City/County
Water and Wastewater Study

Date: September 1, 2009

To: City/County Water and Wastewater Study Oversight Committee

From: Mike Letcher
City Manager

Chuck Huckelberry
County Administrator

Re: **Water for the Environment Technical Paper**

Background

As part of Phase II of the City/County Water and Wastewater Study, the City and County were asked to explore water needs for environmental projects. The Oversight Committee asked the following questions:

- How and where can we best use stormwater, effluent and reclaimed water for environmental benefits and quality of life?
- What are the existing and future water demands for the environment and how should the community prioritize these needs?
- Why are environmental projects that improve ecosystem functions important? How and where can we best preserve and improve ecosystem functions?
- Where are future opportunities for environmental projects in proximity to existing and future water resources?
- What standards and goals should we set regarding reclaimed water use for the environment?

A previous paper, *Riparian Protection Technical Paper*, looked at opportunities for protecting environmentally sensitive natural riparian areas in Eastern Pima County including areas of shallow groundwater and perennial and intermittent streams that support unique riparian vegetation.

This paper addresses these questions by providing an overview of:

- Vegetation and habitat water needs
- Inventory of City and County programs and projects that benefit the environment
- Regional assessment of water potentially availability for environmental projects
- Opportunities for use of potentially available water sources
- Recommendations on best use, standards and goals for use of water resources for environmental project needs and prioritization of those needs.

Why Should We Allocate Water for Environmental Needs?

Riparian ecosystems provide many benefits to the natural environment and society. River systems with wide, well-vegetated floodplains reduce the damaging energy of floods at a much lower cost than structural improvements. The valley floor provides a place for sediment storage. Much of our drinking water supply is pumped from groundwater aquifers that are recharged by streambed infiltration. Riparian areas provide essential habitat for a majority of Arizona's wildlife species, and are crucial for the survival of both resident and migratory bird populations. Riparian vegetation sequesters carbon from the atmosphere and reduces the urban heat island effect. As best stated by Robert Glennon, noted water law expert:

> *These rare riparian habitats are precious jewels in our desert environment and wise stewardship demands action to protect them.*[1]

Riparian preservation, enhancement and restoration projects are implemented for a range of reasons including regulatory compliance, ability to capitalize on grants or other dedicated funding sources, and opportunities to integrate into planned capital projects such as parks, water recharge, wastewater treatment, and stormwater management facilities.

Economics

The economic value of dedicating water to support urban riparian conservation and enhancement projects has been the subject of numerous studies. The growing industry of wildlife watching brings approximate $1.5 billion in total economic effect annually to Arizona's economy, and contributes substantial amounts to the local Pima County economy (2001 figures). Most of the species that attract birding dollars depend on riparian ecosystems for survival. Other studies have shown that homeowners value property with riparian habitat and are willing to pay for it. Studies supported by Tucson Water, found that "households located nearby richly vegetated areas, specifically natural preserves, riparian corridors and golf courses use significantly less outdoor water."[2]

Federal Permitting – Endangered Species Act and Clean Water Act

As Pima County undergoes rapid population expansion, private development and public infrastructure have increased the urban footprint encroaching into natural areas including those providing habitat for threatened or endangered species and watercourses that are defined as Waters of the United States. To comply with the Endangered Species Act (ESA) both the City and County are developing HCPs to address potential impacts of urbanization in their respective jurisdictional areas and to secure Section 10 permits from the U.S. Fish and Wildlife Service (USFWS). The

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[1] Robert Glennon, Tucson's water future depends on stewardship, cooperation, Arizona Daily Star, August 30, 2009.

[2] Halper, E.B and R.H. Bark-Hodgins, no date. "Positive Externalities: Public Green Space and Outdoor Residential Water Use."

MSCP and HCP include conservation measures that require certain actions be taken to preserve, mitigate, or enhance habitat for specific vulnerable species. Similarly, Section 404 of the Federal Clean Water Act requires compensatory mitigation for construction or maintenance activities within jurisdictional Waters of the United States. Public infrastructure projects supporting transportation systems, municipal sewer facilities, water and other utility distribution systems, all may trigger the need for riparian habitat mitigation.

Quality of Life

A major driver of restoration is the ability to restore or enhance habitat that occurs incidental to a jurisdiction's capital improvement projects. Many public projects involve a dedicated water source. Such water sources have often been used to meet both the primary goals of the project and to create or enhance riparian habitat. Parks and linear pathways along the major watercourses provide opportunities to incorporate restoration into park designs. Properly designed stormwater management facilities can retain sufficient water to support xeroriparian and sometimes mesoriparian habitat. Water recharge facilities and wastewater treatment facilities provide the greatest opportunity for restoration, with water available in quantities sufficient to even support limited hydroriparian habitat.

Existing and Proposed Environmental Projects

Both the City and County plan and construct single and multi-purpose ecosystem restoration projects in urban and rural areas, see Figure 1. These projects focus on planning regionally appropriate habitat and wildlife corridors to benefit an array of native species. Projects include multiple riparian and upland zones. The projects have been developed in response to a variety of drivers.

Projects in urban areas require consideration of public access and safety, including trail issues, vector issues and increased maintenance needs. Pima County's multi-purpose Kino Environmental Restoration Project (KERP) is located in an urban setting. KERP provides the full gamut from wetland riparian habitat to upland habitat for the benefit of aquatic and terrestrial species ranging from waterfowl to burrowing owls. Rural projects have less intensive management and public needs than urban projects. The rural North Simpson Farm site consists of retired agricultural land owned by the City of Tucson located in northern Avra Valley. The project is managed through a City partnership with Tucson Audubon Society. For vegetation establishment, water has been diverted from the effluent-dominated Santa Cruz River, pumped from on-site wells, and utilized stormwater-harvesting techniques.

While it may not be possible to return all riparian habitats to pre-20th century conditions, due to irreversible patterns of development, water level decline, and cost; it is, therefore, necessary to identify the locations, habitat types, and aerial extent of restoration that is both possible and feasible in the short term. Such an assessment

should include both determination of need and an emphasis on taking advantage of opportunity.

Effluent Dominated Lower Santa Cruz River

The Lower Santa Cruz River is classified as an effluent dominated stream. By 1970, effluent disposed in the river bed from wastewater treatment facilities at Roger and Ina Roads created perennial or intermittent stream conditions and associated aquatic and riparian habitat from Roger Road to the Pima/Pinal County line. The significance of the effluent-dominated Santa Cruz River to wildlife has been acknowledged in various efforts to achieve Endangered Species Act compliance. The value of the Santa Cruz River habitat for wildlife and particularly for Endangered Species compliance presents a challenge for the region because no allocation of effluent has been made to maintain in-stream flow.

As effluent water becomes more valuable and finds more uses, effluent owners may directly use more of the effluent and less will be discharged into the river, although in-stream aquifer managed recharge may continue. Many different future discharge scenarios are plausible, ranging from the elimination of all discharges to increasing discharges over time. Further complicating the matter is the fact that Pima County is planning to reduce discharge at Roger Road in favor of sending more effluent to be treated at the Ina Road facility downstream. This may reduce in-stream flows and habitat downstream of Roger Road, independent of any reduction in discharge to the stream. More reductions could occur via off-river uses of the Secretary of Interior's share of effluent. While, the volume of effluent needed to maintain in-stream flows is large, about 40,000 acre-feet/year, far less water, 2,000 acre-feet/year is necessary to sustain the acreage of riparian habitat that has incidentally developed as a consequence of the existing flow regime.

Water Availability

The most critical issue in accomplishing environmental restoration in the desert is water availability. In order to balance the water needs for individual restoration projects with the ability to commit appropriate water supplies, it is important to match each restoration project with the least expensive water supply of suitable quality that is physically available for use at the restoration site. Cost, competing demands, variations in quality, and complexity of capture or delivery variously affect the primary water resources in the City/County area: groundwater, CEP water, reclaimed water, secondary effluent, stormwater and harvested rainwater.

Water needs for ecosystem restoration projects range from short-term to long-term supplemental water supplies. A long-term water supply meets the needs of habitats that depend on larger volumes of water than can be provided through natural rainfall and/or ephemeral stream flow. Restoration or enhancement of degraded high-water-use meso- and hydro-riparian areas that no longer have on-going natural water regimes

(shallow groundwater, intermittent surface water flow or perennial surface water flow) may need a long-term supplemental water supply. Natural water sources could be supplemented over the long term using water harvesting to concentrate rainfall, or by irrigation with groundwater, reclaimed water, effluent, or graywater.

Due to the desert climate and on-going drought, almost all projects utilize some irrigation water. Many will ultimately rely on harvested rainwater and/or shallow groundwater for long-term sustainability, with little or no supplemental irrigation beyond an establishment period. Multiple water sources are used on different projects including groundwater, reclaimed water, treated effluent, regional stormwater, harvested rainwater and shallow groundwater. Almost all the projects include some degree of rainwater harvesting, with the current trend being towards maximizing use of this natural water source.

Another water source is the Conservation Effluent Pool (CEP). The 2000 Supplemental IGA, between Tucson and Pima County, essentially established the CEP as a bank account of 10,000 acre-feet of effluent annually that can be used for projects promoting habitat conservation plans or jointly approved riparian environmental restoration projects. While CEP water could be permanently dedicated to a project, during times of drought or high demand for reclaimed water the water supply may be discontinued or proportionately diminished. A permanent dedication of a volume of CEP water to a single project is a permanent withdrawal from the CEP bank account. By developing restoration projects that only need reclaimed water for a shorter establishment period (3 to 5 years), more projects can be completed over time, and the CEP could be used like an "investment pool" to support a myriad of restoration opportunities instead of a few.

Effluent generated by the outlying wastewater treatment facilities also provides opportunities to preserve and restore riparian habitat. While the outlying facilities do not currently have a reclaimed water distribution system, the County owns adjacent land to all the outlying facilities that would be available for restoration.

Recommendations

The recommendations in this paper fall into three areas: identifying environmental restoration priorities and opportunities, identifying water sources for restoration, and addressing the long-term status of the Santa Cruz River.

Environmental Restoration Priorities/Opportunities

- The City and County continue to preserve existing riparian areas to the maximum extent possible through land acquisition and regulatory land use controls, especially springs and Important Riparian Areas.
- City and County collaborate to help people understand the benefits of healthy ecosystems for themselves and nature, and collaborate to encourage increased support to strengthen protection and maintain existing resources.

- Develop standards that maximize opportunities for small-scale environmental restoration in conjunction with stormwater harvesting and retention/detention basins within new developments.
- Develop a regional policy that incorporates stormwater harvesting, non-potable water use, recreation, and ecological amenities to the extent feasible in Capital Improvement Projects budgets, especially in open space areas. For example:
  - Incorporate ecosystem restoration adjacent to wastewater treatment facilities.
  - Explore ways for recharge facilities to support restoration.
  - Retrofit existing large detention basins to support riparian habitat.
  - Include environmental restoration opportunities as component in all new stormwater management projects, so that optimal amounts of stormwater are retained for reuse before being discharged to the respective stormwater conveyance systems.
  - Incorporate, where possible, stormwater harvesting recreation and ecological amenities into public projects.
- Identify potential future CWA Section 404 in lieu mitigation and Endangered Species Act compliance needs and develop a shared regional policy for addressing those regulatory compliance projects that require a short-term (establishment) or long-term (permanent or seasonal) water supply.
- For existing hydroriparian areas, develop contingency plans for providing supplemental water during times of climate-related stress in a cost-effective manner.
- Continue to pursue opportunities to secure grant funding for environmental restoration, such as from the Arizona Water Protection Fund.
- Explore a regional collaboration with respect to how in lieu money received through developer compliance with local watercourse protection ordinances is used to fund restoration activities. Explore opportunities to expand this partnership to include non-governmental entities that receive 404 in lieu mitigation money and/or undertake restoration activities themselves.
- Continue efforts to evaluate the use of existing County- and City-owned lands for suitability for conservation and environmental restoration purposes.
- Work with partners such as Tucson Audubon Society and the University of Arizona to identify long-term water quality implications for restoration areas, such as the impacts of higher salinity of CAP, effluent, and reclaimed water.

