer of design liability because the owner assumes an approval role in the development of the design. This issue highlights the fact that the single step process is a relatively new method for implementing design/build without significant precedent in Arizona.

Special Considerations - Design/Build and Initial Operations. Respondents generally indicated that design/build contractors would not accept responsibility for short-term operations after achieving "acceptance" of the project. The prevailing view appears to be that operations are outside of the core competencies of design/build contractors and, as such, responsibility for operations should transfer to the owner after the successful demonstration of acceptance, which should assure the owner of the proper design and construction of the project. The respondents also noted that design/build warranties cover structure and equipment, but do not cover operations or performance following acceptance. A few respondents suggested that the County should consider design/build/operate if it is concerned about performance and cost issues following acceptance.

3.4 Design/Bid/Operate

Market Interest. The Design/Build/Operate Firms expressed considerable interest in pursuing the major projects in the CIP on a design/build/operate basis. Particular interest was expressed concerning pursuing the new plant at Roger Road on a design/build/operate basis.

Advantages. Design/Build/Operate Firms generally indicated that design/build/operate has the advantage of combining long-term operation guarantees (cost and performance) with the advantages discussed above concerning design/build. The design/build/operate contractor serves as the single point of responsibility for all aspects of design, construction and operations and can achieve efficiencies in design by

considering both construction feasibility and operational efficiency. The owner is not responsible for disputes between the designer, builder and operator.

A few firms indicated that design/build/operate generally results in lower project costs and better outcomes than under the design/build method or other forms of alternative project delivery due to improved life-cycle costs, efficiencies and innovation. Specifically, CH2M Hill responded that the efficiencies inherent in design/build/operate transactions provide the best opportunity to ensure that the lowest life-cycle project costs are obtained and that the performance guarantees that are made are met for the promised operating cost. Design/build/operate can provide long-term operating cost guarantees, long-term performance guarantees and the transference of capital maintenance on a long-term basis.

Disadvantages. Two key concerns with design/build/operate are the limited number of design/build/operate contractors that can pursue large projects nationally and the perceived loss of control by the owner. Some respondents noted that the agreement structure can minimize the loss of control experienced by an owner. Epcor's response indicated that "well structured agreements give local government more control over the quality of services" through: (1) clear performance measures; (2) enforcement provisions and financial penalties for non-compliance; (3) government retention of policy and legislative power to regulate the provision of services; and (4) the separation of operations and the regulation of operations, which better ensures enforcement.

Special Considerations – Treatment of Existing Staff. Treatment of existing staff requires special considerations with respect to a design/build/operate project. Respondents recommended that an RFP and a design/build/operate contract clearly specify those measures that would protect existing staff. Severn Trent indicated that it typically retains existing staff and offers benefits of support from its nationwide and global network of operations and technical professionals. A few firms indicated that design/build/operate contracts can benefit existing staff by providing advantages such as open communication between the operator, staff and the owner, as well as improved compensation, protection against layoffs, employee ownership options, improved working conditions, and career growth and advancement.

Special Considerations – Long-Term Maintenance and Repairs. The long-term nature of a design/build/operate transaction necessitates addressing long-term maintenance obligations in the design/build/operate contract. To assure proper long-term maintenance of a facility, a facility condition evaluation conducted at the beginning and end of the contract term was recommended. Likewise, a predetermined schedule of maintenance, repair and replacement requirements throughout the term is also necessary. Respondents were split on whether they would be willing to accept a limited or even full transfer of capital maintenance risk. Some respondents recommended establishing a capital replacement fund to cover capital maintenance and help to ensure proper maintenance of the facility. Some respondents recommended periodic maintenance inspections by the County and requiring stricter performance standards in the final five years of the contract to help ensure proper maintenance of the facility throughout the term.

Special Considerations – Fixed Service Fee. A long-term contract would provide for a fixed annual service fee for operation of the facility, with annual adjustments based on a blend of indices used for adjusting various components of the service fee, such as those relating to labor and chemicals. Electricity and gas rates could be paid by the County as "pass through" costs.

Special Considerations – Single Guarantor. Often a design/build/operate contract is structured to provide performance security in the form of a "single guarantor" whereby the operator or another single firm, guarantees performance of the entire design/build/operate contract. The single guarantor arrangement creates one point of responsibility for the project throughout the contract term. While some respondents indicated that they would be willing to participate in a procurement structure of this manner, others did not favor the single guarantor structure. CH2M Hill responded that the single guarantor structure provides a best value solution for an owner and that it would offer a single guarantor for its projects. Despite an acknowledgement that the "single guarantor" structure is widely used, Veolia Water indicated that it does not believe the single guarantor structure is viable in today's marketplace. Veolia Water instead favors the "successor guarantor" concept in which the design-builder serves as the guarantor through the design, construction and startup phase of the project and then subsequently at a predetermined time, such as one year following acceptance of the plant, the operating company assumes the obligations of the guarantor.

4. Project Financing

Market Interest. Sixteen of the respondents provided varying levels of discussion regarding private financing of projects in Pima County's CIP. Of these sixteen, eleven provided substantive comments and three provided a discussion that included some details related to the way in which the County could possibly utilize private financing.

Of the eleven respondents that provided significant discussion on private financing, nine indicated a that private financing is a viable alternative to traditional public sector financing under certain conditions; one respondent was skeptical of the viability of private financing; and one was completely against the concept of private financing.

All sixteen of the respondents that addressed the concept of private financing indicated that they had some experience with the concept of private financing of public assets, but only one respondent claimed to have successfully utilized private financing tools to fund water/wastewater assets in the United States.

With regard to the applicability of private financing under the various project delivery options, all of the private financing respondents indicated that private financing was not appropriate under Design-Bid-Build or CMAR project delivery methods and only marginally applicable under Design/Build. All respondents agreed that the potential benefits of private financing could only be realized under the Design/Build/Operate delivery model due to the need to secure the financing with a long-term operating contract.

Many of the private financing respondents also suggested that private financing was more applicable for those components of the Pima County CIP that allowed for a segregation of project cash flows and risks such as the Roger Road Water Reclamation Campus; the biogas and residuals management facilities at Ina Road WPCF; and the regional treatment facilities that serve the outlying areas.

All three of the private financing respondents that provided significant detail regarding private financing packages indicated that the private financing package that provided the greatest potential benefits would involve the use of eighty-five to ninety percent private non-recourse debt and ten to fifteen percent private

equity. Additionally, the private debt would be secured with a twenty- to fifty-year Design/Build/Operate contract that provided for the recovery of interest and return on equity through the periodic service fee.

There was general consensus among the sixteen private financing respondents regarding the potential advantages and disadvantages of using private financing tools to fund projects in Pima County's CIP.

Advantages. Potential advantages of private financing cited by the private financing respondents included:

- Private financing provides the County an alternative if the County Board of Supervisors or the County constituents fail to authorize the use of traditional public financing tools;
- Private financing would most likely not be considered a debt of the County and therefore would not impact the County's capacity to issue debt for other projects;
- Private financing could accelerate project schedules since the County would not be required to go through the process of seeking and gaining the approvals necessary to utilize traditional public financing tools; and
- Private financing, under the right circumstances, could result in lower project life cycle costs assuming that the project delivery/financing model included a private operations component with a term of at least twenty-years and preferably forty- to fifty-years.

Disadvantages. Potential disadvantages of private financing cited by the private financing respondents included:

- Financing costs under a private financing model would be greater due to the higher cost of capital associated with the use of private financing packages comprised of private equity and taxable debt; and
- Due to the fact that there are few, if any, previous transactions that could serve as precedent, the use of private financing would probably require the use of a number of financial advisors/consultants to develop a private financing transaction. As a result, issuance/transaction costs would most likely be higher than they would be under a traditional public financing model.

Special Considerations. All of the private financing respondents indicated that a private financing package that involved the use of Private Activity Bonds offered the greatest potential benefits to Pima County. However, all were quick to point out that under the existing rules that govern the use of Private Activity Bonds it was very unlikely that Private Activity Bonds would be available to fund wastewater projects. It should be noted, however, that efforts are being made within various departments of the Federal government to reduce some of the restrictions of the use of Private Activity Bonds. As such, if these efforts are successful, the use of Private Activity Bonds to fund portions of the County's CIP may be an option in the future.

5. Biosolids – Disposal/Biogas Utilization

While specific submittals addressed biosolids issues only, several others offered comments on biosolids disposal or biogas utilization. Remarks provided in the other submissions on this topic are included in the remarks below.

5.1 Biosolids Disposal

Market Interest**.** Interest in the biosolids disposal from the Pima County wastewater facilities ranged from disposal of current Class B biosolids to processing and disposal of future Class A biosolids to innovative processing technologies. Nine respondents stated an interest in biosolids disposal. Four of the respondents had substantive comments regarding biosolids disposal by a third party. One of those respondents is a major leader, Synagro, in biosolids management with more than 1,000 active accounts for biosolids management nationwide. Three submittals proposed unique approaches to processing biosolids with one those having an innovative disposal option for small plants.

In general, for achieving drier biosolids concentrations required of a Class A biosolids rating, respondents suggested or recommended heat drying technology with provisos that a market for Class A exists, and regulatory issues and risks are adequately addressed by Pima County. Further, the respondents recommended alternative delivery approaches utilizing design/build, design/build/operate, or design/build/finance/operate as a means procurement.

Advantages. Based on the comments from the respondents there is interest in third party disposal of biosolids provided there are appropriate contract provisions. Particularly, the respondents were interested in constructing, operating and possibly financing Class A heat drying facilities provided that an extended period of operations of the facilities is included in the procurement requirements. Most respondents agree that a design/build or design/build/operate procurement of heat drying technology for Class A biosolids is an available and proven project delivery approach.

Disadvantages. Although there is interest in Class A biosolids, the respondents do not stated that a Class A biosolids market exists in Pima County, or that Class A biosolids would be a less expensive disposal option based on a higher value of the end product. Therefore, without regulatory pressure to develop a Class A biosolids, the decision to proceed to Class A will need to be based on an economic analysis and Class A products market study conducted by Pima County.

Special Considerations. Prior to proceeding with Class A biosolids the respondents cautioned to verify that a market for Class A products exists and that regulatory issues and risks are fully addressed. Several firms supported the centralization of solids handling and use of centrifuges for dewatering at the Ina Road Water Pollution Control Facility as recommended in the Regional Optimization Master Plan. Three respondents offered innovative or alternative solutions for biosolids treatment and disposal. The innovative and alternative solutions are largely unproven or would possibly be suitable for very small wastewater treatment facilities. Lastly, Synagro expressed an interest in financing and operating the wastewater treatment facilities for the new Water Reclamation Campus.

5.2 Biogas Utilization

Market Interest**.** Seven respondents addressed collecting the renewable energy source (biogas) from the anaerobic digesters and producing both thermal energy for process needs and electrical power from generator sets. Four of the respondents had substantive comments. Most of the interest in the biogas projects was in design/build/operate or a design/build/finance/operate type projects where private capital could be invested.

All respondents were supportive of generating power from biogas and scalping thermal energy for process use. The respondents viewed the biogas power operation as a non-critical wastewater treatment function and saw it as a potential for third party operation. As such, alternative project delivery approaches were considered to be appropriate for this operation, which could include operations and private financing.

Advantages. Based on the comments from the respondents the advantage of having the biogas power generation operation provided by a third party is that it is not a core business of the wastewater operation and the issues with upgrading existing systems and cost effective operation could shifted to others, who operate these type of system as a core business. The facilities operations would be placed with others in turn for a guaranteed reliable power delivery provided to Pima County. Further, there were comments that with biogas power generation improvements and some rate restructuring, particularly at Roger Road WWTP, there could be some overall power savings accrued to the County. This would be advantageous time because the current electricity service power provider, Tucson Electric Power, is considering change to their rate structure and pricing levels in January 2009. According to APS Energy Services:

"Arizona design build energy savings projects (such as the one contemplated here) can be procured under **ARS 34-455** which encourages public agencies to implement theses types of projects. As long as the project is self-funding from the annual savings and the term length is 25 years or less the agency can define its own criteria for procurement through the request for proposals process."

Disadvantages. The principle disadvantage of a third party operation is the loss of control over power generation and the cost savings provided to the County. With a third party operation the costs of power would be left to the marketplace, unless suitable power rates are negotiated with the power generator which factored in the "green" credits inherent in the operation. With a third party operation the County would most likely be required to guarantee a minimum continuous supply of methane gas from the digester operations. Below the minimum gas production may cause a penalty payment to be imposed on the County which may negate the savings from the third party operation.

Special Considerations. The biogas production is a means for Pima County to reduce overall power costs at Ina Road WPCF. Further there is an increasing market interest in renewable energy sources, such as biogas, as it relates to green credits. This situation should be viewed as an opportunity for the County to obtain a favorable long term deal with a third party interest.

6. Alternative Technologies

Special Considerations. For completeness of the review of the information submitted by respondents to the Request for Expression of Interest, four respondents proposed alternative and innovative technologies for the Pima County wastewater facilities. There was one each for wastewater treatment, sludge treatment, biosolids processing and biosolids disposal. The wastewater treatment technology proposed was a membrane bioreactor (MBR) process that was reviewed during the Regional Optimization Master

Plan activities with many other technologies to achieve the future ammonia toxicity standard for Pima County. While this technology can meet the future treatment requirements and has a small footprint as compared to others, the present worth costs of such a system is more that the recommended treatment technology. Therefore, it was eliminated from future considerations at the Pima County plants.

The proposed sludge treatment system appears to be similar to a physical-chemical treatment process which in years past had proven to be very costly. At this time there exists one small system in the start-up phase of operations in Florida that has not produced data or information to substantiate any claims offered in their letter of interest. Without a proven track record of operating facilities of the size of Pima County facilities, this would be a very risky system to invest County resources. Therefore this system is eliminated from future consideration.

The proposed biosolids processing system combines a solar drying process with indirect mechanical heat drying equipment to produce a Class A biosolids. The biosolids processing begins with solar drying and is finished with mechanical heat drying to achieve a consistent final product. With the solar drying component in the process the system is land intensive and not conducive for use at large treatment plants in Pima Count. In addition, the overall system has a significant odor potential to be addressed with the solar drying process. Therefore, this process is not recommended for use at the major facilities in Pima County.