<u>Water Supply</u>

- The City and County will continue to work to with ADEQ thedefine environmental restoration as a designated use along with its own set of water quality standards.
- Finalize the Conservation Effluent Pool and IGA amendments and develop specific criteria defining how the CEP will be managed and allocated to riparian restoration.

- Continue to coordinate with the Water Resources Research Center on the "Conserve to Enhance" concept and support the objective of earmarking saved water for environmental projects.
- Water and water rights obtained through the County's Open Space Bond Program should be dedicated to preservation or enhancement of existing riparian areas connected with those land acquisitions.

Santa Cruz River

- Lobby State Legislators to revised state statutes to make SAWARSA water eligible for 95-100% credit in managed recharge facilities to order to ensure sufficient effluent will remain in the Santa Cruz River downstream of the regional Wastewater Treatment Plants to protect the riparian corridor.
- Secure necessary permits, including 404 permits, to spread effluent across the river bottom including in former channels in order to increase recharge rates and habitat volume.
- Undertake pilot restoration projects to determine how to maintain riparian habitat along the Santa Cruz River in the event that effluent flows in the river decline or stop.
- Evaluate the feasibility of using recovery wells and effluent recharge credits to maintain habitat value in areas that are not proximate to renewable water supplies, such as the creation of expanded pockets of high quality habitat for migratory birds to supplant narrow, linear effluent flow channel.
- Identify a portfolio of multi-purpose projects using effluent that balances the water needs for direct use, environmental projects, and recharge.
- Develop partnerships and obtain grant funding for multi-purpose projects through the Arizona Water Protection Fund, Bureau of Reclamation, Audubon Society, Arizona Game and Fish Departments, and others.

It is respectfully recommended that the Committee consider this report and provide input to the City and County on its recommendations.

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City of Tucson and Pima County
Water For the Environment
Technical Paper

September 2009

This paper was prepared by a joint team of City of Tucson and Pima County staff and a representative from the Tucson Audubon Society, Kendall Kroesen. The City / County team included representatives from the following departments: City of Tucson – Tucson Water, Office of Conservation and Sustainable Development, and City Manager's Office; Pima County – Regional Wastewater Reclamation Department, Regional Flood Control District, the County Attorney's Office, and the County Administrator's Office. Additionally, Susanna Eden with the University of Arizona's Water Resources Research Center provided peer review of this document.

City of Tucson and Pima County
Water for the Environment
Technical Paper

Water and Wastewater Infrastructure
Supply and Planning Study, Phase II

September 2009

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Supply and Planning Study, Phase II

September 2009

I. Overview

The City of Tucson (City) and Pima County (County) were asked to explore water needs for environmental projects as part of the Joint City/County Water and Wastewater Study. The Oversight Committee asked the following questions:

- How and where can we best use stormwater, effluent and reclaimed water for environmental benefits and quality of life?
- What are the existing and future water demands for the environment and how should the community prioritize these needs?
- Why are environmental projects that improve ecosystem functions important? How and where can we best preserve and improve ecosystem functions?
- Where are future opportunities for environmental projects in proximity to existing and future water resources?
- What standards and goals should we set regarding reclaimed water use for the environment?

This paper addresses these questions by providing an overview of:

- Vegetation and habitat water needs;
- Inventory of City and County programs and projects that benefit the environment;
- Regional assessment of water potentially available for environmental projects;
- Opportunities for use of potentially available water sources; and
- Recommendations on best use, standards and goals for use of water resources for environmental project needs and prioritization of those needs.

Why Are Environmental Restoration, Enhancement, and Preservation Important?

Quality of Life

Why should we allocate water for environmental needs? Riparian ecosystems provide many benefits to the natural environment and society. River systems with wide, well-vegetated floodplains reduce the damaging energy of floods at a much lower cost than structural improvements. The valley floor provides a place for sediment storage. Much of our drinking water supply is pumped from groundwater aquifers that are recharged by streambed infiltration. Riparian areas provide essential habitat for a majority of Arizona's wildlife species, and are

crucial for the survival of both resident and migratory bird populations. Riparian vegetation sequesters carbon from the atmosphere and reduces the urban heat island effect. People are naturally attracted to riparian areas for passive recreation.

Bird and other wildlife watching involves global scale observations as well as people observing wildlife in their own backyards, local parks and nearby natural open space, especially riparian areas. However, natural open space is shrinking with expanding urbanization. Populations of many species of birds and other wildlife are declining including many that are not on the federal threatened and endangered species lists. In the case of birds, many government agencies and non-government organizations recognize these declines.

Healthy ecosystem function is important to maintaining the plant and animal populations that contribute to our quality of life and attract visitors who contribute billions of dollars in tourism income. Maintaining ecosystem function is part of our obligation to reconciling the needs of wildlife and people as we develop land. Habitat restoration and enhancement is often necessary to mitigate development impacts, though sensitive development practices that minimize habitat loss and reduce the need for such intervention.

Economics

The growing industry of wildlife watching brings an approximate $1.5 billion in total economic effect annually to Arizona's economy, and contributes substantial amounts to the County economy (2001 figures). The more natural open space that we can preserve and restore with native vegetation, which acts as habitat for wildlife, the more we can facilitate wildlife watching. Wildlife viewing and associated recreational activities such as hunting, fishing, and birding provide significant financial support for wildlife conservation in our nation's economy.[1]

Southeastern Arizona is a world renowned birding locality. Thousands of people visit the area annually, specifically to look for birds, and many residents also participate in the activity. Most of the species that attract birding dollars depend on riparian ecosystems for survival. Eco-tourism, particularly birding related tourism and recreation, pump millions of dollars into the local economy.[2] Studies by the U.S. Fish and Wildlife Service (USFWS) show that 1.3 million people participated in wildlife and birding activities, spending $838 million in Arizona in 2006. A study from the University of Arizona College of Agricultural and Life Sciences that focused on nature-oriented visitors to the Upper San Pedro River Basin (Sierra Vista area) documents that 19,000 people visited the area to view wildlife over one year, 2000-2001, spending $10 -$17 million at just two birding locales, the San Pedro Riparian National Conservation Area managed by the Bureau of Land Management and Ramsey Canyon managed by the Arizona Nature Conservancy.[3]

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[1] U.S. Fish & Wildlife Service; Birding in the United States: A Demographic and Economic Analysis, Addendum to the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Report 2001-1.

[2] U.S. Fish & Wildlife Service; 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation; Arizona, FHW/06-AZ, January 2008.

[3] Patricia Orr and Dr. Bonnie G. Colby; University of Arizona College of Agriculture and Life Sciences, Nature-Oriented Visitors and Their Expenditure: Upper San Pedro River Basin, February 2002.

The value of dedicating water to support urban riparian conservation and enhancement projects has been the subject of numerous studies. Results have shown that homeowners value property with riparian habitat and are willing to pay for it. The most highly valued areas are densely vegetated washes, washes with high plant species diversity, and watercourses that support shallow groundwater-dependent tree species. Homeowners are willing to pay up to 27% more for a home next to such areas.[4] In Arizona, urban homeowners are one of the primary "consumers" of riparian corridors.

Rosalind Bark-Hodgins and Bonnie G. Colby of the University of Arizona examined the economics of dedicating renewable water to support urban riparian conservation and restoration projects. Dr. Bark and her colleagues have examined human behavior as reflected in economic transactions, including the sale of homes and the purchase of water. They found that people pay for residential proximity to riparian habitat, whether or not they own the habitat or even have access to it.[5] In subsequent work supported by Tucson Water, they found that "households located nearby richly vegetated areas, specifically natural preserves, riparian corridors and golf courses use significantly less outdoor water."[6]

Loss of Riparian Habitat

Habitat loss is the major cause of decline of wildlife species. In our region, habitat loss results from removal of native vegetation, mainly through conversion to human housing, commercial development, mining and industrial development, and through the loss of surface water and riparian vegetation due to unsustainable groundwater pumping. Erosion and channelization of streams and washes has contributed to declines as well. Riparian areas are among the most endangered ecosystems, making preservation and restoration of riparian resources particularly important.

Riparian areas are among the most productive ecosystems in the world providing migratory, breeding and foraging habitat for various species. In the western U.S., less than 1% of the total land area is covered by the riparian vegetation found along rivers, streams and washes. Yet in Arizona and New Mexico, about 80% of all vertebrates depend on riparian areas for at least part of their life cycles, and more than half of these are totally dependent on them. More than half of all bird species that reproduce in the region are heavily dependent on riparian areas.[7]

In Arizona, riparian areas have been called "streams of life" and the "lifeblood" of the desert. Approximately 60% to 75% of Arizona's resident wildlife species are dependent on riparian habitats to sustain their populations, yet these riparian areas occupy less than 0.5% of Arizona's total land.[8] In times of intense heat and drought, riparian areas are even more critical to providing food and shelter for wildlife. During low rainfall years, bottomlands along desert

[4] Bark-Hodgins, Rosalind and Colby, Bonnie G. 2006, Vol. 46 Natural Resources Journal, "An Economic Assessment of the Sonoran Desert Conservation Plan."
[5] Bark, R.H., D.E. Osgood, B.G. Colby, G. Katz and J. Stromberg, 2009. "Habitat Perservation and Restoration: Do Homebuyers Have Preferences for Quality Habitat?" Ecological Economics, 1465-1475.
[6] Halper, E.B and R.H. Bark-Hodgins, no date. "Positive Externalities: Public Green Space and Outdoor Residential Water Use."
[7] Chaney, E., Elmore, W. and Platts, W.S. 1990. Livestock Grazing on Western Riparian Areas. Northwest Resource Information Center, Inc.: Eagle, Idaho.
[8] ARC, 1994. Fact Sheet: Riparian. Arizona Riparian Council

streams produce 3 to 5 times more vegetation than upland areas produce.[9] Seventy percent of threatened and endangered vertebrates in Arizona depend on riparian habitat.[10]

Bird and other wildlife populations are declining due mainly to loss of habitat, including species not on the federal threatened and endangered species lists. The AGFD recognizes over 150 "special status species" in the County alone.[11] Analysis of the Breeding Bird Atlas routes and Audubon Christmas Count data has shown that both rare and common bird species populations have decreased substantially over the last 40 years. Such species are listed in the red and yellow categories of the Audubon/Partners in Flight Watchlist.[12]

Riparian habitat varies by elevation and water availability. Certain species are restricted to aquatic environments provided by springs and perennial streams. In the County, the riparian and aquatic associated species covered by the Sonoran Desert Conservation Plan (SDCP) include:

Riparian Associated Species:		
Mexican Long-tongued Bat	Merriam's (Mesquite) Mouse	Southern Yellow Bat
Allen's Big Eared Bat	Western Red Bat	Arizona Shrew
Southwestern Willow Flycatcher	Abert's Towhee	Bell's Vireo
Western Yellow-Billed Cuckoo	Gentry Indigobush	Mexican Garter Snake
Cactus Ferruginous Pygmy Owl	Chiricahua Leopard Frog	Lowland Leopard Frog
Red-backed Whiptail Lizard	Giant Spotted Whiptail	
Aquatic Associated Species:		
Sonoran Sucker	Gila Chub	Desert Pupfish
Longfin Dace	Gila Topminnow	Desert Sucker
Huachuca Water Umbel		

Climate change implications for ecosystem maintenance and restoration

As reported in *Global Climate Change Impacts in the United States*, prepared by the U.S. Global Change Research Program, "Human-induced climate change appears to be well underway in the Southwest. Recent warming is among the most rapid in the nation, significantly more than the global average in some areas." Projections for climate change in the Southwest include continued increases in average temperature, which has already increased around 1.5 degrees Fahrenheit (^{0}F) in the Southwest since the baseline period of 1960 to 1979. By the end of this century, the annual average temperature in the Southwest could reach as much as 10^0 F higher then in the baseline period.

Rainfall patterns will be affected with an increasing likelihood of drought due to both natural weather cycles and human-induced climate change. The report goes on to state, "Future landscape impacts are likely to be substantial, threatening biodiversity, protected areas, and

[9] Pima County, Riparian Protection, Management and Restoration, Riparian Element, SDCP, 2000.
[10] Johnson, A.S. 1989. The thin green line: riparian corridors and endangered species in Arizona and New Mexico. In: Mackintosh, G. (ed.), In defense of wildlife: preserving communities and corridors. Defenders of Wildlife. Washington, DC. pp. 35-46.
[11] See www.gf.state.az.us/w_c/edits/documents/county_taxon_scientificName_001.pdf.
[12] See http://web1.audubon.org/science/species/watchlist/index.php and http://stateofthebirds.audubon.org/cbid/.

ranching and agricultural land. These changes are often driven by multiple factors, including changes in temperature change and drought patterns, wildfire, invasive species, and pests."[13]

Anticipated drought impacts in Southern Arizona include long periods of drought with short periods of heavy intense rainfall and fewer winter storm systems. Plants that require regular rainfall will be the most stressed. The change in rainfall amounts and patterns along with increased temperatures correspondingly increase wildfire hazards. Warmer winter temperature and increased areas denuded of native vegetation by wildfire will allow non-native plants such as buffelgrass to spread.

For existing aquatic ecosystem maintenance, like at Agua Caliente Park, supplemental water will be necessary when winter rains fail to provide adequate supply for native springs and associated vegetation. For restoration projects to be sustainable, stormwater harvesting and use of plants that are tolerant of long drought periods will be essential for successful, long-term restoration.

II. Ecosystem Descriptions and Water Needs

Ecosystem and Plant Communities Descriptions

The USFWS define an ecosystem as a geographic area including all living organisms, their physical surroundings and the natural cycles that sustain them. An ecosystem can be described as an integrated unit, a biotic community conjoined with its physical environment. Essential to riparian ecosystem restoration is improving or restoring natural floodplain functions including the interdependent components of river systems within a watershed such as the channel, over bank, floodplain, distributary flow zones, riparian vegetation, and shallow groundwater. Restoration of the plant community improves habitat structure and attracts wildlife, supporting increased biodiversity.

Riparian ecosystems comprised of broadleaf deciduous forests and mesquite bosques provide cover and forage for a wide variety of wildlife, including resident and migratory birds, diverse communities of invertebrates, reptiles, and mammals. The riparian scrub plant community is also valuable habitat for a number of wildlife species. A mixture of riparian, grassland, and upland plant communities along river corridors provides varied structure supporting a high diversity of wildlife.

Habitat, or biome, classification is based on plant communities because plant species are definitive of their biomes since they are rooted in place, and generally adapted to the site-specific environment. Plants are also the most obvious and easily recognizable element of the biological community. A plant community will contain characteristic animal life including many insects and other invertebrates specific to that plant community. Most vertebrates are more mobile and few species are restricted to a single habitat. It is also important to note that boundaries between plant communities are rarely distinct and there may be broad transitions zones.

[13] U.S. Global Change Research Program, "Global Climate Change Impacts in the United States, Cambridge University Press, 2009, pages 129-131.

Healthy functioning ecosystems need water. If habitat and riparian areas are to be enhanced, restored or preserved, water must be available for the ecosystem. Water needs depends on the type, density, and maturity of vegetation. Desert riparian plant communities are commonly classified into hydroriparian, mesoriparian, and xeroriparian habitats (which corresponds to the amount of water needed to survive). Hydroriparian, as the name implies, are water dependent plant species like cottonwood and willow that are generally associated with perennial watercourses and/or springs. Mesoriparian habitat is less water dependent and is associated with intermittent watercourses or shallow groundwater. Mesoriparian (meso meaning mid) plant communities include species found in drier habitats like mesquite, but also contain some preferential riparian plant species such as ash or netleaf hackberry. Xeroriparian habitats (xero meaning dry) are associated with ephemeral streams and contain plant species also found in upland habitats, however, these plants are typically larger or occur in higher densities than adjacent uplands. Below in Table 2.1, Sonoran Desert plan communities are described.

Table 2.1: Sonoran Desert Plant Communities

Classification	Plant Community	Description
Hydroriparian	Open Water	Streams, springs, ponds, lakes: provides habitat for aquatic species and resting/forage for water fowl
	Wetland	Cattail-sedge: aquatic, wetland species, moist soil and habitat for food, shelter, and nesting sites, high biodiversity
	Cottonwood Willow Community	Deciduous Gallery Forest: most threatened forest type in North America, one of the most important native habitats, dependent on shallow groundwater, high biodiversity
Mesoriparian	Seasonal Cienega	Riparian grasses, sedges, “edge” habitat bordering bosque and gallery forests: provides forage, shelter, important for wildlife
	Mesoriparian Mesquite Bosque	Mixed forest of mesquite, hackberry, acacia: second most threatened forest type in North America, valuable for wildlife forage and nesting habitat
Xeroriparian	Xeroriparian Mesquite Bosque	Similar plant community to Mesoriparian mesquite bosque: lower total vegetation volume than mesoriparian bosque habitat, occurs along ephemeral streams, Includes Ironwood-Palo Verde community,
	Riparian scrub	Saltbush-wolfberry-graythorn community, also ironwood: historically common along rivers, important to wildlife.
	Riparian grassland	Sacaton, tobosa grass communities: Seasonal cienegas, floodplain fringe
Uplands	Upland Sonoran Desert Scrub	Palo Verde-bursage community
	Desert grassland	Desert grasses, cacti:

Ecosystem and Plant Community Water Needs

Ecosystem water needs can vary seasonally, annually, and over periods of years. The following table and text indicates typical annual water needs by plant community. For comparison of water needs, the average annual water demand for turf is 4 acre-feet per acre and the average annual rainfall in eastern Pima County provides approximately 1 acre-foot of water per acre. Table 2.2 lists average annual water needs in acre-feet of water per acre of plant canopy based on regionally appropriate evapotranspiration rates for different desert plant communities.

Table 2.2: Plant Communities and Associated Water Supply Needs[14]

Community	Average Water Need/ET rate (acre-feet per acre)	Water Need and Supply Notes
Open Water	5.4	Water is naturally supplied by perennial flow, springs, and/or shallow water table.*
Wetland	5.0-6.0	Water is naturally supplied by perennial flow, springs and/or shallow water table. Maintaining marshy conditions with cat tail and reeds and some open water.*
Cienega	3.5 – 4.0	Water is naturally supplied by springs, perennial or intermittent water flow, and/or shallow water table. Seasonally dry wetland area; requires abundant water in wet season.*
Cottonwood Willow Community[15]	Young 8.3 Mature 5.0-5.8	Water is naturally supplied by perennial flow, springs and/or shallow water table.*
Mesoriparian Mesquite Bosque	3.0	Water is naturally supplied by direct rainfall, intermittent stream flow, and/or shallow groundwater table.*
Xeroriparian Mesquite Bosque	2.3	Water is naturally supplied by direct rainfall, ephemeral stream flow and/or shallow groundwater table.*
Riparian scrub	0.5-2.3	Water is naturally supplied by direct rainfall and/or ephemeral stream flow. Restoration areas can be sustainable on harvested rainfall and natural ephemeral stream flow after establishment
Riparian grassland	0.5-2.3	Water is naturally supplied by direct rainfall. Restoration areas can be sustainable on harvested rainfall and natural ephemeral stream flow after establishment
Upland Sonoran Desert Scrub	0.5-1.0	Water is naturally supplied by direct rainfall. Restoration areas can be sustainable on harvested rainfall after establishment
Desert grassland	0.5-1.0	Water is naturally supplied by direct rainfall. Restoration areas can be sustainable on harvested rainfall after establishment

***Note:** Restoration requires natural conditions or equivalent conditions to succeed. Water harvesting can assist but not meet all of these needs for hydroriparian and mesoriparian habitat restoration.

[14] Fonseca, Julia: Internal Memo, Evapotranspiration Rates for Plant Communities, August 2003

[15] Woodhouse, Betsy, 2008. Approaches to evapotranspiration measurement, Southwest Hydrology V.7, N.1 p. 20

III. Elements and Drivers of Environmental Restoration

Defining Ecosystem or Environmental Restoration

For purposes of this paper "environmental restoration" means enhancing existing ecosystems or creating new habitat in areas that are able to support appropriate vegetation and provide ecosystem functions. The goal of restoration is recovery of some components of functional characteristics of the ecosystem being replicated including plant communities and habitat structure. The ecosystem restoration goal focuses on hydrologic connection, vegetation, and eventually species restoration. Environmental restoration involves either the preservation of, or providing for, the physical elements associated with the ecosystem, as well as long-term efforts to maintain the integrity of these physical elements. Restoration requires land, water, and native plants. It also addresses finer spatial and temporal elements such as micro-topography of a site, soil type, sediment transport, vegetation diversity and structure, and timing of water applications. Once a restoration effort is complete and site conditions have improved, wildlife species can be reintroduced onsite or allowed to naturally recolonize.

This paper does not assume that replication of historical ecosystems is either possible or feasible given the current geomorphic and hydro-geologic conditions within the Tucson Basin. However, enhancing vegetation can result in sustainable habitat that can help restore ecosystem functions of river corridors and support the wildlife species that depends on the rapidly shrinking riparian systems for survival within the County.

Preservation of the existing natural resources and ecosystems that support native and migratory species is preferred over restoration. Restoration must be considered in the context of efforts to preserve habitats and critical ecosystem functions before they become degraded.

Ecosystems are not static or isolated systems. They are continually subjected to changes in natural trends such as drought or climate change-induced temperature increases. They are also subjected to myriad anthropomorphic impacts ranging from degradation from human use to changes in water quality or quantity resulting from urban runoff, pumping, or upstream diversion to invasion by non-native species. Restoration and habitat or ecosystem preservation must be considered in concert with mechanisms and resources needed to maintain the long-term integrity of these areas.

Defining an Environmental Project

For the purposes of this paper "environmental project" means a project that preserves, enhances or creates ecosystem functions including habitat, biological connectivity, and species protection/restoration. Environmental projects include:

- acquisition and preservation of environmental and water resources;
- land management activities for recovery and enhancement; and
- constructed enhancement and restoration actions.

While all three of these activities are essential to protecting and maintaining ecosystem function, the emphasis in this paper is on constructed enhancement and restoration actions that require the development of a short-term or long-term supplemental water supply to support the project. These projects will be referred to generically as 'riparian restoration' projects.