Lastly, a process to spray liquid biosolids on agricultural fields to grow crops to be fermented into ethanol was proposed. First a number of regulatory Permits held by the County would need to be revised and sanctioned by the State of Arizona before proceeding with the process. Furthermore, this process is very land intensive and would need to be proven to be commercially viable before Pima County would be positioned to invest in such process. The proposal has a County buyback requirement for the ethanol at $3.80 per gallon. This may have applicability at very small treatment works with access to nearby agricultural land, but the economics would need to favorable to the County.

In summary, each of the technologies had been evaluated during the Regional Optimization Master Plan development and discounted, or the technology is unproven or perhaps suitable for facilities smaller than those of Pima County. None of the suggested alternatives or innovations were worthy of further investigations by Pima County at this time.

7. Application to Pima County Facilities

Based on the aforementioned data and information from the expression of interest respondents, the following range of project delivery can be considered by Pima County for the projects identified in the Regional Optimization Master Plan. The project delivery approaches for each project are to be discussed further in detail before a final specific recommendation for each project element is provided.

Project element	*Suggested Project Delivery**
• New Water Reclamation Campus	D/B or D/B/O
• Ina Road WPCF Upgrades and Expansion	CMAR or D/B (single step)
• Biosolids Disposal	D/B/O or D/B/F/O
• Biogas Utilization	D/B/O or D/B/F/O
• Regional Facilities	CMAR, D/B. D/B/O or D/B/F/O

Comments on the range of project delivery approaches included that procurement would need to develop documents for design/build projects; and the County is not ready for third party operations, but if third party operations were a serious consideration, the current staff issues would need to be thoroughly addressed to protect their jobs and interest. In general, it was agreed by all that there were no deal killers in executing any of the suggested project delivery approaches listed above.

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*	D/B	= design/build	D/B/F/O	= design/build/finance/operate
	D/B/O	= design/build/operate	CMAR	= construction manager at risk

Appendix J

Expressions of Interest

Workshop Meeting Notes and Presentation

Workshop Meeting Notes
Expression of Interest in Pima County Programs and Projects

1. The Expression of Interest Workshop for the Pima County Regional Optimization Master Plan was held on July 30, 2007. The agenda, purpose of workshop statement and flip chart notes recorded during the workshop are attached at the end of the notes. In attendance were:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Mike Bunch
Jackson Jenkins
Jeff Nichols
PCWMD Staff
Ed Curley
Mary Hamilton
Michael Kostrzewski
Ron Riska, Project Manager
Eric Wieduwilt
Legal
Chuck Wesselhoff

DIRECTOR OF COUNTY FINANCE AND RISK MANAGEMENT
Tom Burke

PIMA COUNTY PROCUREMENT DEPARTMENT
John Carter
Terri McMahon
Jerry Rizzo

PIMA COUNTY ADMINISTRATION
John Bernal
Nannette Slusser (part time)

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Eric Petersen
Andy Richardson
Harold Smith
Joe Sullivan

2. Major topics of the workshop were:

- Expression of Interest Workshop
  - Project Delivery
  - Project Financing
  - Biosolids Options
    - Disposal
    - Biogas
  - Alternative Technologies

A set of handouts were provided to each attendee at the workshop.

3. Mike Gritzuk welcomed the attendees to the workshop and reviewed the expectations of the group. The workshop will provide a detailed review of the submissions to the Request for Expression of Interest issued by the County in April, 2007, and list recommendations for the facilities identified in the Regional Optimization Master Plan. With agreement on the recommendations the implementation plan for the Regional Optimization Master Plan will proceed to completion by October. At this point the workshop presentation and discusssion was invited to begin.

4. Andy Richardson quickly outlined the meeting topics and purpose. He further elaborated on his role as facilitator and encouraged all to participate. The workshop objectives were to review the information received by the County through the request for expression of interest process and how the received information relates to the projects in Regional Optimization Master Plan. In addition, an overview of the Regional Optimization Master Plan scope and elements were presented. Critical project dates and element costs were provided for context to the comments offered by the expression of interest respondents. Further, objectives of the Request for Expression of Interest for engaging the marketplace were presented to set the stage for the subsequent workshop presentations.

   Workshop agenda, meeting purpose, ground rules, Regional Optimization Master Plan overview, and Request for Expression of Interest objectives were covered on pages 1 through 8 of the handout.

5. The twofold objective of the Request for the Expression of Interest was to invite private sector comments on public policy decisions, and to seek potential cost savings through market positioning to provide high value at least cost. Overall twenty six (26) submittals were received from engineering firms, construction firms, design/build firms, design/build/operate firms, financial firms, biosolids disposal firms, and firms interested in biogas utilization. Submissions covered the entire spectrum of requested information. An overview of the submissions in response to the Request for Expression of Interest was provided by Eric Petersen. Overarching comments within the submissions included: projects would benefit from some sort of alternative delivery (either construction-manager-at-risk or design/build), no need to break the projects into small packages, and qualifications based selection was the preferred method of procurement. One submission by EPCOR had a particularly interesting perspective on alternative delivery involving value of money and pricing of risk approaches. In general, the level of information provided by the submitting firms was thoughtful and of very high quality.

   Mike Gritzuk asked if the procurement approach outlined by EPCOR to minimize risk was in accord with Arizona law. The response was yes. Also, the EPCOR approach to private sector project finance is within Arizona law. Harold Smith advised that the EPCOR approach is not unique. The Lake Pleasant project for Phoenix included elements of the EPCOR approach.

   Comments on the respondents and general comments from the respondents are covered on pages 8 through 14 of the handout.

6. Joe Sullivan reviewed the comments received from respondents on the traditional design-bid-build and construction-manager-at-risk procurement methods. Most firms expressed interest in the design-bid-build approach. This approach is suitable for all construction projects and is well

understood in the engineering and construction communities. The design-bid-build delivery method is successful when: project documents are accurate and complete, a quality contractor is obtained, and construction oversight is provided. Most respondents indicated that alternative project delivery approaches are preferable due to the size and complexity of the facilities recommended in the Regional Optimization Master Plan.

From the respondent comments construction-manager-at-risk was generally favored over design-bid-build by construction firms, design/build companies and some engineering firms. The value is that the construction manager assists in the preliminary design and the following stages of design to incorporate cost saving features and cost effective construction means and methods. Further, construction reviews, up-to-date cost estimates and fast tracking of projects (shorter delivery schedules) are provide throughout the design and construction process. A guaranteed maximum price for the project will be developed sooner than traditional design-bid-build approach, and with a fuller understanding by all parties of the objectives and challenges involved.

Mike Bunch asked if the construction-manager-at-risk firms could be pre-qualified or limited in number. John Carter offered the County could limit the number of firms based on certain capabilities, but could not limit firms to just a number. The construction-manager-at-risk firm could be procured under qualifications based selection under Arizona law.

Comments on traditional design-bid-build and construction-manager-at-risk were covered on pages 14 through 17 of the handout.

7. Comments from the private sector on alternative delivery methods of design/build and design/build/operate were presented by Eric Petersen. Under both of these approaches the marriage between the designer and the contractor is voluntary, whereas under the construction-manager-at-risk approach the owner selects the designer and then selects the construction manager. This latter process may be described as a “shot-gun wedding” approach.

The design/build approach is a highly collaborative process which spawns innovation and cost savings. Fixed project costs are known early in the design and construction continuum. Also, some project risk is transferable from the owner to the design/build team. For example, the owner is not involved in disputes between designer and contractor. This approach works best when project outcomes are less prescriptive and are based on goals that include measurable and objective criteria (encourages innovation).

Ron Riska indicated that PCWMD has invested time and energy into the selection of a robust, high quality wastewater treatment process for the future major facilities in Pima County. Would prescribing the wastewater process be detrimental to the design/build approach for these facilities? The response is that PCWMD can identify the wastewater process to be used; and because there are enough other elements in these projects, the design/build team can be innovative with the other parts of the project. Contract documents must clearly specify what elements need to be factored into final project outcome.

Mike Gritzuk asked about the history of bid price spreads between design-bid-build and design/build contracts. In general, for design-bid-build projects the spread in bid prices can be as high as 100 percent from the engineer’s estimate. On design/build projects the bid price of the

top two bidders are usually close and the others vary from those. Further, during the execution of the work under a design/build contract protests over bids are nil and change orders are nil both of which may have a cost implication.

Single stage design/build is also known as progressive, or collaborative, or negotiated, or sole source design/build. This is permissible under Arizona law as long as the negotiations for the project are with three firms. The negotiations are not a competitive process, but may be suitable for particular projects, such as to meet n aggressive schedule. This approach has been used in Pima County for the skyline project with a total construction cost of $21 to $22 million. Contractors are interested in this approach, because it eliminates the large development fee costs incurred with the traditional two step design/build selection process. In some regards, the single stage design/build is similar to the construction-manager-at-risk approach where the owner has a role in design.

Adding operations and finance into the design/build project widens the basket of duties for the proposing firm or team, and reduces the number of players to submit on a project scope. It should be noted that design/build does not include an operations component for startup or short term operations before handoff to the owner. The concept of startup and short term operations with design/build can be referred to as enhanced design/build. This concept has fallen out of favor and is likely not to attract interest from the construction community in bidding such an arrangement.

The design/build/operate approach will limit work to 3 and as many as 5 contractors which pursue projects nationally. This approach provides long term operating costs and performance guarantees. Benefits for the County would be lower costs and better performance. Challenges are protection of assets and protection of the existing workforce. Workforce issue would need to be addressed early for successful transition to this new private sector operating mode.

The design/build, design/build (single step), and design/build/operate comments were covered on pages 18 through 25 in the handout.

8. After review of the comments on project delivery approaches from the Expression on Interest respondents, Eric Petersen presented the general business considerations and procurement issues for the alternative project delivery approaches. By all accounts proper risk allocation is key. The least cost approach is to assign risks to the party that is best able to manage it. There are many risks including: condition risk, permitting risk, commodity escalation risk, process engineering risk, sureties influence on risk, and security of performance risk. All of these influence the bottom line cost of a project. Lowering risk will reduce overall project costs.

   Alternative delivery contract documents need to: clearly define the scope of work and contractual obligations, set measurable and achievable performance standards, include effective administration and communications provisions, and establish workable mechanisms for change. Business concerns included: stated dollar limit on liability in contract, reasonable liquidated damages, performance incentives, no consequential damages, protection from commodity price escalation, and clear start-up and testing criteria.

   Procurement processes for alternative delivery need to be open, fair and non-political. The County procurement process should include quality based selection with open book bidding and a

clear set of selection criteria. Shortlisting of three firms is required and advisable. A notice of intent is a good method to alert tentative proposers of impending projects to allow for the formation of teams, and analysis of work load and capacity prior to the project advertisement.

Business terms and risks, and procurement issues were covered on pages 25 through 29 of the handout.

9. The market interest in project financing of public works was covered by Harold Smith. Sixteen respondents provided comment on financing and all suggested private activity bonds would offer the greatest potential benefit to the County. Also, the respondents generally believe that traditional tax-exempt debt is the most cost effective means of financing the PCWMD capital improvements. From the respondents private financing does not appear to be appropriate for design-bid-build or construction-manager-at-risk projects. Private financing for design/build could work, but would be expensive. Private financing would work with design/build/operate where funding is secured by long term revenues (20 to 50 years). Some suggested private financing was more suitable for specialized projects, such as, biosolids disposal and biogas power generation.

   With private financing of projects costs are shifted from debt to operating costs. This could be impacted by State of Arizona restrictions on spending caps. Tom Burke indicated that the State of Arizona had a per capita per year expenditure increase cap, and that service costs would fall under expenditures and would be subject to the cap. Ed Curley indicated that private equity is considered a junior level asset and is not pledged. Private funding remains an option if the voters deny approval of bonds earmarked for the wastewater infrastructure improvements.

   Project financing was covered on pages 29 through 32 of the handout.

10. The market interest in biosolids disposal was summarized by Jerry Bish. In general, respondents are interested in disposal of Pima County biosolids, and supported the centralization of solids handling and use of centrifuges for dewatering at the Ina Road Water Pollution Control Facility as recommended in the regional master plan. For achieving drier biosolids concentrations for a Class A biosolids rating, respondents suggested heat drying technology with the provisos that a market for Class A exists, and regulatory issues and risks are adequately addressed. Further, the respondents recommended alternative delivery approaches utilizing design/build, design/build/operate, or design/build/operate/finance as a means procurement.

    Three respondents offered innovative or alternative solutions for biosolids treatment and disposal. These solutions are largely unproven and would possibly be suitable for very small wastewater treatment facilities.

    Biosolids disposal comments were covered on pages 32 and 33 of the handout

11. Several respondents commented on biogas utilization at the Ina Road Water Pollution Control Facility. All were supportive of generating power from biogas and scalping thermal energy for process use. As summarized by Jerry Bish the respondents viewed the biogas power operation as a non-critical wastewater treatment function and saw it as a potential for third party operation. As such, alternative project delivery approaches are appropriate for this operation, which could

include operations and private financing. Mike Gritzuk offered that APS and a large biogas operation had expressed interest in biogas and were going to submit their response soon. Those responses will be added to the body of information when received.

Biogas utilization comments were covered on pages 34 and 35 of the handout.

12. For completeness of review of the information submitted through the expression of interest process, several respondents proposed alternative and innovative technologies for the Pima County wastewater facilities. There was one each for wastewater treatment, sludge treatment, biosolids processing and biosolids disposal. Jerry Bish indicated that each of the technologies had been evaluated during the regional optimization planning process and discounted, or the technology was unproven or suitable for facilities smaller than those of Pima County. None of the suggested alternatives or innovations were worthy of further investigations by the County at this time.

    Alternative technologies were covered on pages 35 through 37 of the handout.

13. Based on the aforementioned data and information the following range of project delivery suggestions were offered for group comment. The project delivery approaches for each project are to be discussed further in detail before a specific recommendation for each project element is provided.

Project element	*Suggested Project Delivery**
New Water Reclamation Campus	D/B or D/B/O
Ina Road WPCF Upgrades and Expansion	CMAR or D/B (single step)
Biosolids Disposal	D/B/O or D/B/O/F
Biogas Utilization	D/B/O or D/B/O/F
Regional Facilities	CMAR, D/B. D/B/O or D/B/O/F

Comments on the range of suggested project delivery approaches included that procurement would need to develop documents for design/build projects; and the County is not ready for third party operations, but if third party operations were a serious consideration, the current staff issues would need to be thoroughly addressed to protect their jobs and interest. In general, it was agreed by all that there were no deal killers in executing any of the suggested project delivery approaches listed above.