Riparian restoration could consist of the creation of new habitat areas or actions that enhance the quality of existing habitat. It may be useful to enhance established riparian habitat in areas where past water diversions and pumping have led to insufficient naturally available water to prevent habitat from being lost over time. Riparian habitats can be enhanced by activities that do not require supplemental water including:

- fencing to protect lands from grazing, off-road vehicles, dumping, disturbance of natural and cultural resources, etc.;
- retirement or rotation of grazing rights; range management;
- erosion abatement projects;
- removal and control of non-native invasive vegetation;
- abandonment and revegetation of roads and trails;
- implementation of trail management plans;
- retiring wells or reducing groundwater use; and
- returning diverted surface flows to riparian areas.

Water Supply Needs for the Environment

Restoring, enhancing, or preserving ecosystems requires providing the necessary seasonal water supply through rainfall and stream flow, or supplemental irrigation for plant establishment during extended drought and, for aquatic ecosystems, a permanent supply of water if needed. If natural water sources are no longer available in the volume, timing, or location, the plants' need, alternative water supplies will be needed. If adequate natural water supplies are still available, supplemental water supplies may only be needed during establishment.

Water Supply Needs for Ecosystem Restoration of Degraded Systems

Water needs for ecosystem restoration projects range from short-term to long-term supplemental water supplies. A long-term water supply meets the needs of habitats that depend on larger volumes of water than can be provided through natural rainfall and/or ephemeral stream flow. Restoration or enhancement of degraded high-water-use mesoriparian and hydroriparian areas that no longer have ongoing natural water regimes (shallow groundwater, intermittent surface water flow or perennial surface water flow) will need a long-term supplemental water supply. Natural water sources could be supplemented over the long term using water harvesting to concentrate rainfall, or by irrigation with groundwater, reclaimed water, effluent, or graywater.

A short-term water supply is one needed to support vegetation establishment at a site for up to 5 years or to make up a shortfall in natural rainfall, especially during drought. Degraded upland ecosystems and xeroriparian ecosystems could in some cases be restored using harvested rainwater alone, though providing water for establishment of new plantings will accelerate the pace of restoration. Controlling development impacts to maintain a natural regime of overland flow in the upland and ephemeral flow in channels is a high priority for these areas.

Selection of appropriate native species for the ecosystems that are being restored and enhanced is the key to success. Nearby healthy vegetation communities that has similar regimes of water availability, elevation, soil types and other characteristics can serve as reference populations when determining appropriate species and distributions for restoration plantings in degraded areas.

Water Supply Needs for Preservation of Healthy Ecosystems

A brief discussion of City and County efforts to protect healthy ecosystems is provided in Appendix A and in the Shallow Groundwater Paper. Preservation of healthy ecosystems is largely outside the scope of this paper, though preserving existing areas in light of projected climate change does need consideration when discussing water supply needs.

Sonoran Desert ecosystems are adapted to the historic climate regime for this region. Projections of climate change impacts over the coming decades indicate that this climate regime will be changing, potentially dramatically and swiftly. It may be necessary in a hotter, drier future to provide supplemental water to hydroriparian and mesoriparian habitats that are presently self-sustaining. Seasonal water supplementation has already been required in response to the current multi-year drought. For example, the ponds at the Aqua Caliente Park are generally maintained by natural springs; however, during extended periods of drought supplemental water is required to maintain the park and habitat.

Maintaining existing healthy riparian ecosystems requires an ongoing supply of water in the volume, timing and location of delivery the plants have evolved to use. High-water use mesoriparian and hydroriparian ecosystems (using greater then 2.3 acre-feet/ac/yr) are best maintained by securing the natural delivery processes these plants evolved with (Table 2.2 in Section II). The priority in these cases is to ensure that natural stream flows, springs, and shallow groundwater tables are maintained (see Shallow Groundwater Paper). Supplemental water supplies may be needed to aid such ecosystems during periods of particular stress.

Maintenance of healthy xeroriparian ecosystems that use moderate to low volumes of water on an annual basis (around 2.3 acre-feet/ac/yr or less) may be accomplished in part with human intervention to supply additional water. However, irrigation requires installation of water supply infrastructure, and requires ongoing input of water and maintenance of the system. Construction of water harvesting earthworks around healthy existing plants can be problematic due to impacts to plant roots and resulting changes in microtopography.

The most xeric healthy natural systems, such as riparian scrub and riparian grassland, rely on a combination of ephemeral stream flow and direct rainfall. Maintaining natural ephemeral stream flow is important to keeping riparian scrub and riparian grasslands intact so that human intervention does not become necessary to maintain the ecosystems. Development activities can impact natural drainages. Policies intended to decrease these impacts, such as addressing erosion and avoiding channelization, will be beneficial to natural watercourses.

Healthy upland ecosystems rely on rainfall alone for water supply. Barring the introduction of destabilizing conditions such as invasion by nonnative species, burning, development, or excessive human use, these systems should not need additional water supplies in order to be maintained in a healthy state.

Drivers of Riparian Restoration

Riparian restoration projects are implemented for a range of reasons including regulatory compliance, ability to capitalize on grants or other dedicated funding sources, and opportunities to integrate into planned capital projects such as parks, water recharge, wastewater treatment, and stormwater management facilities.

Federal Permitting

Endangered Species Act

As the County undergoes rapid population expansion, private development and public infrastructure have increased the urban footprint encroaching into natural areas, including those providing habitat for threatened or endangered species. The Endangered Species Act (ESA) prohibits the taking of threatened or endangered species, except an incidental take is allowed provided there is an approved Habitat Conservation Plan (HCP) and an ESA Section 10 Permit in place. Both the City and County are developing HCPs to address potential impacts of urbanization in their respective jurisdictional areas and to ensure compliance with the ESA by securing Section 10 Permits from the USFWS.

The SDCP recognizes that there is a correlation between growth and the consumption of natural resources, but defines goals for directing growth in ways that protect the quality of life for County citizens (see Figure 3.1). To help implement sensible growth under the SDCP and comply with the ESA, the County has developed a HCP; the Multi Species Conservation Plan (MSCP). The MSCP will lead to issuance of a federal permit under Section 10 of the ESA and provide predictability for the County's regulatory commitments to the USFWS for development activity that may impact endangered species.

The City is developing an Avra Valley HCP which will apply to various water resource related activities conducted by Tucson Water. The City is also developing the Southlands HCP, which will apply to public improvements and private development activities in an area south and west of Tucson.

The County's MSCP and the City's HCPs include conservation measures that require certain actions be taken to preserve, mitigate, or enhance habitat for specific vulnerable species. Implementation of these measures is required for compliance with the associated federal permits. These measures may include actions that necessitate the use of supplemental water to create or enhance riparian habitat. For example, some riparian species such as Huachuca water umbel and the southwest willow flycatcher may need additional habitat creation or habitat enhancement in order to be adequately protected within the MSCP or HCP permit areas. If this habitat creation or enhancement was deemed necessary, the permittee (County or City) would be obligated to ensure that supplemental water of appropriate quality and quantity was available to support the required restoration.

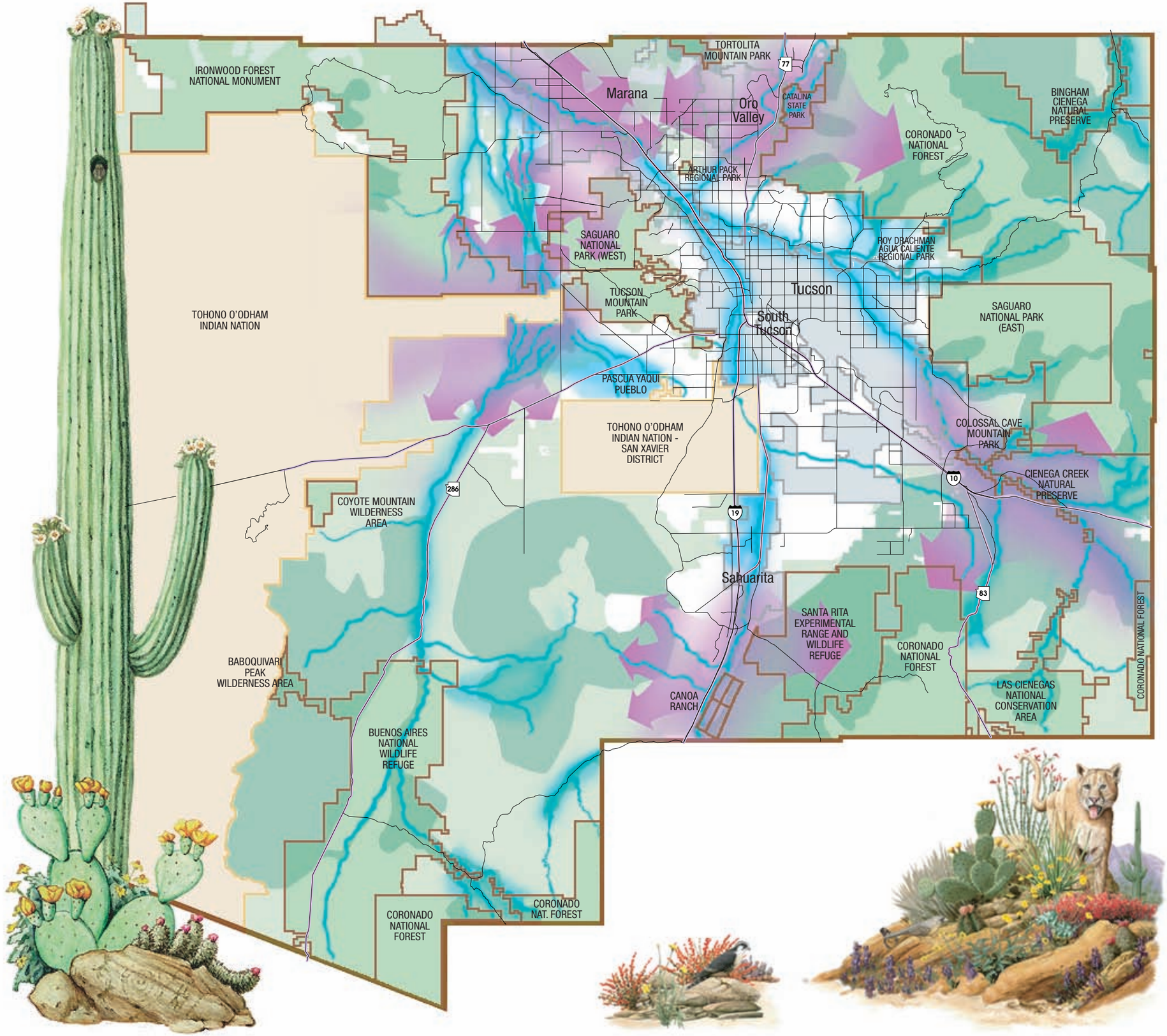
The Federal Clean Water Act

Section 404 of the federal Clean Water Act requires permitting and compensatory mitigation for construction or maintenance activities within jurisdictional Waters of the United States. Public infrastructure projects such as transportation systems, municipal sewer facilities, water and other utility distribution systems, may all trigger the need for mitigation of loss of jurisdictional waters. Environmental projects can serve as mitigation for public safety projects to meet 404 Permit requirements.

SONORAN DESERT CONSERVATION PLAN

BIOLOGICAL CORRIDORS AND CRITICAL HABITAT

The work on the biological corridors and critical habitat element of the Sonoran Desert Conservation Plan revealed that biology is the basis for all other elements. The strong interconnections of all five elements is critical in forming a viable land management plan that ensures continuing biodiversity for Pima County.