* D/B = design/build
D/B/O = design/build/operate
CMAR = construction manager at risk
D/B/O/F = design/build/operate/finance

Agenda
Expression of Interest - Workshop
July 30, 2007

Time	*Topic*	*Presenter*
8:15 am	*Health and Welfare Building, 150 W. Congress - 4th Floor Training Room*	
8:30 am	Opening Session • Welcoming Remarks • Review Agenda • Workshop Purpose	 Mike Gritzuk Andy Richardson
8:35 am	Expression of Interest Process	Andy Richardson
8:45 am	Project Delivery	Eric Petersen
8:55 am	Traditional Design – Bid – Build	Eric Petersen/Joe Sullivan
9:00 am	Construction Manager @ Risk	Eric Petersen/Joe Sullivan
9:30 am	Design - Build	Eric Petersen/Joe Sullivan
10:00 am	Design - Build – Operate	Eric Petersen/Joe Sullivan
10:20 am	General Business Considerations	Eric Petersen
10:30 am	Procurement Terms	Eric Petersen
10:35 am	Break	
10:50 am	Project Financing	Harold Smith
11:25 am	Biosolids • Disposal • Bio-Gas / Bio-Power	Jerry Bish
11:40 am	Alternative technologies	Jerry Bish
11:50 am	Summary Wrap-Up • Comments by Group • Closing Remarks	Andy Richardson Mike Gritzuk
12:00 pm	Adjourn	

Purpose of Workshop

Review and discuss the project delivery methods available to the County for the implementation of the Regional Optimization Master Plan (ROMP) facilities based on the submittals received from more than 25 respondents to the County's Request for Expressions of Interest. Presentations will address the submittals, the respondents, the depth of market interest in each delivery method, commentary from the respondents on which method is appropriate for each project, pros and cons of the various delivery methods from the contractors' standpoint, market views on how best to structure each procurement, and the potential for private project financing for some of the facilities.

Flip Chart Notes – July 30, 2007

Comments and Questions

- Think about how public/private firms would relate to rates and time factor
- EPCOR doable AZ law & public firm
- DBB – Can do some prequalification
- First step – DB County has possible $20 million level

Recap - What we heard this morning?

- Tom Burke comments on CAP
- Procurement ok with methods discussed

Workshop Meeting Notes
Expression of Interest in Pima County Programs and Projects – Part 2
(ROMP Implementation Plan)

1. Part 2 of the Expression of Interest Workshop for the Pima County Regional Optimization Master Plan (ROMP) was held on the afternoon of July 30, 2007. This workshop applied the data and information presented in the morning workshop to the identified ROMP projects. Comments and suggestions to be used by the project team were recorded on flip charts. The recorded items are attached at the end of the notes.

   In attendance were:

PCWMD
Director
Michael Gritzuk
Deputy Directors
Mike Bunch
Jackson Jenkins
Jeff Nichols
PCWMD Staff
Ed Curley
Mary Hamilton
Michael Kostrzewski
Ron Riska, Project Manager
Mandley Rust
Eric Wieduwilt

GREELEY AND HANSEN PROJECT TEAM
Jerry Bish
Bart Kreps
Eric Petersen
Andy Richardson
Harold Smith
Joe Sullivan

14. Major topics of the ROMP Implementation Plan workshop were:

- Expression of Interest (ROMP Implementation Plan) Workshop
  - Funding Source and Rate Impacts Discussion
  - Implementation Schedule
  - Santa Cruz Interceptor Phase IV
  - Water Reclamation Campus
  - Electrical Service modifications
  - Ancillary Projects
  - Regional Facilities

A set of handouts, entitled ROMP Implementation Plan, were provided to each attendee at the workshop.

15. Mike Gritzuk welcomed the attendees to the continuation of the morning workshop on the Expressions of Interest from the marketplace and how that information applies to the specific ROMP projects. At this point the workshop presentation was invited to begin.

16. Andy Richardson quickly outlined the meeting agenda, purpose and objective. The meeting purpose was:

- Review and discuss private project financing and rate impacts for some of the facilities.
- Review and discuss the project delivery methods available to the County for the implementation of the Regional Optimization Master Plan (ROMP) facilities based on the County's Request for Expressions of Interest information. Address which method is appropriate for each project, and pros and cons of the various delivery methods.

The objective of the afternoon workshop activities was to identify number of ROMP projects and the appropriate project delivery approach for each. Attendees were reminded to participate fully.

The agenda and workshop purpose were covered on page 2 of the handout.

17. The project funding issues for the ROMP elements were reviewed by Harold Smith. Funding for the major treatment works construction will be traditional public debt financing, unless there is consideration for long term operations included in the scope of work. Public financing provides the best value for money and therefore the least cost to the County. Projects like the biosolids disposal and biogas utilization are subject to a different financing plan depending on the chosen approach to implementation. For these public-private partnerships may be possible with the use of private financing.

18. Implementation details for the Regional Optimization Master Plan project elements were reviewed by Jerry Bish. The Santa Cruz Interceptor Phase IV (plant interconnect pipeline), new Water Reclamation Campus, Ina Road WPCF upgrades and expansion, Electrical service modifications, ancillary projects and regional wastewater facilities are included under the project elements. Critical project dates, project elements, phasing, and individual project element schedules were outlined for discussion by the group. The suggested project delivery approaches

for each project element was carried over from the morning workshop session for further discussion. The objective was to further narrow the possible project delivery approaches for each element to a specific one or two.

The ROMP implementation details including a summary scope and schedule of each project element were covered on pages 4 through 18 of the handout.

19. The Santa Cruz Interceptor Phase IV work is underway. The project delivery approach had been chosen by PCWMD as construction-manager-at-risk (CMAR) and the design engineer was selected. The solicitation for the construction management firm was underway at the time of the workshop. In addition, the project manager for the work has been selected. The remaining project need will be the addition of a construction manager when the project advances to that stage.

20. The new Water Reclamation Campus will be constructed as a single phase 32 mgd facility. Demolition of the existing Roger Road WWTP will be performed under a separate contract. The phases of work and recommended project delivery are shown below.

New Water Reclamation Campus

-	Scope	Start	Complete	Recommended Project Delivery
1	Engineering – 32-mgd Facility (includes power feeds/standby power)	2007/08	2010	Professional
2	Construct – 32-mgd Facility	2011	2015	CMAR or single step D/B
3	Engineering – Demolition Existing Facilities	2014	2015	Professional
4	Demolition – Existing Facilities	2015	2017	D-B-B (Design Bid Build)

21. The Ina Road WPCF upgrades and expansion will be designed under one contract and constructed in phases. Phases of work and recommended project delivery are summarized below.

Ina Road WPCF Upgrades and Expansion

Phase	Scope	Start	Complete	Recommended Project Delivery
1	Engineering – 50-mgd + Biosolids + Future Biosolids (Class B) ■ New 12.5 mgd NdeN ■ Rehab BNRAS ■ New 25 mgd NdeN (HPO replacement ■ Biosolids handling and treatment ■ Interim sludge facilities	2007/08	2010	Professional
2	Construct – 50-mgd Facility ■ New 12.5 mgd NdeN ■ Rehab BNRAS ■ New 25 mgd NdeN (HPO replacement) ■ Construct – Biosolids Facilities ■ Interim Sludge Facilities (one digester and GBF)	2010 2009	2014 2011	CMAR CMAR
3	Construct - Biosolids Facilities (future)	2017	2020	D-B-B
4	Engineering/Construct – Class	After 2020	After 2020	D/B/O or D/B/O/F

	A Biosolids			

D/B/O – Design Build Operate
D/B/O/F – Design Build Operate Finance

22. Electrical Service Modifications included work at the new Water Reclamation Campus and at Ina Road WWTP. The decision was made to have the electrical service with the new campus include with the construction of the facilities and to have the work passed accordingly. The Ina Road WPCF power unification would occur under a separate contract from the other project work at Ina Road WPCF. Lastly, the biogas power generation would be given further consideration as a candidate for third party operations. The phases of work for electrical service modifications and recommended project delivery are summarized below.

Electrical Service Modifications

Phase	Scope	Start	Complete	Recommended Project Delivery
1	Engineering – Ina Road WPCF Power Unification Modifications	2008	2009	Professional
2	Construct – Ina Road WPCF Power Unification Facilities	2010	2011	D-B-B
3	Construct – Biogas Power Generation Facilities	2012	2014	D/B/O or D/B/O/F

23. Ancillary Projects included the interim sludge facilities at Ina Road WPCF, central laboratory, PCWMD general administration facilities, and instrumentation and control. The interim sludge facilities at Ina Road WPCF are permanent facilities that need to be online once the interconnect pipeline is constructed to accommodate additional sludge processing needs at the plant. This work is to be included with the other project work at Ina Road WPCF, but will be identified as a project for early construction at the site.

The central laboratory was recognized as special work and would remain as a separate contract for design and construction. The general administration facilities were not viewed as special work and are to be included in the new Water Reclamation Campus work.

Instrumentation and controls is another specialized area of work. There was discussion about this being a separate contract including the work at Ina Road WPCF and the new Water Reclamation Campus, but a final resolution was not achieved. More discussion within PCMWD will be required before a final direction is provided.

Ancillary Projects

Phase	Scope	Start	Complete	Recommended Project Delivery
1	Architectural Services – Central Laboratory	2007	2010	Professional
2	Construct – Central Laboratory	2011	2013	CMAR
3	Engineering - Instrumentation & Control	2008	2009	*
4	Construct – I&C	2010	2012	*

* Undecided at this time

24. Project delivery approaches for the regional facilities were quickly mentioned at the meeting. It was generally agreed that the expansion projects would be CMAR. It was as further suggested that the Southlands could be D/B or D/B/O for the first phase. It is noted that existing Arivaca Junction, Pima County Fairgrounds and Vista Rillito facilities will be phased out of operation over time. Further, it is possible that Mt.Lemmon WWTP may be expanded based on studies underway. Expansion of that facility is to be determined (TBD). The recommended project delivery approaches for the regional facilities expansions should be revisited prior to finalization.

Regional Facilities

No.	Facility	Expand 1	Expand 2	Expand 3	Expand 4	Recommended Project Delivery
1	Arivaca Junction	-	-	-	-	No expansions
2	Avra Valley	2006 / 2007	2008 / 2009	-	-	CMAR
3	Corona de Tucson	2006 / 2007	2018 / 2019	2027 / 2028	-	CMAR
4	Southlands	2009/2010	2010 / 2011	2012 / 2013	2014 / 2015	D/B, D/B/O, CMAR
5	Green Valley	2011 / 2012		-	-	CMAR
6	Marana	2006 / 2007	2008 / 2009	2018 / 2019	2027 / 2028	CMAR
7	Mt. Lemmon	TBD	-	-	-	Possible expansion
8	PC Fairgrounds	-	-	-	-	No expansions
9	Rillito Vista	-	-	-	-	No expansions

25. Andy Richardson summarized the number of ROMP projects derived from the workshop discussions as presented in the above tables. It was noted that contracts for project management and construction management services were generally not included in the above listings.

Flip Chart Notes – July 30, 2007

Objectives for this afternoon

- Number of projects
- How delivered

Roger Road Contracts

- Prepare D/B documents
- One D/B contract for 32 mgd facility.
- Demolition contract later
- Look at O when preparing D/B documents

Projects

- New Water Reclamation Campus – Method D/B or possibly D/B/O
  - One contract for 32 mgd facilities
- Ina Road WPCF – Method CMAR or D/B (single step)
- Biosolids disposal/class "A" – Method D/B/O or D/B/O/F
- Biogas - Method D/B/O or D/B/O/F
  - Move up dates
  - 2010 & 2011 – overall plant
- Regional facilities – Method D/B or CMAR or D/B/O/F

Ina Road Projects

- 1 designer @ CMAR for entire Ina Road WPCF work
- Phase 2 & 3 scope CMAR
- Phase 4 (later) – move forward
- 4 Contracts
  - CMAR design services
  - CMAR project management services
  - CMAR construction
  - CMAR construction management services

Electrical Service Modifications

- Put Phase 1 into water campus project – have this phased
- Put Phases 3 & 4 into Ina Road design contract for MCC
- Link HPO electrical into power grid
- Separate project for power upgrade

Ancillary Project

- Lab separate from D/B construction work

Move Administration into new Water Reclamation Campus

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Expression of Interest Workshop

July 30, 2007

Agenda

- Introduction
- Project Delivery
- Project Financing
- Biosolids
  - Biosolids Disposal
  - Biogas
- Alternative Technologies

Purpose of Workshop

- Review and discuss project delivery methods available to the County for implementation of the Regional Optimization Master Plan (ROMP) facilities
- Based on Submittals received from 26 respondents to the County's Request for Expressions of Interest.

  Address:
  - submittals, respondents, depth of market interest
  - commentary on which delivery method is appropriate for each project
  - pros / cons of various delivery methods from contractors' standpoint
  - market views on how best to structure each procurement
  - potential for private project financing for some of the facilities

Groundrules

- Listen attentively and respectfully to others
- Everyone must participate fully to the extent of their expertise
- Understanding is our objective, but consensus is not required
- We agree to speak up honestly and with candor
- Disagreements are with opinions or issues, and have basis in fact, not with personalities

Role of Facilitator

- Remain neutral and objective
- Expedite adherence to agenda and schedule
- Negotiate changes in agenda, schedule, or procedure
- Ensure an equal opportunity to be heard
- Keep group focused on discussion as planned
- Manage discussion, sequence speakers, and exercise leadership

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Introduction - ROMP & Expression of Interest Process

Andy Richardson

ROMP Scope

- Develop the optimal treatment process and plan to comply with regulatory requirements to reduce total nitrogen concentrations in discharged effluent
- Master plan addresses foreseeable future regulatory requirements
- Determine the long-term capacity needs of the County metropolitan facilities, conveyance system and outlying growth areas

ROMP Scope, cont.

- Develop long-term plan for treatment, handling and beneficial use of bio-solids and bio-gas
- Develop a detailed implementation schedule to meet regulatory implementation deadlines and optimization master plan
- Develop a financial plan to support the system's regulatory and other needs for the next fifteen years

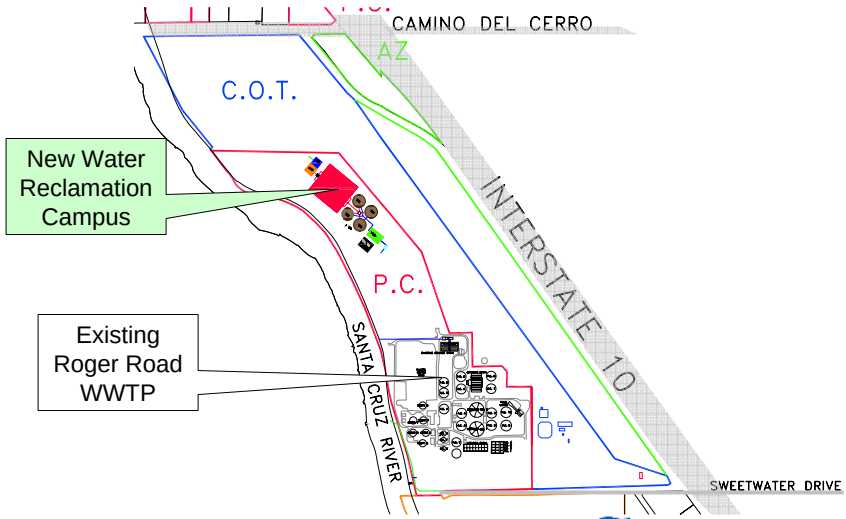
Regulatory Implementation Requirements to Reduce Total Nitrogen Concentrations

	Ina Road WPCF	Roger Road WWTP
■ Complete initial engineering study ■ Provide recommendation for upgrading treatment plants ■ Submitted recommended plan letter to ADEQ on January 26, 2007	February 1, 2007	January 30, 2007
■ Award contract for construction	December 31, 2010	January 30, 2011
■ Treat plant effluent to non-toxic nitrogen levels	January 30, 2014	January 30, 2015

Selected ROMP Plan

- Construct new 32 mgd Water Reclamation Campus (adjacent to Roger Road WWTP)
- Expand Ina Road WPCF to 50 mgd
- Plant Interconnect – 28 mgd average flow
- Decommission existing 41 mgd Roger Road WWTP

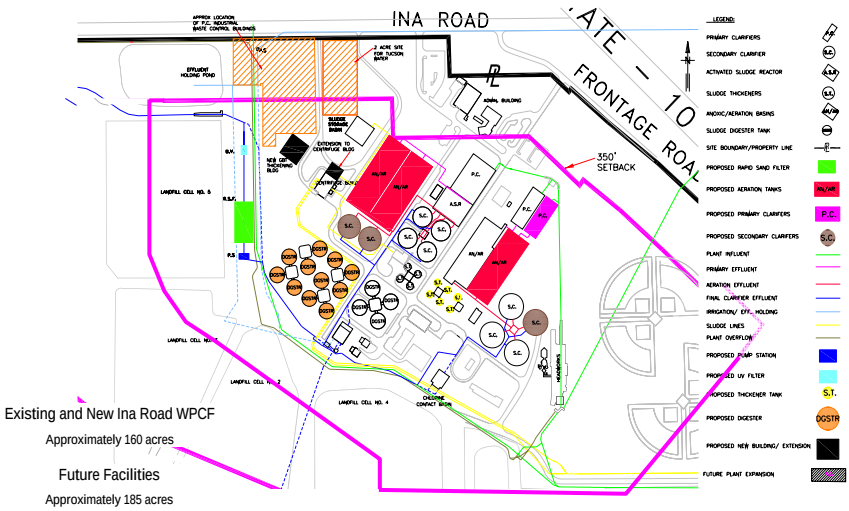
Water Reclamation Campus – New 32-mgd Facility



Ina Road WPCF

- Expand treatment capacity to 50 mgd
  - Requires 12.5 mgd expansion and significant retrofit of existing facilities
  - Most cost-effective utilization of existing headworks capacity of 50 mgd
- Centralized biosolids processing and handling
  - Reduces overall cost
  - Provides for bio-gas operations / utilization at one location
  - Provides one point of distribution of final product

50-mgd Ina Road WPCF



Existing and New Ina Road WPCF

Approximately 160 acres

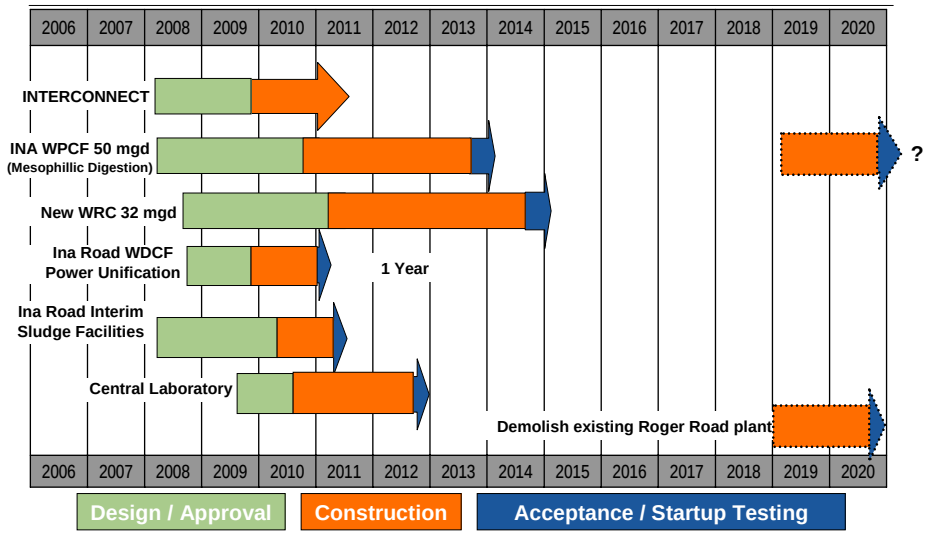
Future Facilities

Approximately 185 acres

ROMP Cost Estimate (2006 dollars)

	Roger Road Greenfield 32 mgd Ina Road 50 mgd
Ina Road Treatment Plant	$243,900,000
Plant Interconnect	$22,300,000
Water Reclamation Campus	$211,000,000
Electrical Upgrades	$35,000,000
Reclaimed Water Return	$270,000
Roger Road WWTP Demolition	$23,800,000
Total Construction Cost	$536,270,000 Cost estimate includes 5% contingency

Project Sequence



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Request for Expression of Interest

RFEI - Objectives

- Engage the Marketplace
  - Solicit and receive private sector comments to inform public policy decisions
  - Gather perspectives from interested parties' on project delivery, private financing and related matters

RFEI – Objectives, cont.

- Seek Potential Cost Savings
  - Evaluate ability to provide cost savings based on current market conditions
  - Gain knowledge from market on how best to position ROMP projects for highest value at lowest costs

RFEI - Schedule

- RFEI posted April 23, 2007
- Pre-submittal meeting May 23, 2007
- Submittals June 22, 2007
- After receipt of submittals
  - Review Submittals
  - Assess ROMP report impacts
- Workshop July 30, 2007

RFEI – Types of Projects

- Proposed Projects
  - New Water Reclamation Campus
  - Ina Road WPCF Expansion/Upgrade
  - Biosolids Disposal Services
  - Biogas/Power Facilities
  - Regional Facilities
  - Innovative / Alternative

RFEI – Procurement Approaches

- Alternative Project Delivery Methods
  - Design - Bid - Build
  - Construction Manager at Risk
  - Design / Build and Related Project Delivery Methods
  - Design / Build / Operate

RFEI Content

- Private Project Financing

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Project Delivery

Eric Petersen / Joe Sullivan

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26 Respondents

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Engineering Firms

- Brown and Caldwell
- Carollo
- Kennedy Jenks
- Malcolm Pirnie

Construction Firms

- Kiewit
- McCarthy
- Mortenson
- Sundt
- Western Summit

Design-Build Firms

- AMEC Infrastructure
- Black & Veatch
- MWH
- Parsons

Design-Build-Operate Firms

- CH2M Hill
- EPCOR/Stantec/PCL
- GE Water and Process Technologies
- PCL
- Severn Trent
- Veolia

Financial Firms

- Goldman Sachs
- Lehman Brothers

Biosolids Firms

- Synagro
- Fenton
- Bio Chem
- Sweet Ethanol
- Comments by others

Biogas Power Firms

- NZ Legacy
- Comments by others

Providers of the Most Comprehensive Responses

- Black & Veatch (D/B)
- CH2M Hill (D/B, D/B/O)
- EPCOR (D/B/O, DBFO)
- Lehman Brothers (DBFO)
- Parsons (D/B)
- Veolia (D/B/O)

Some Non-Respondents

- Responses were not required as a condition to future participation
- Some non-respondents:
  - American Water
  - Southwest Water
  - Tucson Electric Power
  - Other engineering firms
  - Other construction firms
- May nonetheless propose

Overall Comments (1)

- Most said all projects would benefit from some form of alternative delivery
- Engineering, construction and D/B firms favored CMAR or D/B
- D/B firms split on whether they would participate in a D/B/O
- Each would participate in all 5 projects if:
  - Their preferred delivery method was chosen
  - RFQ and RFP are properly structured

Overall Comments (2)

- No need to break up large projects into smaller packages
- Efficiency and economy could be sacrificed
- Pre-procurement one-on-one meetings between County and potential contractors are valuable
- During procurement, schedule one-on-one meetings on technical issues
- Qualifications-based selections are preferred
- An honorarium is not a major factor in decision to propose unless very substantial

Overall Comments (3)

- Seek to minimize protracted procurement processes
- Decide financing approach before RFP is issued
- In D/B/O, describe parameters of the “net present value” calculation of D/B/O price
- Solicit input directly from sureties and insurance companies

Projects of Interest (1)

- Water Reclamation Campus:
  - All construction firms; all D/B firms; all D/B/O firms
- Ina Road WPCF:
  - All construction firms; all D/B firms; all D/B/O firms
- Biosolids Disposal:
  - 1/5 construction firms; all D/B firms; 5/6 D/B/O firms

Projects of Interest (2)

- Biogas Power:
  - All D/B firms; 4/6 D/B/O firms
- Outlying Facilities:
  - 2/5 construction firms; all D/B firms; 5/6 D/B/O firms
- Interest in particular projects depends on how they are packaged and procured

Alternative Delivery Works Best Where Projects:

- Are schedule-sensitive
- Are relatively complex
- Cost more than $10 million
- Have a variety of technical solutions
- Require long term performance assurances
- County is concerned with life-cycle costs
- Can benefit from risk sharing
- Involve "greenfield facilities"

A Canadian Perspective on Alternative Delivery

- EPCOR Utilities, Inc.
- Value for money
- Pricing risk
- Multiple criteria analysis

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Traditional Design-Bid-Build (D-B-B)

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Market Interest in D-B-B

- Most engineering, construction and D/B firms expressed interest in D-B-B
- Most said D-B-B is suitable for all facilities
- D-B-B is well known and understood
- Most said alternative methods are preferable for all facilities due to complexity and size of projects

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D-B-B and Engineering Firms

- Engineering firms recommended D-B-B or CMAR
- D-B-B provides most control over cost and quality
- D-B-B successful when:
  - Design documents are accurate and complete
  - A quality contractor is obtained
  - County procures experienced construction oversight
- But D-B-B prevents collaboration with construction firms

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Construction Manager at Risk (CMAR)

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General Comments

- CMAR generally favored over D-B-B by the D/B firms, construction firms, and some engineering firms
- Important to have CM assist with preliminary design
- Engage CM concurrently with engineer or by 30% design stage; no later than 60% stage

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CMAR Services (1)

- Constructability reviews of the design
- Cost estimating
- Value engineering throughout design
- Project management (procurement, construction, start-up, commissioning)
- Quality assurance
- Safety

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CMAR Services (2)

- Procure long lead time items
- Permitting assistance
- Self perform work
- Fast track bid packages
- Responsible for quality of construction and conformance with design specifications

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CMAR Advantages (1)

- Qualifications-based selection of CM
- Transfer of pricing risk through GMP
- Construction can begin before design is 100% complete
- Shorter delivery schedule, earlier price certainty than D-B-B

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CMAR Advantages (2)

- Cost savings from constructability review and schedule optimization
- Competitive bid process retained
- Strong team relationship between parties
- Non-adversarial partnering of CM with owner, engineer

Guaranteed Maximum Price (GMP)

- Fix anywhere between 20-100% design
- Fixing at 60-90% is common
- Earlier fixing results in higher contingencies
- Consider shared savings as against GMP
- Specify assumptions
- Base contingency on unknowns, not a certain percentage of GMP

CMAR Disadvantages

- Risk of design liability and project performance not transferred
- Schedule, cost savings, and risk transfer small in comparison to D/B, D/B/O
- Owner in middle of designer and contractor for resolving disputes
- Owner still primarily responsible for project outcomes and performance
- "Sticker shock" often occurs when GMP is set late

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Design-Build (D/B)

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D/B Advantages

- D/B strikes balance between goals of:
  - Well built, high quality project, and
  - Opportunity for competitive, innovative proposals
- D/B is likely (relative to D-B-B, CMAR) to:
  - Shorten project delivery schedule
  - Reduce project costs
  - Transfer risks
- D/B & D/B/O Firms: D/B is superior to D-B-B, CMAR

D/B Advantages (2)

- Price known (fixed) at 30% design stage for basic intent w/o owner changes
- Single source guarantee of price, schedule, performance
- Owner removed from potential disputes between engineer and contractor
- Contractor responsible for project outcomes and performance

Works Best When:

- Owner is comfortable with performance-based solutions
- D/B contractor can innovate to reduce cost and manage its risk
- Project definition is clear
- Little chance of unforeseen circumstances
- No expected owner change orders after construction begins

General Observations

- Sureties play a key role, and insist on reasonable risk allocation
- Adding operations and financing to D/B diminishes number of potential participants
- Need to assure quality control, given the flexibility in design
- County should be open to other technologies if performance is guaranteed

“Best Value” Selection

- Capital cost price
- Non-price factors
  - Financial stability
  - Personnel qualifications
  - Company experience
  - Technical solution proposed
  - Business terms and conditions

Design Requirements and Performance Guarantees

- Base them on goals for each project
- Include measurable, objective criteria
- Utilize performance-based requirements
- Include owner’s preferred equipment and process specifications
- State acceptable processes or technologies

D/B and Initial Operations

- Firms generally will not accept any responsibility for short term operations after project acceptance
- Warranties typically cover structures and equipment, not operations or performance
- D/B/O covers operations, but the operations term must be medium or long term

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Single Step Design Build (D/B)

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Single Step D/B (1)