LEGEND

- Important Riparian Areas
- Biological Core Areas
- Multiple Use Areas
- Wildlife Corridors

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Visit the Sonoran Desert Conservation Plan Web site
www.pima.gov/sdcp

Sonoran Desert Conservation Plan
County Administrator's Office
130 West Congress, 10th Floor
Tucson, AZ 85701
520-740-8162

Figure 3.1

While similar to environmental mitigation for compliance with the ESA, environmental projects for compliance with Section 404 are watershed based and address specific actions that cause a disturb or loss of Waters of the United States. Mitigation to comply with the ESA, due to impact to threatened or endangered species, cannot be used to meet 404 mitigation requirements which are specific to loss of stream channels, watershed impacts, etc.

Opportunities for Grant Funding and Partnerships

The City and County pursue opportunities to obtain state and federal funds that support restoration planning and/or restoration project implementation. Among these funding opportunities are Arizona Water Protection Fund grants for riparian restoration, AGFD grants for land management activities, and various U.S. Army Corps of Engineers (USACE) programs such as Section 206 for small ecosystem restoration projects, as was used to create the Swan Wetlands. These funds can provide an impetus for the development of a restoration plan or project. However, they do not cover the cost of long-term maintenance and supplemental water. So while they may spur a specific restoration project, the location, cost and availability of existing water sources, methods to capture and use stormwater, or the potential to obtain new water sources must be taken into account in project planning. Grant-funded projects for invasive species removal, fencing, seeding and unirrigated planting would not require supplemental water.

Tucson Water partnered with the Tucson Audubon Society to undertake restoration at the City-owned North Simpson Farm site located along the Lower Santa Cruz River in Avra Valley. To accomplish the restoration, the Tucson Audubon Society utilized CWA Section 404 in-lieu mitigation fees from private developers, grants from the Arizona Water Protection Fund, and a grant from the USFWS Partners in the Fish and Wildlife Program. The County allows payment of in-lieu fees for impacts to riparian habitat due to development. These funds are used for County sponsored restoration projects. Most recently, the County approved an offsite riparian restoration project where Granite Construction will provide restoration at the County's Kolb Road Detention Basin as compensation for riparian habitat disturbance at a proposed sand and gravel pit south of the Tucson Airport.

Multi-Purpose Projects

A major driver of restoration is the ability to restore or enhance habitat that occurs incidental to a jurisdiction's capital improvement projects. Many public projects involve a dedicated water source. Such water sources have often been used to meet both the primary goals of the project and to create or enhance riparian habitat. Parks and linear pathways along the major watercourses have permanent irrigation installed. Landscaping can incorporate native xeroriparian and upland habitat. Properly designed stormwater management facilities can retain sufficient water to support xeroriparian and sometimes mesoriparian habitat. Water recharge facilities and wastewater treatment facilities provide the greatest opportunity for restoration, with water available in quantities sufficient to even support limited hydroriparian habitat.

Local Regulatory Compliance

Private developments are required to comply with a range of local ordinances, some of which can result in the creation or enhancement of riparian habitat. Currently, the City requires water harvesting on all commercial properties, in common areas of subdivisions, and properties associated with all capital improvement projects. This water harvesting, if done thoughtfully and carefully, can be used to create habitat, which is especially valuable if it is done adjacent to an existing watercourse. Both the City and County have wash protection regulations that require impacts to riparian habitat be mitigated on or offsite. While mitigation is replacing habitat that will be lost, the mitigation plan does provide an opportunity to enhance the overall value of the remaining habitat, especially in combination with onsite water harvesting and invasive species control.

IV. Existing and Proposed Environmental Projects

Project Water Usage and Management Considerations

Both the City and County plan and construct single and multi-purpose ecosystem restoration projects in urban and rural areas. These projects focus on planning regionally appropriate habitat and wildlife corridors to benefit an array of native species. Projects include multiple riparian and upland zones. The projects have been developed in response to a variety of drivers.

Due to the desert climate and ongoing drought, almost all projects utilize some irrigation water. Many will ultimately rely on harvested rainwater and/or shallow groundwater for long-term sustainability with little or no supplemental irrigation beyond an establishment period. Multiple water sources are used on different projects including groundwater, reclaimed water, treated effluent, regional stormwater, harvested rainwater and shallow groundwater. Almost all the projects include some degree of rainwater harvesting, with the current trend being towards maximizing use of this water source.

Projects in urban areas require consideration of public access and safety, vector control issues and increased maintenance needs. The County's multi-purpose Kino Environmental Restoration Project (KERP) project is located in an urban setting. KERP provides the full range of habitat from wetland habitat to upland habitat and benefits aquatic and terrestrial species ranging from waterfowl to burrowing owls. In addition, excess harvested stormwater is utilized for irrigation of nearby ballparks, roadway medians, and landscaping. When harvested stormwater and rainwater are lacking, reclaimed water sustains the wetland areas.

Another urban project is the Old West Branch Preserve. This formerly groundwater-dependant environment was historically used for agriculture. The area no longer has access to shallow groundwater or agricultural irrigation due to groundwater depletion and cessation of farming. The 72-acre open space provides beneficial floodplain functions and preserves habitat for the Giant Spotted Whiptail lizard. In response to scientific monitoring of declining habitat conditions and active neighborhood involvement, the County provides drought contingency irrigation to over two acres of habitat along the riparian strand by seasonally applying reclaimed water to sustain deeply rooted perennial vegetation.

Rural projects have less intensive management and public needs than urban projects. The rural North Simpson Farm site consists of retired agricultural land owned by the City located in northern Avra Valley. The project is managed through a City partnership with the Tucson Audubon Society. For vegetation establishment, water has been diverted from the effluent-dominated Santa Cruz River, pumped from onsite wells, and harvesting in water harvesting earthworks. A variety of planting, seeding and irrigation approaches have been used to maximize project success.

The County's Bingham Cienega Preserve lies along the San Pedro River and has historically been supported by shallow groundwater, a spring, and flows in the river. The former agricultural land was restored to an alkali sacaton grassland and riparian mesquite bosque. The vegetation was established using onsite groundwater wells for irrigation, but no supplemental irrigation has been added for the last eight years. This remote area is managed through a partnership between the County and The Nature Conservancy.

Most existing and planned projects presented in Tables 4.1 and 4.2 are 50 acres or less in size. Several larger planned/proposed projects are partnerships between the jurisdictions and the USACE. The proposed USACE projects are generally addressed at the end of this section, however, the tables do include: (1) projects that have already been funded, and (2) small portions of these projects that have been constructed or planned using local funding (e.g., Old West Branch and Ajo to 29th Bond project: Paseo de las Iglesias Phase One).

Existing Environmental Projects

Existing County and/or City environmental projects are shown on Figure 4.1. Table 4.1 gives a brief project description including the water source and water demand for these 12 constructed environmental projects. Some of these projects are a portion of a larger multi-purpose project, and in these cases the non-environmental acreage was omitted when it could be separated from the overall project.

Other types of environmental projects include environmentally valuable land that is actively managed to provide habitat protection or enhancement by removing stressors without adding supplemental water. Land management to remove stressors includes installing fencing, installing small grade control structures, removing grazing and removing invasive species, among others. These projects do not need supplemental water to be of environmental value, and may rely on rainwater or stormwater harvesting to provide a self sustaining water supply. See Appendix B for land management projects.

Planned & Proposed Environmental Projects

Planned and proposed environmental projects proposed by the City and/or County are shown on Figure 4.1 and Table 4.2 gives a brief project description including the potential water source and estimated water demand for these planned or proposed environmental projects. This count includes projects that are part of larger multi-purpose efforts. This list represents projects where land and water availability present opportunities to meet current or future multiple purposes, including regulatory compliance with 404 Permit requirements for flood control structures, among others.

Environmental Projects

Existing Environmental Project

Proposed Environmental Project

Simpson Farm

Anza Park

Martin Farm

Marana High Plains & Oxbow

Bingham Cienega

Cortaro Mesquite Bosque

Tres Rios del Norte

Massingale Basin

Oro Valley Big Wash

Santa Cruz River at Rillito & CDO

Sweetwater Wetland

Swan Wetlands Rillito

Pantano Confluence

El Rio Medio

Arroyo Chico

Paseo Phase One

Old West Branch

Paseo de las Iglesias

Kino Environmental Restoration Project

Parque de Santa Cruz

Black Wash Avra Valley

Pantano Wetlands at Melpomene

Atterbury Wash

Kolb Basin Enhancement

Cienega Creek Streamflow Restoration

Pantano Jungle 1 & 2

Pantano Jungle 3 & 4

Canoa Ranch Restoration

Cortaro Mesquite Bosque

Kino Environmental Restoration Project

Old West Branch Santa Cruz River

Figure 4.1

Table 4.1: Existing Environmental Projects

Project Title	Project Goal	Habitat Size Acres	Water Source	Supplemental Water Need	Water Notes	Restoration Driver
Bingham Cienega	To restore natural ecological processes and to prevent floodplain development.	28	Natural Shallow Groundwater	50 acft/yr for 1998-2001	Estimate from Barbara Clark, TNC based on acreage and estimated ET	Restore historic hydromesoriparian habitat and natural floodplain function on retired agricultural land
Cortaro Mesquite Bosque	The goal of the project is to increase vegetation structure and biological diversity of the floodplain and provide wildlife habitat, forage, and nesting area for birds.	80	Harvested stormwater, rainwater, and non-potable shallow groundwater	44 – 50 acft/yr for establishment 20-30 acft/yr 2012-perpetuity	2008/9 values based on usage. Projected to increase to support growth stage prior to weaning down to minimal water needed to sustain vegetation.	Restore floodplain and habitat function (ADWR Grant)
Kino Environmental Restoration Project (KERP)	The idea of the project was to restore to the basin a habitat representative of wetland and riparian vegetative communities that would have been present under historical/optimal conditions for the region.	141	Storm water and rainwater harvesting, reclaimed water	172 acft/yr 2002-2004 95 acft/yr 2004-2006 110 acft/yr 2006-2018	Establishment estimate by USACE; Spray field irrigation was retired in 2004; Recent usage calculated via ET for existing vegetation & open water areas.	Multi-purpose project including restoration of floodplain and habitat function plus surplus stormwater harvesting; in detention basin (USACE funding)
Marana High Plains with Oxbow Channel	Recharge treated effluent into the local groundwater aquifer while creating wildlife habitat and public recreation opportunities associated with wetland/riparian ecosystems	2.6 around recharge basins; 22.7 in oxbow channel	Effluent	6 acre-feet per year utilized by vegetation around recharge basins 113.5 acre-feet per year utilized by vegetation along oxbow channel	Calculated based on acreage and ET.	Multi-purpose project including groundwater recharge and restoration of floodplain and habitat function
Martin Farm	Revegetate with plant species that are locally native and that provide habitat for birds and other wildlife. Stabilize local erosion problems.	30 acres	Rainwater harvesting, diverted surface water from Santa Cruz River	One acre-foot per year during establishment, then shut off water for long-term survival	Actual water use not measured or calculated.	404 in-lieu mitigation
Massingale Detention Basin Reclamation	Provide mitigation for visual impacts of the basin.	16	Stormwater runoff	Water need unknown, uncalculated	Stormwater detention basin is self sustaining	Multi-purpose project incl. restoration of floodplain and habitat function in detention basin

Oro Valley Big Wash	Restore self-sustaining mix of native vegetation based on the characteristics of nearby, undisturbed, reference sites	77	Potable water from onsite TOV wells; rainwater harvesting	90 acft for 2009-2010 120 acft for 2011-2020	Calculated estimate based on acreage and ET for mostly mixed mesquite and open shrub communities	Developer funded mitigation for grading and bank protection
Pantano Jungle Revegetation Phase 1 & 2	Reestablish mesquite bosque and sacaton grassland habitat in an area dominated by non-native vegetation and increase structure and diversity of native vegetation for the benefit of neotropical migratory birds	17.5 (9 irrigated)	Natural shallow Groundwater	9 acft/year 1997 - 1999	Calculated estimate based on acreage and estimated ET	Restore floodplain and habitat function (USFWS Grant)
Parque de Santa Cruz	Restore habitat, create basic river park infrastructure, flood control	41 of habitat, plus 49 acres along landscaped trail	Groundwater	40 acft/yr 2009 to 2015 20 acft 2016-purpetuity	Planned to use reclaimed water once service is extend to the Irvington/Drexel Area	404 mitigation by developer
Simpson Farm	Revegetate with plant species that are locally native and that provide habitat for birds and other wildlife. Stabilize local erosion problems	200 acres	Rainwater harvesting, groundwater, diverted surface water from Santa Cruz River	Approximately 5 acft/yr then shut off for long-term survival	2.4 acre feet used in 2007.	404 in-lieu mitigation
Swan Wetlands/ Rillito Riparian	The goal of the project is to restore a self-sustaining ecosystem by increasing vegetation diversity and density	30	Water harvesting & Reclaimed water	23 acft/yr 2008-2009 30 acft/yr 2010-2012 15 acft/yr 2013-2018	Partially measures and calculated post initial operation.	Restore floodplain and habitat function (USACE funds)
Sweetwater Wetlands	Treat and recharge effluent into the local groundwater aquifer while creating wildlife habitat and public recreation opportunities associated with wetland/riparian ecosystems	18	Secondary effluent	Project Water supply is generated from the filtering process of the reclaimed system, amt dependent on the reclaimed line volume	The 18 acres is emergent vegetation and open water. There is some additional riparian habitat along the perimeter of the treatment train.	Tertiary water treatment and recharge
Old West Branch Santa Cruz River	Irrigate drought-stressed mesquite trees and associated native vegetation along an ecologically unique urban watercourse	2.2	Reclaimed Water	3 acre-feet/year	Average annual measured usage	Protect floodplain and habitat function, 404 in-lieu mitigation acquisition

* PCRFCD estimates these values may be reduced by up to 50% in some cased based on 1) new published evapotranspiration data, 2) water demand of previously constructed projects, 3) incorporating additional water harvesting measures, 4) use of irrigation moisture sensors, and/or 4) incorporating more low-shrub/grassland for burrowing owl considerations.

Table 4.2: Future Planned Environmental Projects that May Require Water for Establishment and/or Maintenance

Project Title	Project Goal	Habitat/ Vegetation Size	Estimated Construction Timeframe	Water Source	Supplemental Water Need	Water Notes	Restoration Driver
Anza Park	Use onsite effluent to preserve and create additional habitat to supports Priority Vulnerable species that are know or could occur in the vicinity	170 enhanced of 280 total acres	2015	Effluent from adjacent Marana WWTF	~200 acft/yr currently available; Expected to increase in the future as facility is only at 27% of capacity.	Treated effluent from adjacent Marana WWTF	Proximity to effluent supply
Arroyo Chico Phase IIB	Multi-purpose project with flood control, environmental, and recreation benefits	23 acres	2010 to 2012	Reclaimed water	10 acft/year, year 1 50 acft/yr years 2-3 10 acft/yr year 4	Calculated estimate based on acreage and ET for mixed mesquite and riparian grassland communities	Multi-purpose project including restoration of floodplain and habitat function
Atterbury Wash	Maintain and restore riparian habitat that has been impacted by channel erosion and desiccation of the flood plaint	20 acres riparian, 35 acres of upland	2010 - 2012 (funded with Arizona Water Protection Fund grant)	Harvested stormwater, rainwater, and non-potable shallow groundwater	2 acre-feet per year during plant establishment period. Shut off for long-term survival	Water need unknown, uncalculated	Multi-purpose project including restoration of floodplain and habitat function (AWPF Grant funded)t
Black Wash/Avra Valley	Preserve and create additional effluent-dependant habitat that supports Priority Vulnerable species that a re know or could occur	Undetermined ; (hundreds of acres available)	2010-11	Effluent from adjacent Avra Valley WWTF	Unknown, likely under 100 acft/yr	Recon; Avra Valley–Black Wash Ecosystem Evaluation and Restoration Feasibility Study, Prepared for Pima County Regional Flood Control District, 2008.	Proximity to effluent supply
Canoa Ranch	Restore the floodplain buffer area to provide erosion control and enhanced wildlife habitat	90 acres	Pending Construction of sewer line from Amado	Storm and rainwater harvesting, +/- effluent from future Canoa wastewater scalping plant	100 acft/yr Yr 5-purpetuity 115 acft/yr Year 4 140 acft/yr Year 2 & 3 90 acft/yr Year 1	Establishment plus some perpetual use for pond, landscaping, and pasture	Restore floodplain and habitat function
Cienega Creek Downstream Flow Restoration	Restore several miles of stream flow to recreate natural riparian condition	32 to 182	Proposed - pending negotiations with landowner	Stop diversion & groundwater pumping; supply Vail Water Co. w/ effluent, CAP, or other groundwater	985 acre-feet/year (calculated "Base Flow")	Calculated "Base Flow" per ADWR permit	Restore floodplain and habitat function by returning historic stream flow

Kolb Road Detention Basin Habitat Enhancement	Enhance xeroriparian habitat and control slope erosion problems	18 (140 available)	2010-2011 (funding approval exp. 7/09)	Rain watering harvesting, groundwater for establishment	5 acft/year, year 110 acft/yr years 2-3	Establishment only. calculated estimate based on acreage and ET for xeric mesquite and riparian grassland communities	Restore floodplain and habitat function in detention basin, developer in-lieu mitigation
Pantano Wetlands at Melpomene	To enhance habitat and address erosion issues	40, up to 10 acres irrigated (temp.)	2010 for 404 Permit Mitigation	Rainwater harvesting, +/- surface water harvesting.	40 acft/year, year 1 80 acft/yr years 2-3	Establishment only. Calculation based on acreage and ET for xeric mesquite and riparian grassland communities	Restore floodplain and habitat function, 404 in-lieu mitigation
Pantano Jungle Revegetation Phase 3 & 4	Re-establish mesquite bosque and sacaton grassland habitat in an area dominated by nonnative vegetation	20	404 Permit Mitigation	Shallow Groundwater; harvested rain- and stormwater	10 acft/year, year 1 50 acft/yr years 2-3 10 acft/yr year 4	Calculated estimate based on acreage and ET for mixed mesquite and riparian grassland communities	Restore floodplain and habitat function, 404 in-lieu mitigation
Pantano Wash Confluence Mitigation and Restoration	Address bank failure risks and provide ecosystem restoration and enhance groundwater recharge	47 (along 3.5 miles of river)	404 Permit Mitigation	Shallow Groundwater for establishment only; harvested water thereafter.	20 acft/yr years 1-3 0-10 acft/yr years 4 to perpetuity	Projected establishment and drought contingency watering only.	Multi-purpose project including restoration of floodplain and habitat function
Paseo de las Iglesias Phase One Ajo to 29th Bond Project:	Increase riparian wildlife habitat, provide erosion protection, and passive recreation opportunities	150	2010-2011 (funded with by 2004 Bonds)	Water harvesting & Reclaimed water	150 acft/year, year 1 300 acft/yr years 2-4 50 acft/yr in perpetuity	Calculated estimate based on estimated acreage and ET for mostly mixed mesquite and open shrub communities	Multi-purpose project including restoration of floodplain and habitat function (PC Bond funded)
Santa Cruz River at Rillito & Canada del Oro	Address bank failure risks, provide ecosystem restoration and enhance recharge	Potential 125 ac for restoration	2011	Stormwater, rainwater and Effluent	125 acft/yr yr 2-3 250 acft/yr yr 1-2 65 acft/yr yr 5-purpetuity	Calculated estimate based on estimated acreage and ET for mixed mesquite communities	Multi-purpose project including restoration of floodplain and habitat function

* PCRFCD estimates values may be reduced by up to 50% in some cased based on 1) new evapotranspiration data, 2) water demand of previously constructed projects, 3) incorporating additional water harvesting measures, 4) use of irrigation moisture sensors, and/or 5) incorporating more low-shrub/grassland for burrowing owl considerations.

Proposed U. S. Army Corps of Engineers Ecosystem Projects

The USACE has been working with local sponsors in evaluating four potential environmental restoration projects. The USACE has partnered with the County on the Rillito River (formerly Rio Antiquo) and Paseo de las Iglesias (Santa Cruz, Los Reales to Congress) projects. The Tres Rios del Norte (Santa Cruz River, Prince Road to Sanders Road) project is co-sponsored by the County, City, and Town of Marana (Marana). The El Rio Medio (Santa Cruz River, Congress to Prince) project, co-sponsored with the County and City, is in the early stages of evaluating if improvements are feasible.

These very large planning investigations allow the County, City, Marana and others to evaluate the river systems, habitat, groundwater, flood control, and economic components of environmental restoration along the Santa Cruz River and its tributary. Initial USACE studies of these projects found potential to increase or create breeding habitat, foraging habitat and travel corridors for several species along the river systems. Due to the costs and complexity of providing restoration at a scale envisioned by the USACE, it is unlikely any of these projects will be developed in their entirety. These feasibility studies are providing valuable insight into where environmental restoration may be most feasible, what options and constraints exist, water requirements and availability, and what would be the "best buy" for the community for implementing environmental restoration along the major rivers.

Rillito River (Rio Antiguo) Restoration

The Rillito River Restoration Project evaluated the potential for environmental restoration from Campbell Avenue to Craycroft Road. Much of this stretch of river has been bank protected with little riparian habitat remaining. There were significant constraints due to flood control needs for existing development. However, the USACE and County were able to complete the 60.7-acre Swan Wetlands Ecosystem Restoration Project along the Rillito River from Craycroft Road to Columbus Boulevard. The objectives of this project were to "restore riparian vegetative communities within the river corridor to a more natural state, increase the acreage of functional seasonal wetland habitat within the study area, minimize the potential for sediment and organic matter accumulation in restored areas, increase habitat diversity…, [and] increase recreation and environmental education opportunities within the study area."[16]

The Swan Wetlands Ecosystem Restoration Project was constructed to create riparian and xeroriparian woodlands along stretches of the river (see Figure 4.3). The project includes mesoriparian and xeroriparian communities. The xeroriparian habitat provides a buffer around the mesoriparian vegetation and around the multi-use trail. The project includes passive water harvesting along existing channels that flow into the project area. The project will increase and enhance the cottonwood community that currently exists, as well as enhance the mesquite bosque and xeroriparian vegetation.

[16] USACE, Los Angeles District. 2003. *Rillito River Pima County Ecosystem Restoration Report and Environmental Assessment.* Los Angeles: USACE.