- Recommended by major D/B Firms
- Also known as “progressive”, “collaborative”, “negotiated” or “sole source” D/B
- 3 pre-qualified firms
- Can be integrated D/B firms, or engineering/construction JV
- Best qualified firm selected to negotiate a design contract
- May or may not lead to a D/B contract

Single Step D/B (2)

- Owner, owner’s representative and selected firm collaborate on design
- Selected firm is paid currently for design
- At 50-60% completed design, owner and firm negotiate a D/B contract
- If parties cannot agree on a D/B contract, firm completes design and project is done using D-B-B

Single Step D/B (3)

- If D/B contract is executed, firm self-performs 10-20% of work
- Remaining 80-90% is bid-out competitively
- Firm's fee for remaining design and self-perform work is sole-source negotiated

Single Step D/B (4)

- Potential advantages
  - Saves proposers the high cost of proposal preparation
  - Owner participates in design more extensively
  - Collaborative process between parties
  - Owner flexibility

Single Step D/B (5)

- Potential drawbacks
  - No precedent in Arizona
  - No competition for self-performed work
  - Owner may retain "design liability", despite purported transfer, due to extensive role in design

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Design Build Operate (D/B/O)

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D/B/O Generally

- D/B comments apply to D/B/O as well
- Limited number (4-5) of D/B/O contractors that can pursue large projects nationally
- D/B/O firms asserted projects costs lower, outcomes better than D-B-B
- Some preferred DBFO, DBFOO due to improved life-cycle costs, innovation

D/B/O Advantages

- Long term operating cost guarantee
- Long term performance guarantee
- Long term capital maintains risk transferred
- Owner not responsible for disputes between designer, builder, operator

D/B/O and Existing Staff

- Workforce protection measures must be clearly stated in RFP and D/B/O contract
- D/B/O contract operations may result in increased operating efficiencies and cost savings
- Protection of existing staff occurs through:
  - Open communication
  - Protection against layoffs
  - Improved compensation
  - Employee ownership
  - Improved working conditions
  - Career advancement opportunity

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Assuring Proper Long Term Maintenance

- Facility condition evaluation at start and at end
- Condition requirements at end
- Scheduled repairs and replacements during term
- Capital replacement fund
- Periodic maintenance inspections
- Limited or full transfer of capital maintenance risk
- More onerous performance standards in last 5 years

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Service Fee Structure

- Fixed annual service fee
- Annual adjustments based on basket of indexes
- Indexes reflect cost components such as labor and chemicals
- Electricity and gas rates "passed through"

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Security for Performance – "Single Guarantor"

- Common practice
- Operating service company guarantees all design, construction, and operation obligations
- One point of responsibility
- Some said single guarantor is best structure
- One said single guarantor is not viable in today's marketplace

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Security for Performance – "Successor Guarantor"

- D/B contractor guarantees performance until project acceptance
- Operating contractor then guarantees operations and performance
- Some willingness to help develop a workable structure
- No precedents
- May or may not expand number of potential D/B/O respondents

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General Business Considerations for Alternative Project Delivery

Eric Petersen

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Business Terms

- Proper risk allocation is key
- A few prefer "standard" forms (industry prepared)
- Allocate risk to party best able to manage it
- Clearly define the work scope and contractual obligations
- Set measurable and achievable performance standards
- Include effective project administration and communication provisions
- Establish workable mechanisms for future changes

County Retained Risks

- Subsurface conditions
- Site contamination
- Change in law and regulations
- Land and easement acquisition
- Material cost escalation

Limited Loss of Control under Alternative Delivery

- Some loss of control in D/B, D/B/O over specific technical approaches and specifications
- Project definition and workscope assures best control
- Also handle contractually by proper risk allocation
- Design and construction oversight is important
- CMAR and single-step D/B offer more control by joint development of design and technologies
- Level of innovation is inversely proportional to level of specification

Key Business Concerns

- Contract must have a stated dollar limit on liability
- Reasonable liquidated damages
- Performance incentives
- No consequential damages
- Mutual indemnification
- Well-defined influent parameters and effluent standards
- Protection from commodity price escalation
- Clear start-up and testing criteria

Ina Road Upgrade Challenges – "Condition Risk"

- Availability and reliability of as-built documents
- Availability of operating data and maintenance
- Unknown remaining equipment life
- Continued operations during the upgrades
- Need for extensive interaction among parties
- Varied views on whether D/B, CMAR or D-B-B is best suited for upgrades
- Varied degrees of willingness to assume "condition risk"

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Permitting Risk

- Broad range of willingness to assume
- Some object unless permitting problems are due to contractor fault
- Others will accept this risk unless problems are caused by agency responsiveness
- Many are willing generally to risk the permitability of their design

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Commodity Price Risk

- Risk of fluctuations in steel, concrete, copper, fuel and other commodities
- Most believe that the lump-sum D/B price can be adjusted for commodity price risk using indexes
- Some question this and urge "open book" pricing
- Others state risk can be "hedged" by contractor locking in prices at proposal date

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"Sureties" Influence

- Sureties consider design-build projects high risk
- Projects involving "process engineering risk" are more difficult to bond today
- Significant surety involvement in business terms
- Concerns reflect the "design liability" the sureties are bonding against

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Security for Performance

- Performance bonds (cover construction and process performance)
- Parent company guaranty, where contracting company is a subsidiary or has weak credit
- Letter of credit
- Requiring all 3 may discourage participation
- Professional liability insurance in D/B contracts

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Procurement Process

Eric Petersen

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General Procurement Process Advice

- Open, fair, non-political
- Consider QBS process, with open-book bidding
- Short listing 3 firms is required and advisable
- Avoid protracted, costly processes
- Use clear selection criteria
- Knowledgeable selection committee

Procurement Schedule

- Issue a notice of intent in order to alert proposers
- Gain environmental clearances
- For responding to RFQ – 3 to 4 weeks
- For responding to RFP – 3 to 4 months
- Time for drafting RFQ, RFP and for evaluation and selecting contractor – highly variable

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Project Financing

Harold Smith

Market Interest

- 16 Respondents provided discussion
- 11 provided substantive comments
- 3 provided significant detail
- 9 believe private financing is viable, 1 completely against, 1 is skeptical
- All suggested that Private Activity Bonds offered the greatest potential benefit
- Most claim successful experience with private financing of public assets
- Only 1 claimed significant experience with water/wastewater assets in the US

Public vs. Private

- Respondents generally believe that traditional tax-exempt debt is the most cost effective means of financing the PCWMD CIP.
- Respondents believe that it is in PCWMD's best interest to explore private financing.

Delivery Methods

- Private financing is not appropriate for D-B-B or CMAR.
- Private financing could work with a D/B, but would not be economical.
- DBOF and DBFOOT are the only viable options for private financing.

Applicable Projects

- Most applicable to “stand-alone” projects for which cash flows could be isolated.
- Some suggested private financing was more suitable for specialized components such as biosolids handling and power generation

View of the Respondents

	Public	Private
Ease of Use	✓	
Interest Rate	✓	
Issuance Cost	✓	
Impact on Schedule		✓
Impact on Debt Capacity		✓
Approval Process		✓
Project Life Cycle Cost		✓

Typical Private Financing

- Private non-recourse debt (85 to90%)
- Equity (10 to 15%)
- Funding secured by revenues from long-term (20 to 50 years) D/B/O contract
- Interest and return on equity included in service fee.

Potential Rate Impacts

- Greater total payout with private financing.
- Creative structuring and longer term could reduce impacts.
- PABs would be equal to revenue bonds.

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Biosolids

Jerry Bish

Disposal – Market Interest

- 9 Respondents addressed disposal
- 4 with substantive responses
- 3 with alternative/innovative processes
- 1 is leader in biosolids management nationwide.

General Comments

- Supported centralization of biosolids treatment
- Supported centrifuge dewatering process

Applicable Projects

- Recommended heat drying for achieving Class “A” biosolids
  - Provided market exists
  - Regulatory issues/risks are addressed
- Suggested D/B, D/B/O, DBFO for delivery of Class “A” biosolids

Special Considerations

- Interest in County biosolids disposal operations
- Alternative / innovative processes for small scale projects
- Alternative / innovative processes largely unproven

Biogas - Market Interest

- 6 Respondents addressed biogas
- 3 with substantive responses
- All indicated third party interest
- Private financing available

General comments

- Supported generating power from biogas
- Supported scalping thermal energy for process utilization
- Biogas is an asset

Special Considerations

- Biogas power generation is not critical to wastewater treatment
- Green (biogas) power will reduce long term costs or generate revenue
- Large power utilities did not respond directly, but indirectly indicated interest

Delivery Methods

- D/B, D/B/O, DBF, DBFO

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Management Department
Tucson, Arizona

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Alternative Technology

Jerry Bish

Innovative or Alternative Technologies

- 4 Respondents with Alternative or Innovative approaches
- 1 - wastewater treatment process
- 1 - sludge treatment process
- 1 - biosolids process system
- 1 - biosolids disposal

Alternative Technology

- Wastewater treatment process
  - MBRs considered under wastewater treatment system evaluation
  - First Cost and Life – Cycle Costs more expensive than selected process

Innovative/Alternative Process

- Sludge Treatment process
  - Only one system exists
  - System in start-up and evaluation phase at small facility
  - Unproven claims
  - Dependent on aggressive chemicals (acids and bases - operate unfriendly)
  - Similar to another process that is costly

Innovative/Alternative Process (2)

- Biosolids process system
  - Combines two unit operations to dewater biosolids to Class “A” reqts.
  - Utilizes solar drying and mechanical dewatering in tandem
  - Land intensive for large plants
  - System reliability
  - Odor potential

Innovative/Alternative Process (3)

- Biosolids Disposal
  - Emerging from experimental development
  - Applicable to small facilities
  - Produces green energy (ethanol)
  - No comment on final waste by-product disposal
  - Operational reliability concerns (shared risk)
  - Requires County buy back of end product
  - Requires County to modify APP

Innovative / Alternative Considerations

- Sludge treatment process
  - Not proven
- Biosolids process system
  - Not required in short term / perhaps suited for small facilities / process needs verification
- Biosolids disposal
  - Perhaps suited for small plants / experimental / technical issues / not proven to be commercially viable / requires significant county involvement

Pima County Wastewater
Management Department
Tucson, Arizona

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Summary

Andy Richardson

Pima County Wastewater
Management Department
Tucson, Arizona

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Closing

Mike Gritzuk

Pima County Wastewater
Management Department
Tucson, Arizona

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ROMP Implementation Plan

July 30, 2007

ROMP Implementation Plan - Agenda

1. Opening Remarks/Review Agenda/Workshop Purpose
2. Funding Source and Rate Impacts Discussion
3. Implementation Schedule
4. Santa Cruz Interceptor Phase IV
5. Water Reclamation Campus (24 mgd + 8 mgd)
6. Ina Road WPCF (50 mgd) Upgrade/Expansion
7. Electrical Service Modifications
8. Ancillary Projects
9. Regional Facilities
10. Summary / Closing

Purpose of Workshop

- Review and discuss private project financing and rate impacts for some of the facilities.
- Review and discuss the project delivery methods available to the County for the implementation of the Regional Optimization Master Plan (ROMP) facilities based on the County's Request for Expressions of Interest information. Address which method is appropriate for each project, and pros and cons of the various delivery methods.

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Funding Source/Rate Impacts Discussion

Implementation Details

- Implementation Schedule
- Project delivery
- ROMP CIP projects
  - Conveyance
  - Treatment Facilities

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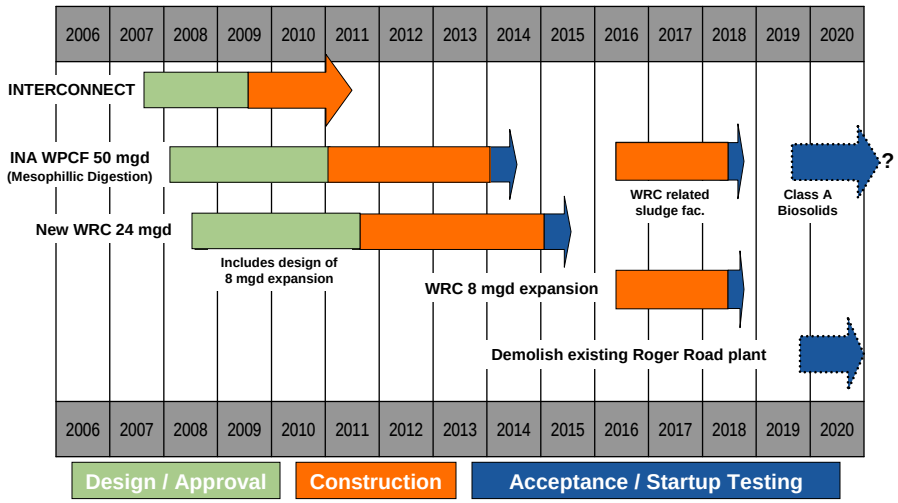
Project Sequence/Schedule



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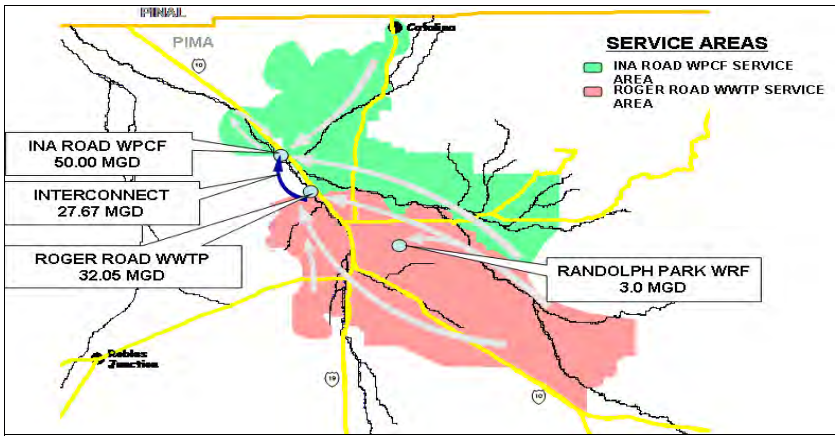
Santa Cruz Interceptor Phase IV
(Plant Interconnect Pipeline)

Year 2030 Location of Major WWTPs Relative to the Metropolitan Tucson Service Area



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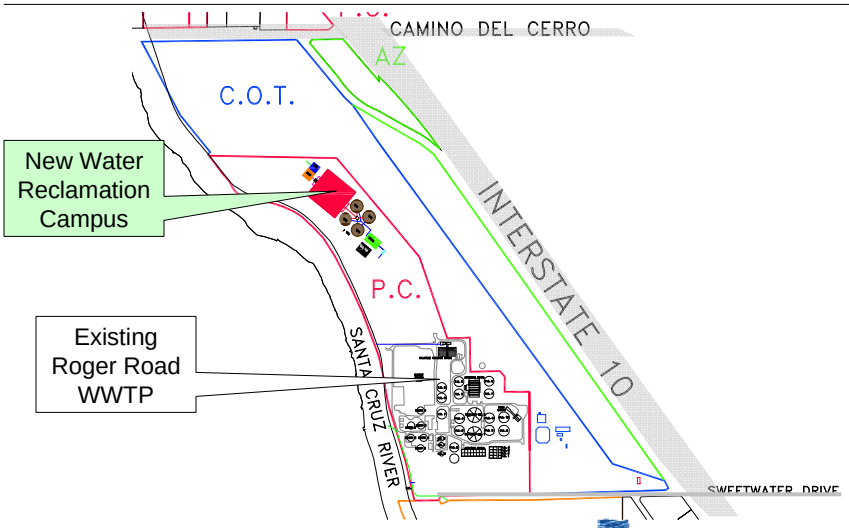
Santa Cruz Interceptor Phase IV

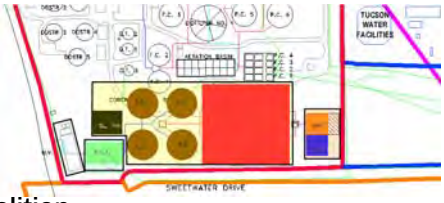
Phase	Scope	Start	Complete	Project Delivery
1	Engineering – Santa Cruz Interceptor *Phase IV*	2007	2008	Professional
2	Construct – Santa Cruz Interceptor *Phase IV*	2008	2010	CMAR

Water Reclamation Campus – New 24-mgd + 8 mgd Facility



Water Reclamation Campus (24 mgd)

- Site preparation
- Headworks
- Bardenpho treatment (including clarifiers, solids thickening/pumping)
- Disinfection
- Administration/control building
- Standby power generation
- Future 8-mgd Bardenpho system (including clarifier)
- Future (8 mgd) gravity belt thicke
- Existing Roger Road WWTP demolition



Roger Road Projects

Phase	Scope	Start	Complete	Potential Project Delivery	Recommended Project Delivery
1	Engineering – 24-mgd + 8-mgd Facilities	2007/08	2010	Professional	
2	Construct – 24-mgd Facility	2011	2015	CMAR, D/B or D/B/O	
3	Engineering – Demolition Existing Facilities	2014	2015	Professional	
4	Demolition – Existing Facilities	2015	2017	D/B, CMAR or D-B-B	
5	Construct – 8-mgd Facility	2017	2020	CMAR or D-B-B	

Ina Road WPCF Upgrade/Expansion

- Site preparation
- Preliminary treatment expansion
- Primary clarifier
- Bardenpho treatment (including clarifiers)
- Demolish HPO and oxygen system
- Mesophilic digestion (5 new, 4 existing)
- Gravity thickening (primary sludge)
- Gravity belt thickening (WAS sludge)
- Centrifuge thickening/dewatering
- Sludge storage
- Disinfection
- Power unification
- Biogas power generation
- Future (WRC 8 mgd) mesophilic digester
- Future (WRC 8 mgd) thickening/dewatering fac.
- Future Class A biosolids facilities

Ina Road Projects

Phase	Scope	Start	Complete	Potential Project Delivery	Recommended Project Delivery
1	Engineering – 50-mgd + Biosolids + Future Biosolids (Class B) ■ New 12.5 mgd NdeN ■ Rehab BNRAS ■ New 25 mgd NdeN (HPO replacement ■ Biosolids handling and treatment	2007/08	2010	Professional	
2	Construct – 50-mgd Facility ■ New 12.5 mgd NdeN ■ Rehab BNRAS ■ New 25 mgd NdeN (HPO replacement)	2010	2014	CMAR or D-B-B	
3	Construct – Biosolids Facilities	2010	2014	CMAR or D-B-B	
4	Construct - Biosolids Facilities (WRC 8 mgd}	2017	2020	CMAR or D-B-B	
5	Engineering – Class A Biosolids	2018/19	2020	Professional	
6	Construct Class A Biosolids	After 2020	After 2020	D/B/O or D/B or CMAR	

Electrical Service Modifications

Phase	Scope	Start	Complete	Potential Project Delivery	Recommended Project Delivery
1	Engineering – Roger Road WRF Power/Standby Power	2008	2010	Professional	
2	Construct – Power Services for New Facility	2011	2013	D/B, CMAR or D-B-B	
3	Engineering – Ina Road Electrical Modifications	2008	2009	Professional	
4	Construct – Power Unification Facilities	2010	2011	CMAR or D-B-B	
5	Construct – Biogas Power Generation Facilities	2012	2014	D/B/O, D/B, CMAR or D-B-B	

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Ancillary Projects

Phase	Scope	Start	Complete	Potential Project Delivery	Recommended Project Delivery
1	Architectural Services – Central Laboratory/General Admin Bldg.	2007	2010	Professional	
2	Construct – Central Laboratory	2011	2013	D/B, CMAR or D-B-B	
3	Construct – General Admin Bldg.	2013	2015	D/B, CMAR or D-B-B	
4	Engineering - Instrumentation & Control	2008	2009	Professional	
5	Construct – I&C	2010	2012	D/B, CMAR or D-B-B	
6	Construct - Interim Facilities @ Ina Road WPCF	2009	2010	CMAR or D-B-B	
7	Other				

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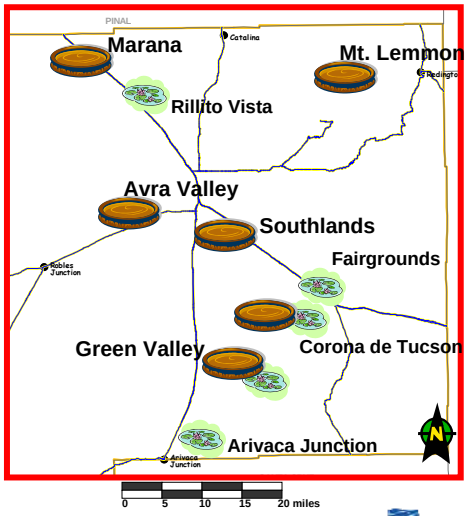
Future Outlying Facilities



Outlying Facilities Expansion

- Southwest Region
  - Avra Valley WWTF
    - Expansion 1 (from 1.2 to 2.2 mgd)
    - Expansion 2 (from 2.2 to 4.0 mgd)
- Southeast Region
  - Corona de Tucson WWTF
    - Expansion 1 (from 0.3 to 1.3 mgd)
    - Expansion 2 (from 1.3 to 2.3 mgd)
    - Expansion 3 (from 2.3 to 3.3 mgd)
- Southland WWTF
  - Expansion 1 (from 0 to 2.0 mgd)
  - Expansion 2 (from 2.0 to 3.0 mgd)
  - Expansion 3 (from 3.0 to 4.0 mgd)
  - Expansion 4 (from 4.0 to 8.0 mgd)
  - Expansion 5 (from 8.0 to 12.0 mgd)

Outlying Facilities Expansion

- South Region
  - Green Valley WWTF
    - Expansion 1 (from 4.1 MGD to 6.1 MGD)
- Northwest Region
  - Marana WWTF
    - Expansion 1 (from 0.5 to 1.5 MGD)
    - Expansion 2 (from 1.5 to 3.0 MGD)
    - Expansion 3 (from 3.0 to 4.5 MGD)
    - Expansion 4 (from 4.5 to 6.0 MGD)
- Mt. Lemmon WWTF
  - No change unless changes in area restrictions

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Outlying Facility Expansion

Facility	Expand 1	Expand 2	Expand 3	Expand 4	Rec'd PD
Arivaca Junction	-	-	-	-	-
Avra Valley	2006 / 2007	2008 / 2009	-	-	
Corona de Tucson	2006 / 2007	2018 / 2019	2027 / 2028	-	
Southlands(1)	2009 / 2010(2)	2010 / 2011	2012 / 2013	2014 / 2015	
Green Valley	2011 / 2012		-	-	
Marana	2006 / 2007	2008 / 2009	2018 / 2019	2027 / 2028	
Mt. Lemmon(3)	TBD	TBD	TBD	TBD	
PC Fairgrounds	-	-	-	-	
Rillito Vista	-	-	-	-	

(1)Additional expansion in 2022/2023
(2)By others
(3)Long range planning study in progress

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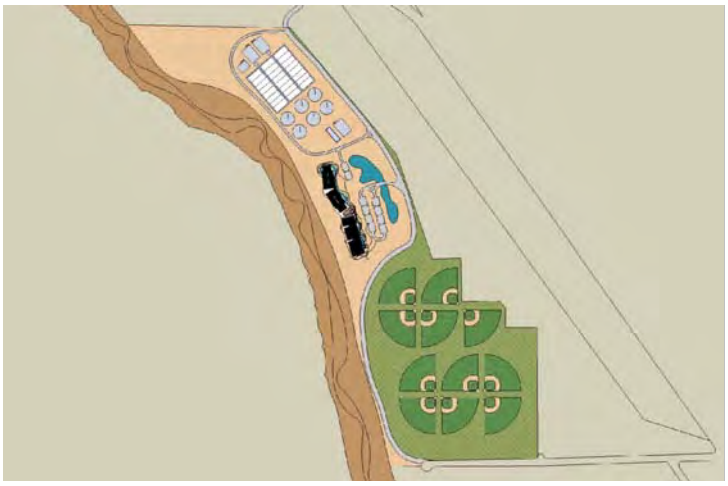
New Water Reclamation Campus



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APPENDIX K

Alternative Project Delivery Methods

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1 - Alternative Project Delivery Methods

1.1 Introduction

Arizona law offers considerable flexibility to local government agencies in the procurement of public works. In addition to the design-bid-build (bid-build) method of contracting traditionally used by local government agencies across the United States, Arizona law enables local government agencies in Arizona to use the following alternative project delivery methods: design-build (including design-build-operate, design-build-finance-operate and design-build-finance-own-operate); construction-manager-at-risk; and job-order-contracting. A brief discussion concerning the design-build, design-build-operate and construction-manager-at-risk project delivery methods follows.[1]

The following discussion assumes a familiarity with the traditional, bid-build method of project delivery. The County has a great deal of experience with this traditional method. The bid-build method is addressed throughout the following discussion on a comparative basis with each of the alternative project delivery methods

1.2 Design-Build

1.2.1 Description

General. Under the design-build method of project delivery, a governmental agency contracts with a single entity to provide both design and construction services for a project. In selecting the design-build contractor, the governmental agency employs a competitive proposal process, which consists generally of the issuance of a request for qualifications followed by the issuance of a request for proposals. The design-build contractor is selected based on the overall value of the proposal, considering factors such as qualifications, performance guarantees, and the quality of the proposed design, as well as price, rather than price alone.

The typical design-build contract requires the design-build contractor to design and construct a project in accordance with a basic set of "design requirements" and to demonstrate that the project can achieve a defined set of "performance standards" through the successful completion of an "acceptance test". Design and construction services are generally completed in concurrent phases, enabling the design-build contractor to achieve efficiencies in the design and construction schedule. Following "acceptance" of the

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[1] Job order contracting method has limited applicability to the types of major capital improvements contemplated by this report. Additionally, discussion concerning design-build-finance-operate or design-build-finance-own-operate are not included. Private financing, with or without private ownership, involves a large number of additional complexities beyond the scope of this report. Nonetheless, Arizona law does appear to authorize these methods should the County wish to consider them in connection with the projects considered in this report. As the repayment of any private financing would involve a long-term operations and maintenance contract for the privately financed asset, many of the considerations set forth below concerning design-build-operate will apply to design-build-finance-operate and design-build-finance-own-operate.

project, primary responsibility for the project, including project operations (if applicable), transfers to the owner-governmental agency, subject to basic warranties of construction for a limited period (typically, one to two years).

Structuring the Design-Build Project. The first step in implementing a design-build project is for the governmental agency to develop a basic description of the project and to define the required performance standards for the project. Owner-governmental agencies typically contract with engineering and procurement consultants to assist in defining project requirements, drafting procurement documents, and drafting and negotiating the design-build contract. In the context of a County wastewater treatment facility, the procurement documents would include the performance standards that the completed facility would be required to meet and any design elements that the County wishes to mandate for inclusion in any proposed design.[2] The preliminary design included in the proposal selected through the procurement process forms the basis of the "design requirements" under the design-build contract.

Transfer of Design Liability. A critical function of the design-build contract is the transfer of design liability to the design-build contractor. As discussed above, the design-build contractor proposes the preliminary design for the project as part of the procurement process and, once the design-build contract is signed, develops the detailed plans and specifications for the project in a manner that is fully consistent with the contractual design requirements. In this way, the design-build contractor is fully responsible for the design of the project and therefore bears all risk associated with design errors or defects. The design-builder will be "on the hook" under the contract until the project passes the acceptance test, subject to relief only in the event of the occurrence of circumstances beyond the design-builder contractor's control.[3]

Single Point of Responsibility. A well-drafted design-build contract establishes the design-build contractor as the single point of responsibility for all aspects of design and construction, with the sole responsibility for disputes between design subcontractors and construction subcontractors. If the project fails to perform, the owner-governmental agency has a contract claim against the design-build contractor

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[2] For example, the County may wish to mandate that any proposed facility include membrane technology in the treatment process so that, in order to be responsive to the request for proposals, respondents would need to incorporate membrane technology in their proposed design. Problems can arise where a governmental agency is overly prescriptive in developing its project requirements. As discussed below, the transfer of design liability is premised upon the fact that the design-build contractor is responsible for developing the design from the preliminary design level to the detailed plans and specifications. The owner-governmental agency runs the risk of negating this transfer of design liability where detailed plans and specifications are included in the procurement documents.