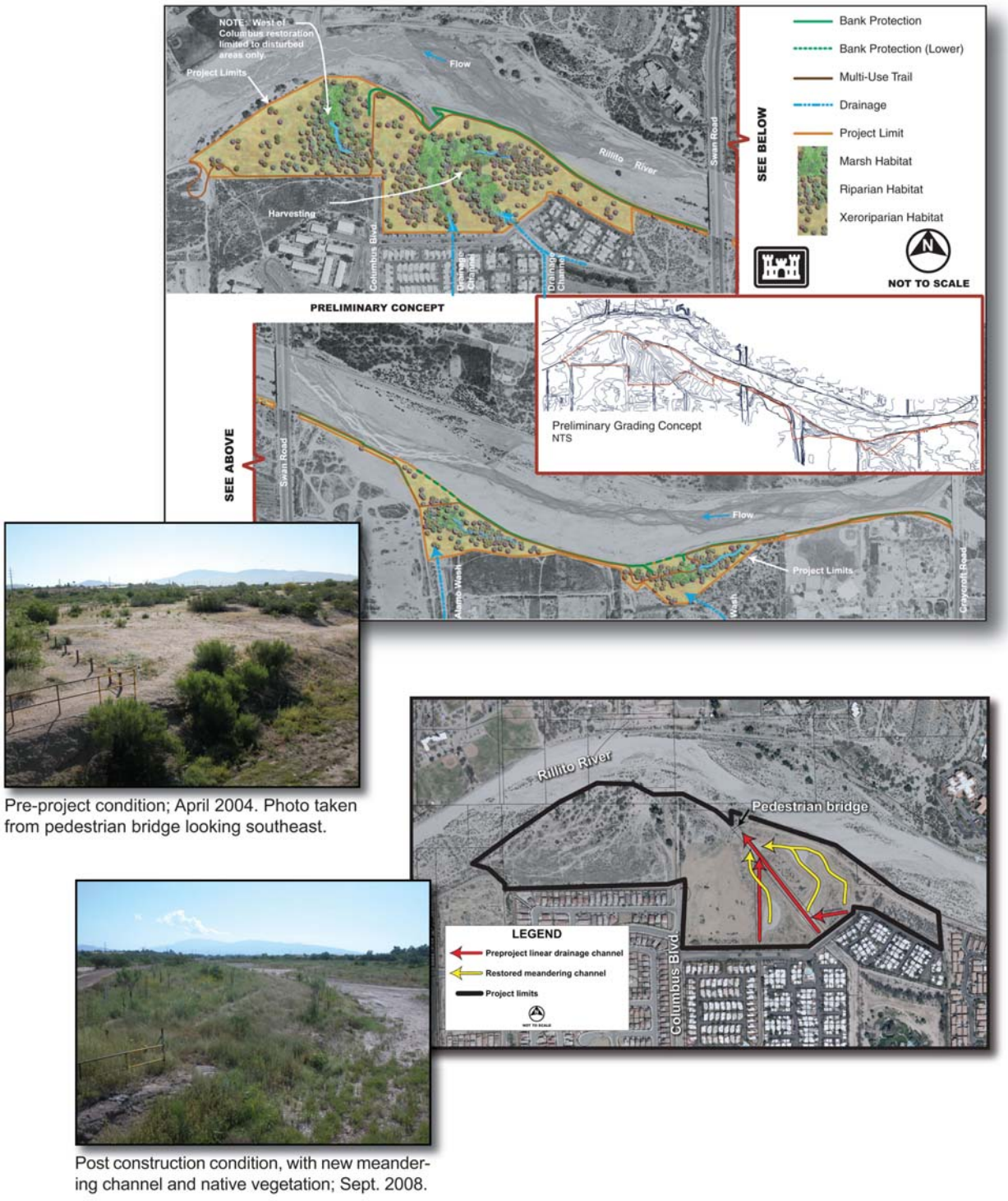


Figure 4.3: Images of Preliminary Concept Plan used for "design build" guidance, results of channel realignment, and before and after pictures showing new water harvesting and native seed recruitment.

Paseo de las Iglesias Ecosystem Restoration

The Paseo de las Iglesias Feasibility Study areas are located along the Santa Cruz River from Los Reales Road to Congress Street, and include the West Branch of the Santa Cruz River. Currently, this stretch of the Santa Cruz River is ephemeral with almost no riparian habitat and deeply incised banks. The Paseo de las Iglesias planning objectives are to "increase the acreage of functional riparian and floodplain habitat within the study area; increase wildlife habitat diversity by providing a mix of riparian habitat within the river corridor, riparian fringe and historic floodplain; provide passive recreation opportunities; provide incidental benefits of flood damage reduction, reduced bank erosion and sedimentation, and improved surface water quality consistent with ecosystem restoration goals; and integrate desires of local stakeholders consistent with Federal policy and local planning efforts." [17]

At the local level, the County's 2004 Bond Election provides $14,000,000 in general obligation bonds for environmental preservation, recreation, and flood control along the northern portion of Paseo de las Iglesias along the Santa Cruz River and Old West Branch of the Santa Cruz River from Ajo Highway to 29th Street. The plans are to expand acquisition of existing habitat for preservation while developing a river park system to provide trails and recreation amenities along with environmental restoration.

Tres Rios del Norte Ecosystem Restoration

The Tres Rios del Norte study area is located along the Santa Cruz River from Prince Road to Sanders Road (19 miles). Currently, effluent discharge supports a stretch of riparian vegetation along the low flow channel, despite groundwater levels approximately 100-250 feet below surface. The existing in-stream flows create valuable riparian habitat for many wildlife species, particularly riparian and migratory bird species[18].

The planning objectives for Tres Rios del Norte are to restore the wetland and riparian vegetative communities and to increase the habitat diversity in the river corridor and along the riparian fringe and buffer.[19] The tentative alternative selected plan is to restore habitat along the Santa Cruz River and its floodplains. The restoration would improve mesquite, cottonwood-willow, and emergent wetland habitat to conditions more suitable to wildlife, while also providing aesthetic and recreation benefits. This plan includes in-channel effluent flows and piped delivery of almost 9,000 acre-feet of tertiary reclaimed water annually.

[17] USACE, Los Angeles District. 2005. Paseo de Las Iglesias Final Feasibility Report Los Angeles: USACE.
[18] SWCA, Inc., Environmental Consultants. 2000. *Draft Avian Surveys Along the Santa Cruz River at Five Locations.* Prepared for U.S. Bureau of Reclamation. Tucson, Arizona.
[19] USACE, 2006. Tres Rios del Norte Draft Environmental Impact Statement. Prepared by RECON Environmental Inc.

V. Effluent-Dominated Santa Cruz River near Tucson

History and Ecological Conditions

The Santa Cruz River streambed downstream of Tucson was historically ephemeral or intermittent, although archeological evidence indicates the presence of a shallow water table upstream of Avra Valley Road[20]. Well records, photographs and place names from the late 19th century and early 20th century suggest that at locations upstream of Avra Valley Road, the water table was close enough to the surface to support mesquite woodland with occasional cottonwoods. By the 1970s, effluent disposed in the riverbed from wastewater treatment facilities at Roger and Ina roads changed the nature of the river from ephemeral to perennial or intermittent stream conditions in the river reach downstream of the Roger and Ina roads treatment facilities outfall pipes. By 2003, effluent flows amounted to 57,000 acre-feet per year and extended downstream through La Osa Ranch in Pinal County.

Effluent disposal to the riverbed has not re-established a permanent floodplain aquifer within the rooting zone of riparian vegetation. Effluent recharge would cause a rise in the regional water table, except that continued extraction of groundwater along the river corridor keeps the water table 80 to 300 feet below the land surface. One consequence of the lack of connection to the aquifer is that the riparian corridor is narrow. When flows shift from one location to another, as can happen after floods or as a result of human activity, established riparian vegetation dies. Moreover, when large scouring flows occur, infiltration improves so dramatically that flows do not extend as far downstream, and the extent of flow may not recover for months[21].

Despite these conditions, the now effluent-dominated reach downstream of Tucson has the second largest areal extent of Sonoran cottonwood-willow in the County, exceeded only by Cienega Creek[22]. Structural diversity of riparian woodland on the Santa Cruz River below the treatment plants has increased since 1979, and by 1991, municipal effluent sustained approximately 300 acres of Goodding willow- or willow-tamarisk-dominated vegetation along the river[23]. More recent estimates are similar, indicating some stability despite erosion[24].

Open water, fields of riparian grassland and riparian scrub, and riparian woodlands adjacent to upland vegetation make this reach of the river an important stopover for many migrating birds, including wading birds, warblers, sparrows, waterfowl and raptors. Priority vulnerable species using the effluent-dominated reach for breeding include substantial numbers of Abert's towhee and Bell's vireo[25]. The Lower Santa Cruz River hosts resident burrowing owls and is an important component of Marana's HCP for burrowing owl, and potentially for the Tucson shovel-

[20] Arizona Stream Navigability Study for the Santa Cruz (Gila River Confluence to Headwaters) Final Report, SFC Engineering Company for the Arizona State Land Department.
[21] Galyean, K. 1996. Infiltration of Wastewater Effluent in the Santa Cruz River Channel, Pima County, Arizona. Water Resources Investigation Report 96-4021, U.S. Geological Survey, Tucson Arizona
[22] Postillion, Frank and Fonseca, Julia. 2004. Pima County Memorandum, Effluent and Water Needs for Riparian/Recharge Projects.
[23] Galyean, K. 1996.
[24] USACE, 2006. Tres Rios del Norte Draft Environmental Impact Statement. Prepared by RECON Environmental Inc.
[25] Pima County. 2000. Riparian Protection, Management and Restoration. Riparian Element of the Sonoran Desert Conservation Plan.

nosed snake. Occasional sightings of yellow-billed cuckoo have occurred, including 6 detections in July 2005 with the potential that 2 or more breeding pairs were occupying Gooding's willow habitat on the Santa Cruz River west of Marana. Southwestern willow flycatchers and other rare or uncommon migrant species have also been observed along this reach of the river[26].

Because of the ecological significance of the riparian vegetation along the effluent-dominated Santa Cruz River, the Science Technical Advisory Team (STAT) has urged protection of effluent flows in the Santa Cruz River (Appendix C).

Habitat Conservation Planning

The significance of the effluent-dominated Santa Cruz River to wildlife has been acknowledged in various efforts to achieve ESA compliance. The County and Marana are developing habitat conservation plans that include effluent-dominated reaches of the Santa Cruz River. Both the County and Marana's conservation goals within the Santa Cruz River corridor are 95% protection of existing habitat. Marana and the County are proposing to mitigate any unavoidable impacts of their activities through riparian restoration or acquisition of riparian habitat.

The wildlife connection through conserved riparian habitat along the Santa Cruz River near Avra Valley Road is a focus of both the County and Marana HCPs. This reach of the Santa Cruz River near Continental Ranch is part of a biological corridor[27] linking the Tortolita Mountains to the Tucson Mountains and providing water and supporting habitat for other species of birds, reptiles and mammals identified as covered species in the Marana Draft Habitat Conservation Plan.[28] This area is also part of a key linkage between the Tortolita and the Tucson recovery units for the cactus ferruginous pygmy owl (USFWS, draft recovery plan). The river here offers cottonwood, willow and mesquite to a species that relies on tree cover for movement.

River Management

The Santa Cruz River is a dynamic system that is impacted by natural events and man made changes. Floods serve to scour the channel increasing recharge, modify channel conditions through erosion, and remove vegetation. The volume and quality of effluent flows have a direct impact on the stream channel geometry, channel bed erosion and the riparian habitat. In the future the challenge will be to balance, within the natural system, effluent water discharges with needs for water supply, groundwater recharge, water quality regulations, flood control and the environment.

The Santa Cruz River channel is also a pathway for groundwater recharge of effluent and includes two managed underground storage facilities, the Tucson/Bureau of Reclamation Santa Cruz Management Recharge segment from Roger Road outfall to Ina Road (5.1 miles) and the Lower Santa Cruz Managed Recharge segment from Ina Road to Trico Road (17.91 miles). In

[26] Tucson Audubon Society's Rare Bird Alert for Southeast Arizona archives; NBHC AZ/NM Birds [BIRDWG05@LISTSERV.ARIZONA.EDU]

[27] http://www.corridordesign.org/arizona/ is the link to the Tucson-Tortolita linkage model.