[3] In order to provide for a clear allocation of risk between the parties to a design-build contract, it is generally recommend that the parties attempt to negotiate an "uncontrollable circumstance" definition in the contract. For example, in no event should any act, event or circumstance that would not have occurred had the affected party complied with its obligations under the contract constitute an uncontrollable circumstance. Conversely, a change in applicable law is generally beyond the control of a party and should therefore be defined as an uncontrollable circumstance. The occurrence of an uncontrollable circumstance (including traditional "force majeure") generally entitles the design-builder to price, schedule and performance relief.

without the need to establish the negligence of the design subcontractor or to become involved in disputes between the design subcontractor and the construction subcontractor.

1.2.2 Advantages

Risk Transfer. As discussed above, the design-build contracting method enables the owner-governmental agency to transfer risks associated with design liability and disputes between design subcontractors and construction subcontractors to the design-build contractor. This is in contrast to the traditional, bid-build method of contracting where the owner-governmental agency must enter into separate contracts for design and construction. Under established United States Supreme Court precedent, when an owner-governmental agency furnishes plans and specifications to a construction contractor, as under the traditional, bid-build method of contracting, there is an implied warranty that the furnished design is capable of construction.[4] Accordingly, the extent of the obligation of a construction contractor under a bid-build contract is the construction of the project in accordance with the furnished plans and specifications. The construction contractor bears no liability for the furnished design. Moreover, the design engineering contract in a bid-build project is generally not a performance-based contract, which means that an owner-governmental agency must establish the negligence of the design engineer in order to prevail in a claim if there are design issues encountered in a project. This negligence standard creates a bar to relief for an owner-governmental agency in the event design issues cause a project to not operate properly or otherwise fail that is significantly higher than the claim available under a design-build contract. Additionally, it is often unclear as to whether issues that cause a project to fail originate from a project's design or from its construction, which can leave an owner-governmental agency under a bid-build contract forced to pursue claims against both the design contractor and the construction contractor, with each pointing the finger at the other. Under a design-build project, one party (the design-build contractor) is responsible for making the project work. If the project does not work, absent carefully defined uncontrollable circumstances, the design-build contractor is responsible, regardless of whether the reason for the failure is due to design or construction issues. That single contractor, rather than the owner-governmental agency, has to sort out issues among its various subcontractors.

Prequalification. The procurement process authorized under Arizona law for a design-build project enables the owner-governmental agency to pre-qualify potential design-build firms through the issuance of a request for qualifications preceding the issuance of the request for proposals. Through this process, the owner-governmental agency is able to narrow the field of respondents to the request for proposals to those firms possessing the best financial and technical qualifications for the project. While this pre-qualification process is generally available for the other alternative project delivery methods discussed in this chapter, it is not available for the selection of a construction contractor under the traditional bid-build method of contracting. Prequalification is particularly important in projects such as wastewater facility projects, which involve sophisticated technology and can take a number of years to implement. The prequalification process can provide assurance to the County that its contracting partner has the technical expertise to address challenges as they arise and the financial wherewithal to sustain a long-term project effort.

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[4] See generally United States v. Spearin, 248 U.S. 132 (1918).

Competition on Factors Other than Price. The request for proposals process enables competition on factors other than price, which can result in innovative proposals and enable an owner-governmental agency to tap into private sector ingenuity to solve the particular design challenges of a given project. This is particularly useful in the context of a project involving a public utility asset such as a wastewater treatment facility, as contrasted to the construction of an office building, which does not have to "work". Through the request for proposals process, an owner-governmental agency can stipulate a basic set of performance requirements for the completed facility and require the design-build firms to compete on proposed design solutions in their proposals. As price is also a factor in the selection process, the design-build method generates competition over the optimal way to achieve the performance requirements in the most cost-effective manner.

Collaboration on Design and Construction. The design-build contracting method enables collaboration between the design subcontractor and the construction subcontractor in the development of the proposal. The exchange of ideas between these two parties can avoid problems down the road when the construction subcontractor actually begins to implement the design with shovels in the ground. In contrast, under the bid-build method and, to a lesser extent, the construction-manager-at-risk method, the construction contractors have no involvement in the development of the design or in constructability issues, and therefore run a greater risk of encountering problems in the implementation of the owner-governmental agency's design.

Early Stage, Lower Cost Price Certainty. Both bid-build and design-build contracting offer fixed pricing: bid-build for the construction work, and design-build for both design and construction services. The key difference is that under the design-build method, the lump sum price for the project can be ascertained by the owner-governmental agency much earlier in the procurement process, and for a much lower "transactional" cost. Design-build contractors will propose a fixed price in response to a request for proposals based on a 20-30% complete design; bid-build contractors, by virtue of the nature of the procurement method, must await a 100% complete design from the owner in the request for bids. Further, design-build transaction costs (primarily the owner-governmental agency's procurement and engineering advisors) typically run between 1-3% of the project's construction cost, while bid-build transaction costs can run from 8-12% of construction cost (mostly engineering fees for the 100% complete design). Using these benchmarks for a hypothetical $200 million treatment plant, an owner-governmental agency can know the actual cost of the project under design-build within approximately nine to 12 months (the time for project planning, design to 20-30%, and proposal), with procurement transaction costs of $3-5 million. However, contract negotiations may protract the time. Under the bid-build method, actual project costs will not be known for 18-24 months (the time for project planning, design to 100%, procurement and bidding), with transaction costs of $16-24 million (project design, engineering and procurement costs). Estimated project costs are prepared at the preliminary stage under either method, but under design-build, the owner-governmental agency is in a much better position than it is under bid-build in the event actual pricing is unexpectedly higher than the early planning estimates.

Schedule Compression. Design-build contracting is particularly useful in the context of a project where schedule is a key concern. As contrasted with the bid-build method of contracting where the design must be fully developed under a separate contract prior to the procurement of the construction contract, the design-build method contemplates concurrent design and construction of the project, which enables the design-build contractor to achieve efficiencies in the design and construction schedule. Indeed, more

rapid project delivery is often cited as the key reason for selecting the design-build project delivery method.

Minimization of Change Orders. Design changes under a design-build contract are generally the responsibility of the design-build contractor. In the event that the design-build contractor determines that a change to the design is required in order to meet the performance requirements of the design-build contract, the design-build contractor must make such changes at its own expense and without schedule or performance relief. Change orders under a design-build contract generally issue only in the event of the occurrence of uncontrollable circumstances or in the event that the owner-governmental agency's project requirements change. Conversely, change orders are common under the bid-build and construction-manager-at-risk methods of contracting where the owner-governmental agency retains liability for the furnished design and where, as a practical matter, modifications to the complete design are required due to inadvertent errors or newly determined objectives.

1.2.3 Disadvantages

Lack of Full Design Control. One of the concerns raised by representatives of the County in our discussions concerning alternative project delivery and, particularly, design-build, was the fact that the County would have limited control over the development of the final design for a project. County representatives noted the importance of operator input in the design of a wastewater treatment facility and expressed concern over the limited opportunity for such input under the design-build method. As discussed above, in a typical design-build transaction, the owner-governmental agency develops only a basic description of the project and its requirements, focusing primarily on the performance standards that the completed project will be required to meet and on construction quality standards. While an owner-governmental agency may include prescribed design elements in a request for proposals, an overly prescriptive request for proposals runs the risk of negating the transfer of design liability.[5] Accordingly, the nature of design-build does require an owner-governmental agency to relinquish some control over design development. This makes the development of the performance requirements and construction quality standards for the completed facility in the request for proposals all the more important, as such performance requirements can serve to dictate the nature of the design of the facility.

Lack of Familiarity. While we understand that the County has some experience with the design-build method of project delivery in projects such as the Skyline Drive Design-Build Improvement Project, the County has never implemented a design-build wastewater project, where the operations of the facility can be critical. The role of the County utilities department in implementing a design-build wastewater project would be different from the role associated with a traditional bid-build project. During the design and construction phase following contract signing, the County's role would be limited to monitoring the design-build contractor's progress to determine whether the work is progressing in accordance with the design requirements set forth in the contract. The County would review and comment on design

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[5] See generally note 2, above. There is no bright-line rule to determine how much is too much in terms of including prescribed design elements in a request for proposals. For any given project, an owner-governmental agency must evaluate the importance of its preferences, considering the tension between stipulating design elements and transferring design liability.

submittals and other deliverables, but would not have an "approval" role with respect to such deliverables. Rather, the focal point of a design-build project is project acceptance, which occurs only after demonstration through the performance of an acceptance test that the project has been constructed in accordance with the design requirements and that it meets the performance standards. Prior to project acceptance, the design-build contractor has primary control over the means and methods toward achieving project acceptance, provided that such means and methods comply with applicable law and the specific terms and conditions of the design-build contract. Over-involvement by an owner-governmental agency in the design and construction phase can lead to disputes over responsibility in the event that things go wrong and may serve to negate the transfer of design liability.[6] Accordingly, in order to implement a design-build wastewater project, the County would likely need to reexamine its general contracting policies and procedures to adapt to the different roles associated with design development and implementation in the context of a design-build project.

Lack of Long-Term Vested Interest. A potential disadvantage of implementing a project such as a wastewater treatment facility on a design-build basis is the lack of a long-term stake on the part of the design-build contractor with respect to the operations of the facility. Respondents to a request for proposals are motivated by the competitive process to propose the lowest cost facility that will achieve the performance standards. However, the design-build contractor's responsibility with respect to project performance effectively ends at the completion of the acceptance test and the turnover of operation responsibility to the owner-governmental agency.[7] Accordingly, while the County can be confident that the design-build process will result in a facility that will pass the acceptance test, risks associated with post-acceptance operations, including project operability and operations, maintenance, repair and replacement costs, will remain with the County. While this risk can be mitigated by carefully developed selection criteria, prescribed design elements and performance standards, there are risks associated with these mitigation measures. For example, while the County can include items such as project operability and life cycle costs as evaluation factors in the selection criteria, there is no way to contractually guarantee such items, as the design-build contractor has no control over project operations following acceptance and will therefore not ordinarily assume risks associated with such operations. Additionally, prescribed design elements carry the risks associated with the effective transfer of design liability discussed above. While the County can attempt to develop performance standards that will form the basis of an acceptance test that will measure long-term operability and cost efficiency, the acceptance test will be time limited and, by its nature, will only go so far as a long-term indicator. It is important to note that the absence of a long-term vested interest in the project on the part of the contractor is also a fundamental characteristic of the traditional bid-build method.

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[6] For example, an interim "approval" by the County of a design submittal may provide the design-build contractor with a defense in the event of an ultimate failure of the project to pass the acceptance test. Generally, approvals of interim design submittals are inconsistent with the notion that the design-build contractor bears full responsibility and liability for the design.

[7] While a typical design-build contract includes a one to two year warranty of construction following project acceptance, its extent is generally limited to a warranty that the design-build work complies with the design-build contract and is free of defects. Design-build contractors will not ordinarily warrant or guarantee the performance of an operating facility beyond performance during an acceptance test, as they have no control over the operations of the facility.

These risks associated with project operations are mitigated through the bid-build method of project delivery through the development of a project design tailored to the County's particular operating concerns. However, in the bid-build context, the County will ultimately bear the operating risk, as well as the design and construction risks discussed above. In determining which method will best serve the County's needs, the County will need to weigh the risks associated with project operations in the design-build context, along with the mitigation measures discussed above, against the advantages and benefits of design-build. One way to solve for the operations risks associated with design-build, while retaining its advantages and benefits, is through the design-build-operate method discussed below.

1.3 Design-Build-Operate

1.3.1 Description

Generally. The design-build-operate project delivery method combines long-term operation and maintenance services with project design and construction services into a single service contract. The primary purpose for combining design, construction and operation into a single contract is to integrate all three areas of expertise and responsibility during every phase of the project. The aggregation of these services allows for an "operator-driven" design and permits a full level of cooperation between the designer, builder and operator. By knowing their partners, and working together on all aspects of the project, an optimal design can be created and optimal pricing established by the reduction of the pricing contingencies typically included by these participants when they work individually, without the opportunity to collaborate, in the typical bid-build process. The design-build-operate contractor serves as the single point of responsibility for all aspects of design, construction and operation for the term of the service contract (typically 15 to 20 years following project acceptance).

The Design-Build-Operate Service Contract. A typical service contract incorporates the design-build contract provisions generally discussed above and further requires the design-build-operate contractor to operate and maintain the facility for the term in accordance with carefully defined performance guarantees. The service contract will provide for the payment of an annual fixed service fee for the performance of the operations and maintenance services, subject to an indexed inflation adjustment factor.[8] Accordingly, in addition to assuming the risks associated with design and construction, the design-build-operate contractor assumes risks associated with project operations, including the risks of project performance and the costs of operations and maintenance. As under the design-build method, the typical service contract provides for price, schedule and performance relief only in the event of carefully defined uncontrollable circumstances.[9]

The Selection Process. Under Arizona law, an owner-governmental agency employs the same competitive proposal procedures in selecting a design-build-operate contractor as are employed in

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[8] The indexed adjustment factor is ordinarily based on the Consumer Price Index and applied on an annual basis.

[9] For example, the service provider may be relieved of its obligations under the facility effluent guarantee in the event that flows and loadings received at the facility exceed contractually stipulated levels of flows and loadings. See also note 3, above.

selecting a design-build contractor. As such, many of the same considerations discussed above with respect to the design-build method of contract delivery apply to the structuring of a design-build-operate project and the evaluation of its advantages and disadvantages. Accordingly, the following discussion will focus primarily on the operations considerations associated with design-build-operate projects, while pointing out the differences in design and construction considerations between the design-build and design-build-operate methods.

Structuring the Design-Build-Operate Project - The Project Description and Performance Guarantees. An owner-governmental agency will consider similar factors in developing the project description as considered under the design-build method. However, as the contracting entity will assume long-term operations and maintenance responsibility for the project, prescribed design elements are generally less of a concern, enabling the owner-governmental agency to rely on the performance requirements to generate competition over the optimal, most cost-effective design. Additionally, the design-build-operate method enables owner-governmental agencies to "look down the road" toward anticipated changes in law in developing the operating performance guarantees. "Enhanced standards" can be included in a design-build-operate contract in order to capture standards expected to be required under applicable law in the future.[10]

Structuring the Design-Build-Operate Project - Workforce Protection Practices. Any consideration of the design-build-operate method of project delivery for a County wastewater treatment facility must factor in the County's existing wastewater operations and maintenance workforce. Customarily, when an owner-governmental agency implements a design-build-operate wastewater project with an existing operations and maintenance staff, the design-build-operate contractor is required to offer unconditional employment to the existing operations and maintenance staff on terms that equal or exceed the employment terms offered by the owner-governmental agency. Example design-build-operate projects that have included such a stipulation include projects implemented by the City of Springfield, Massachusetts in 2000, the City of Newport, Rhode Island in 2000 and the City of Holyoke, Massachusetts in 2005. These service contracts require wages and benefits that are equal to or better than existing wages and benefits, recognition and crediting of years of service, the transfer of accrued liabilities (e.g., annual leave, sick leave and incentive payments), recognition of unions and labor agreements, and the obligation to bargain in good faith with any recognized collective bargaining agent.[11]

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[10] Generally, the basic operating performance standards under a design-build-operate contract require the contractor to comply with applicable law. For example, a wastewater facility effluent guarantee will require the facility effluent to meet all standards of applicable law. Enhanced standards can be used to address particular concerns of the owner-governmental agency not covered by applicable law, or, as suggested, to address requirements that are expected to be implemented in the foreseeable future. Enhanced standards can be included in the performance guarantees with associated liquidated damages for nonperformance or, alternatively, on an incentive basis where the contractor will be entitled to additional payment for achieving the enhanced standard.

[11] In the Holyoke, Massachusetts example, the City determined to specifically require respondents to the request for proposals to offer the existing employees a defined benefits package similar to the City's pension plan, rather than allowing respondents to demonstrate that a proposed benefits package including a 401k plan would equal or exceed the City's plan. While this approach was ultimately successful for the City of Holyoke, it can

These contracts also stipulate that the design-build-operate contractor may not terminate a "transferred employee" in the absence of just cause. The particular considerations associated with the County's existing wastewater operations and maintenance staff should be factored into the structuring of any design-build-operate project involving the wastewater facilities.

1.3.2 Advantages

Risk Transfer. In addition to the transfer of design liability and the risk of disputes between various subcontractors, the design-build-operate method enables the owner-governmental agency to transfer significant operating risks to the contracting entity. The basic obligation of the design-build-operate contractor with respect to operations is to operate and maintain the facility in accordance with applicable law, including all permit requirements and stipulations.[12] In the event of a failure of the contractor to comply with applicable law in the operation of the facility, the contractor is ordinarily responsible for all fines and penalties assessed by the applicable governmental bodies and must indemnify the owner-governmental agency from any and all third-party claims. The contractor therefore bears the basic risks associated with the operation and maintenance of the facility, including the risk that the facility simply costs more to operate and maintain than anticipated by the contractor in developing its proposal and offering its fixed service fee. As noted above, in a typical design-build-operate contract, the design-build-operate contractor's fixed service fee will be subject to adjustment only in accordance with the indexed inflation adjustment factor or in the event of the occurrence of carefully defined uncontrollable circumstances. If, for example, the design-build-operate contractor requires more chemicals in the operation of the facility than originally budgeted or must implement a more aggressive maintenance schedule than originally planned, the associated operating costs are for the account of the contractor and not the owner-governmental agency.

Operator Collaboration in the Preparation of the Design - Vested Interest in Long- Term Operations. As suggested above, the design-build-operate method enables the development of an "operator-driven" design, which will likely involve significant attention to project operability. The risks assumed by the design-build-operate contractor in the operations phase help to ensure that the project will be designed and constructed in a manner that will produce a highly operable, cost-effective facility. When the owner-governmental agency steps in upon expiration or earlier termination of the service contract, it can do so with a high level of confidence in the operability and cost-effectiveness of the facility.

Strong Companies. The companies that compete in the design-build-operate industry are strong companies that specialize in providing the services required for a design-build-operate project. More often than not, these companies have investment grade credit ratings, which enable them to provide the financial security required in connection with major capital improvement projects. Owner-governmental

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have the effect of limiting competition, as most companies are unwilling or unable to offer a pension plan similar to a municipal pension plan.

[12] As suggested above, this basic obligation may be enhanced by the inclusion of enhanced standards in the design-build-operate contract. See note 10, above.

agencies can be confident that sufficient resources will be brought to bear on the successful completion of a design-build-operate project, given the nature of the companies in the industry and the prequalification procedures authorized under Arizona law.

Design-Build Advantages Apply. In addition to the foregoing, each of the advantages discussed above in connection with the design-build method of contracting apply equally under the design-build-operate method.

1.3.3 Disadvantages

Control by Contract. The design-build-operate method of project delivery requires owner-governmental agencies to relinquish direct operating control over a critical public asset to the design-build-operate contractor. While the governmental agency remains the owner of the asset and retains the power to set the associated rates, control over the day-to-day operations transfers to the contractor. In the event service issues arise affecting ratepayers or the general public, the owner-governmental agency must work within the parameters of its rights in the design-build-operate contract to address such issues. For this reason, it is critical that the design-build-operate contract clearly define the service responsibilities of the contractor and provide real enforcement mechanisms for the owner-governmental agency. Additionally, the owner-governmental agency must understand that it will have a continuing contract administration and monitoring role for the life of the contract. It should be noted that many governmental agencies, based on their experience, believe that private contract management of utility assets that have been procured on a design-build-operate basis actually gives municipalities greater control over operations than direct management of public employees actually provides, with its attendant issues of labor relations, limited appropriations for capital maintenance, and the absence of contractually specified standards of performance.

Limited Market. While, as noted above, the companies that compete in the design-build-operate industry are strong companies, they are limited in number and meaningful competition can be a concern. In the current market, public design-build-operate projects often attract interest from only two, three or four companies. However, these market conditions are shifting in nature and only five years ago, an owner-governmental agency conducting a design-build-operate procurement could expect to receive five or more responses to the request for qualifications.

1.4 Construction-Manager-at-Risk

1.4.1 Description

Generally. The construction-manager-at-risk (CMAR) procurement method preserves the traditional bid-build bifurcation of design contracts from construction contracts. The key difference between bid-build and CMAR is that the owner-governmental agency is permitted to select the construction manager on a qualifications basis, and also to negotiate an “at risk” guaranteed maximum price (GMP) for the construction of the project.

Services and Selection. Arizona law permits a construction management contract to be entered into simultaneously with or later than the design contract. The design work and the construction services may

be performed in sequential phases (as with bid-build), or in concurrent phases (as with design-build). The construction manager is permitted to provide advice (including supplemental design services) during the design phase. The construction management contract may also include related finance maintenance and operations services, although such services are not typically part of a CMAR arrangement in practice.

CMAR procurements begin with a qualifications-based selection of an engineering firm to provide a 100% complete design of the project. Concurrently with, or more often subsequent to, the procurement of the design engineering services, the owner-governmental agency conducts a separate qualifications-based procurement for the construction manager. The firms seeking construction manager work normally are those with specialized construction management expertise or general contractors willing to serve in a construction management role. The pricing of construction management services is not a selection factor, but is negotiated with the firms determined to be the highest qualified based on the selection criteria included in the request for qualifications. The procurement in essence is conducted on a professional services basis.

Construction Manager Responsibilities. The design engineer is responsible for the full design of the project, which is typically divided into several, separately biddable, "packages". Once the design packages are complete, the construction manager is generally responsible for supervising the letting of the various construction contracts on a low-bid basis on behalf of the owner, and coordinating the performance of the work of all of the contractors to whom the project contracts are awarded. The construction contracts normally, but not always, are entered into between the owner-governmental agency and the various contractors, rather than between the construction manager and such contractors. CMAR permits the owner-governmental agency, nonetheless, to negotiate a GMP for entirety of the construction work, based on the construction manager's estimate as to where all of the bids will come in. The negotiations center typically around how far the project design needs to be advanced before the construction manager can be asked to propose a GMP, the reasonableness of the GMP and its contingencies, and the extent to which, if the actual total price is less than the GMP, the savings will be shared between the owner and the construction manager. If the actual price exceeds the GMP, the construction manager ordinarily bears the loss. The effect of design changes made after the GMP is agreed upon, and of change orders once the construction contracts are let, complicate GMP-related determinations.

1.4.2 Advantages

Professional Selection of Construction Interface. A primary advantage of CMAR is the ability of an owner-governmental agency to select the firm managing the construction on a qualifications basis. The construction manager usually oversees the construction work, rather than self-performing and subcontracting the work in the manner of a general contractor. Thus, in CMAR the construction manager is the key interface between the owner and the actual performance of the construction work, rather than the general contractor, as is the case with bid-build. Through the CMAR qualifications-based selection of the construction manager, the owner can take into account factors such as experience, skill, record of performance, professionalism and similar elements of judgment. Such factors cannot be used in the selection of a general contractor under bid-build, except insofar as they pertain to whether the bidder is "responsible."

Guaranteed Maximum Price. The total cost of the construction work under CMAR will be the sum of the construction manager's fee, plus the prices bid by the various contractors under all of the construction contracts let by the owner based on the design engineer's bid packages. As discussed above, CMAR permits the negotiation of a GMP at some point during the design process, usually toward the end. The GMP can give the owner a reliable assurance as to total project price when the design is largely but not fully complete and before it is actually bid, which may help with the owner-governmental agency's project planning and budgeting process.

Design Phase Assistance. CMAR permits the construction manager to assist the owner in the development of the project based on the firm's construction experience and any design expertise it may have. The construction manager can, accordingly, contribute to the project in a value-engineering sense, as well as from a constructability standpoint. This participation does not operate to transfer any design liability from the design engineer to the construction manager. It does, however, give the construction manager a reasonable basis for proposing a guaranteed maximum price for the work. Thus, the construction manager is not at "at risk" for the design or for whether the project will operate as intended, but may be "at risk" for price.

Delivery Schedule. CMAR may permit a slightly faster delivery schedule than bid-build. If separate bid packages can be prepared and construction of some portions of the project commenced earlier than other portions, CMAR contracting has the potential to expedite the project, at least in comparison to bid-build. It should be noted that the design-build method generally offers an even greater schedule advantage.

Complete Control of Design. The owner-governmental agency completely controls project design under CMAR, as it does under bid-build, and is able to bring to bear on the project's design any experiences it may have with the development and operation of similar facilities. CMAR has the additional advantage of potential design and constructability input from the construction manager. Like bid-build, the owner has complete discretion to modify the design throughout the entire design process, and even during construction, through the issuance of change orders (with the attendant cost and risks that design changes entail).

1.4.3 Disadvantages

Multiple Points of Responsibility. CMAR does not fundamentally change the basic structure of responsibility involved in bid-build contracting. The owner-governmental agency retains design liability, as it does traditionally in bid-build. The design engineer is responsible only for professional negligence, not for project performance, cost or schedule. The various contractors are responsible for constructing their portion of the work in accordance with the engineer's design, but not for the operational efficacy of their portion of the work or the overall project. With multiple points of responsibility, CMAR raises the potential for disputes among the owner and the design engineer, the construction manager and the various contractors, and the attendant risk of added cost, delay and performance deficiencies.

Retention of Design Liability. Under CMAR, as with bid-build, the owner retains design liability. Inadequate design may result in poor project performance, higher than expected operating or maintenance costs, additional construction costs due to the need for corrective work, and similar adverse conditions. The owner can rely to a certain extent on the design engineer's professional competence, and errors and

omissions professional liability coverage, but none of these design liability risks is transferred to the construction manager or any firm involved in performing the construction work.

No Design Competition. As with bid-build, there is no competition among engineering or construction firms interested in securing project contracts. The owner-governmental agency thus foregoes any benefits that such a design competition may afford, including design, construction and technology innovations; cost savings from different or improved designs; and improved performance.

Limited Life Cycle Cost Considerations. CMAR, again like bid-build, focuses predominately on design and construction costs. Long term operating and maintenance costs are estimated by the owner, designer and construction manager based on reasonable assumptions, but they are not proposed and guaranteed by a private operating contractor. Potential operating and maintenance practices and innovations that might affect capital construction or otherwise lower total project life cycle costs over a 20 or 30 years period tend to receive less consideration under CMAR (as well as under bid-build and design-build) than they do under various forms of design-build-operate contracting.

Degree of Design Conservatism. The CMAR and bid-build procurement methods often lead to a very high degree of design conservatism, which in turn can produce construction and operating costs significantly in excess of those that would be entailed under the more moderately conservative designs characteristic of the design-build and design-build-operate methods. Highly conservative designs tend to result from processes like CMAR and bid-build in which there are limited incentives built into the development process (other than general rate resistance) to produce a less costly design, and strong incentives built in so that design engineers can be assured of properly discharging their professional responsibilities and owners can be assured that the project has enough redundancy and ease of operability for a general public-sector workforce. Excess design conservatism can thus be regarded as a disadvantage (from a cost perspective) or as an advantage (from the perspective of the likelihood having treatment capacity that is more than sufficient).

1.5 Procurement Method Selection Considerations

Selecting among the procurement methods legally available to the County under Arizona law requires a weighing of numerous relevant criteria. Different procurement methods may be determined to be appropriate for each of the three major projects that are expected to be implemented under the County's regional optimization master plan for the wastewater system. Set forth below is a list of selection criteria involving procurement process, design and construction, and operation and maintenance considerations. As noted earlier, this analysis assumes the availability of conventional public financing for the capital improvement program. If the County wishes to consider private financing, it is likely that some form of design-build-operate procurement would be necessary to support the private financing plan.

1.5.1 Procurement Process Considerations

- County familiarity and experience with the project delivery method
- Transactional and engineering costs for conducting the procurement process
- Stage at which actual project costs are known
- Schedule: time to commencement of construction
- Depth and quality of contractor market

- Selection process complexity
- Likelihood of re-design and re-bid

1.5.2 Design and Construction Considerations

- Possibility of selections based on performance and qualifications
- Risk of disputes between owner-governmental agency, designer and builder
- Schedule: time to completion of construction
- Degree of owner-governmental agency design control
- Potential for innovation through design and construction competition
- Transfer of design, construction and acceptance liability
- Degree of design conservatism desired
- Suitability for "greenfield" projects
- Suitability for modifying and expanding existing facilities treatment
- Suitability for pipeline and transmission facilities
- Guaranteed permit compliance
- Total contract price for design and construction
- Construction monitoring costs
- Likelihood of bid/proposal protests
- Likelihood of change orders

1.5.3 Operation and Maintenance Considerations

- Control by owner-governmental agency over project operations
- Direct versus contract
- Guaranteed operational performance
- Guaranteed regulatory compliance
- Overall 20-year life cycle costs of the project
- Guaranteed operating and maintenance costs
- Operational integration of project with entire wastewater system

GREELEY AND HANSEN

4400 East Broadway, Suite 600P
Tucson, AZ 85711
602-275-5595
www.greeley-hansen.com