[28] http://www.fws.gov/southwest/es/arizona/HCPs.htm#marana is the link to the Marana HCP.

2007, the combined total recharge volume was 29,755 acre-feet with total recharge credit of the 14,877.5 acre-feet (50% credit for managed recharge).

The infiltration and recharge rate of the river has the potential to vary significantly over time which makes it difficult to predict future recharge credits and estimate the downstream impacts from effluent flows. Channel infiltration rates vary over time with higher rates following large flood events and lower rates due to algal layers that form within the channel sediments. The 1983 flood was an extreme event which forever altered the river channel downstream of the confluence with the Rillito River and Canada del Oro Wash. Infiltration rate of effluent after the 1983 flood was 100% with no to little flow downstream of Ina Road. Similarly, after the 1993 flood, the infiltration rate increased to 6.7 acre-feet/mile/day[29]. For the Tres Rios del Norte Feasibility Study, the USACE used 4.0 acre-feet/mi/day as an average infiltration rate[30]. The 2003 Aspen Fire, and resulting ash in flood waters, clogged the river bed resulting in an infiltration rate of only 0.64 acre-feet/mile/day. Several investigators have also evaluated riverbed recharge of effluent and have estimated the range of recharge rates from 2.4 acre-feet/mile/day to 6.0 acre-feet/mile/day, with larger rates occurring shortly after large flood flows[31].

Based on an average recharge rate of 4 acre-feet/mile/day, a total discharge of approximately 40,000 acre-feet per year is needed to maintain the existing riparian habitat to the County line in its current form and function. Because the existing habitat is estimated to transpire slightly less than 2,000 acre-feet of that water, there may be opportunities to develop additional or supplemental riparian habitat along the river with water supplies such as using recovery wells to utilize effluent recharge credits dedicated to environmental restoration, even as the total amount of water in the Santa Cruz River channel declines.

Consequences of Effluent Reduction/Removal from the Lower Santa Cruz River

Valuable riparian and aquatic habitats have developed as a result of treated effluent flowing in the channel downstream of the metropolitan wastewater treatment plants. These habitats have proved to be resilient to drought, mechanical alteration and flood flows, but many of the habitat features largely depend on continuous or near-continuous effluent flows. Reductions in effluent discharge would cause reduced areal extent of the aquatic and native willow forestland and aquatic habitats. Without effluent, wetland plants, moist soil habitats, ponded water and riparian vegetation along the entire length would likely be replaced by a less diverse desert shrub type plant community.

An example of the habitat stress caused by removing surface flow is occurring just upstream of Avra Valley Road Bridge (Figure 5.1). Effluent flows have been diverted by natural channel movement depriving riparian vegetation on the old channels of perennial flow. Riparian trees and shrubs will re-grow along the new channel where effluent still flows. Minor modifications could be made in the river bottom to spread effluent into these former channels while maintaining flow in the new channel, increasing recharge rates and habitat volume.

[29] Galyean, 1996.
[30] USACE, 2006
[31] Galyean, 1996.

May 2006 May 2008

Figure 5.1: Example of riparian vegetation stress when surface flow is unavailable. Aerial photographs show a location south (upstream) of Avra Valley Road Bridge on the Santa Cruz River.

Opportunities for Water Balancing

The County's Regional Optimization Master Plan (ROMP)[32] has identified plans to build a new 32 million-gallon per day (mgd) treatment plant at Roger Road, upgrade the Ina Road Facility to 50 mgd, and build an inter-connect between the two facilities. Effluent water quality will be upgraded substantially by year 2015, enhancing the diversity and productivity of aquatic life in the river.

In 2007, the Roger Road Plant discharged an average of 21.8 mgd. ROMP will reduce effluent discharges at the Roger Road Plant by sending flows to the Ina Road Facility. The Interconnect Agreement, between Tucson Water, the County and the Regional Flood Control District (District), specifies that the Roger Road facility will have a capacity of 32 mgd (35,800 acre-feet/yr) and the County will make all reasonable efforts to maintain a minimum of 25 mgd (28,000 acre-feet/yr) of effluent available to the City at their Water Reclamation Campus. The City can take a maximum effluent volume of 25 mgd on any given day. At full capacity, the facility will produce enough effluent to discharge annually 7,000 acre-feet of effluent into the river that will be used towards managed recharge credits and to maintain riparian vegetation between Roger Road to Ina Road. Discharges from the Ina Road Facility could increase or decrease, depending on the actions of effluent owners.

Action by regional stakeholders will be needed to maintain the Lower Santa Cruz River's ecosystem function and structure, maintain floodplain functions, and preserve native vegetation. Natural or "managed" recharge of effluent that is left in the channel has historically been a low-cost mechanism for recharging the aquifer and a mechanism for maintaining ecosystem functions. This process generates effluent storage credits that can be used to recover water

[32] Greenley and Hanson, 2007, Pima County's Regional Optimization Master Plan Final Report

elsewhere. Recovery of storage credits allows water providers to conduct additional pumping and still comply with state water management goals.

Under existing state rules, a managed recharge facility can generate only 50% credit for the effluent volume recharging the river. This creates an incentive to remove effluent from in-channel flow and divert it to off-channel basins in order to generate 100% effluent storage credit. Lobbying the state legislature to allow 100% credit for the Secretary of the Interior's 28,200 acre-feet of effluent in exchange for keeping this water in the river could further several causes: the Tucson region supporting the federal government in meeting its obligations to the Tohono O'odham Nation, and providing guaranteed flows of effluent in the Lower Santa Cruz River to maintain the habitat.

Another opportunity to protect habitat and in-stream flow is to allocate effluent from the CEP. A CEP allocation to the river could be made in the context of an HCP, a Section 7 consultation, or a project conducted by a contributor to the CEP. Procedures for allocation of CEP must be finalized in an Intergovernmental Agreement (IGA) between the County and City before any allocations will be implemented.

Individual effluent owners could voluntarily allocate effluent to the river, but there are no incentives to do so except in the context of recharge. Various water entities have discussed the potential for enhancing infiltration rates in the riverbed by spreading the water, but many challenges remain to accomplishing this.

What the Future May Hold?

The value of the Santa Cruz River habitat for wildlife and particularly for ESA compliance presents a challenge for the region because no allocation of effluent has been made to maintain in-stream flow. Effluent in the river is owned by a variety of entities, but principally by the Secretary of the Interior, and the City. The Secretary of the Interior is required to use the effluent indirectly to "firm" the Tohono O'odham Nation's access to CAP water during times of shortage. The City maintains the option to withdraw its share of effluent from the river channel. Effluent currently being discharged into the river includes portions the CEP, the City's and County's allocations, and the Secretary's allocation. Future effluent estimates for the metropolitan treatment plants for 2030 is 95,287 acre-ft/yr, see Section VI.

As effluent becomes more valuable and finds more uses, water providers/effluent owners may directly use more of the reclaimed water and less effluent will be discharged into the river, although in-stream aquifer managed recharge may continue. Many different future discharge scenarios are plausible, ranging from the elimination of all discharges to increasing discharges over time as the County's population grows.

Projecting to 2030, Tucson Water's and Oro Valley's effluent entitlements, of 43,813 acre-feet/yr and 3,152 acre-feet/yr respectively, are planned to be fully utilized through their reclaimed water system. The remaining volume of effluent, 48,321 acre-feet, would potentially be discharged into the river. Reductions could also occur via off-river uses of the Secretary of the Interior's share of effluent; potential off-river uses could include constructed recharge in the area between Avra Valley Road to Sanders Road, or as direct agricultural use on farmlands within Avra Valley.

As discussed further in section VI, the City and the County agreed to create a Conservation Effluent Pool (CEP) consisting of up to 10,000 acre-feet of effluent per year for use in riparian restoration. The CEP would be derived from the Roger, Ina and Randolph treatment facilities; uses related to ESA compliance have preference. Based on average infiltration rates, it is likely the CEP allocation of up to 10,000 acre-feet is insufficient in and of itself to maintain in-stream flows and riparian habitat that has developed incidentally as a consequence of the existing flow regime, if that becomes the established use for the CEP. Unless the CEP allocation was augmented with other in-stream sources it is unclear how the CEP could be applied to sustain the existing acreage of riparian habitat along the river corridor.

Planning Ahead

Since there are no immediate plans by the Secretary of the Interior or other effluent owners to remove effluent from the river, effluent could continue to flow for some time into the future. This provides the opportunity to plan for future conditions and evaluate strategies and alternatives to maintain habitat while minimizing water demand. Potential options to maintain and enhance the vegetation and biological connectivity could include:

- Restoration using rainwater and stormwater harvesting from tributary flows, estimated volume of water is 3,999 acre-feet/yr along the river and tributaries from Prince to Sanders Road[33];
- Multi-benefit projects for constructed recharge and riparian habitat mitigation, including permitting for effluent recharge at the Lower Santa Cruz Replenishment Project;
- Using recovery wells to recover effluent recharge credits to create expanded pockets of high quality habitat to replace narrow linear effluent flow channels; and
- Develop partnerships and obtain grant funding for multi-purpose projects through the Arizona Water Protection Fund, Bureau of Reclamation, Tucson Audubon Society, Arizona Game and Fish Departments, and others.

VI. Regional Assessment of Water Availability for the Environment

Multiple water sources may be available for environmental uses. These water courses, and corresponding legal issues and constraints are discussed below.

Potential Water Sources to Meet Environmental Needs

The regional water resources potentially available in the County to meet environmental needs include rainwater, stormwater, groundwater, and effluent. Wastewater effluent and reclaimed water is a significant portion of the region's potentially available water resources. Regionally there are competing uses for available water for potable use, re-use (reclaimed water), recharge of the aquifer for future use, environmental restoration projects, and ecosystem support.

[33] USACE, 2006.

Rainwater and Stormwater

Rainwater and stormwater (stream flow) harvesting are a part of virtually every riparian restoration project now under consideration. Land grading and contouring, basin construction, creating meandering drainageways, using porous underlying materials, and other techniques can aid in collection and storage rainwater and stormwater.
Existing stormwater detention basins offer excellent cost-effective opportunities for providing wildlife habitat in urban areas. The high volume of runoff from urban areas can support even hydro-mesoriparian vegetation. The County's Countryside, Massingale and Rita Ranch basins have tall, mature mesquites and cottonwood trees, supported solely on stormwater without a connection to the water table. Countryside and Massingale are located in pygmy-owl habitat, as well, and suggest that ecologically-friendly detention basins may contribute directly to the objectives of the SDCP.

At the Swan Wetlands Ecosystem Restoration Project, ground contouring and soil modification were used to capture and store rainwater to create artificial cienega-like conditions. Local drainage channels were redesigned to meander and spread stormwater flow to enhance infiltration and the storage of stormwater. The KERP was developed from an existing flood control structure expanded into a multi-purpose facility. The facility was designed to collect and distribute surface and reclaimed water for the purpose of irrigating public ball fields and park areas containing wildlife and riparian habitat. The surface water used at KERP is stormwater trapped during normal rainfall events then distributed throughout the KERP facility. Since the stormwater collected at KERP is appropriable surface water, the District filed for a surface water right for the stormwater it collects and uses at the KERP facility.

Groundwater

Due to the need to conserve potable water, the use of groundwater for environmental restoration projects is limited. Non-potable groundwater pumped along the Santa Cruz River is being used by the County to water the Cortaro Mesquite Bosque.

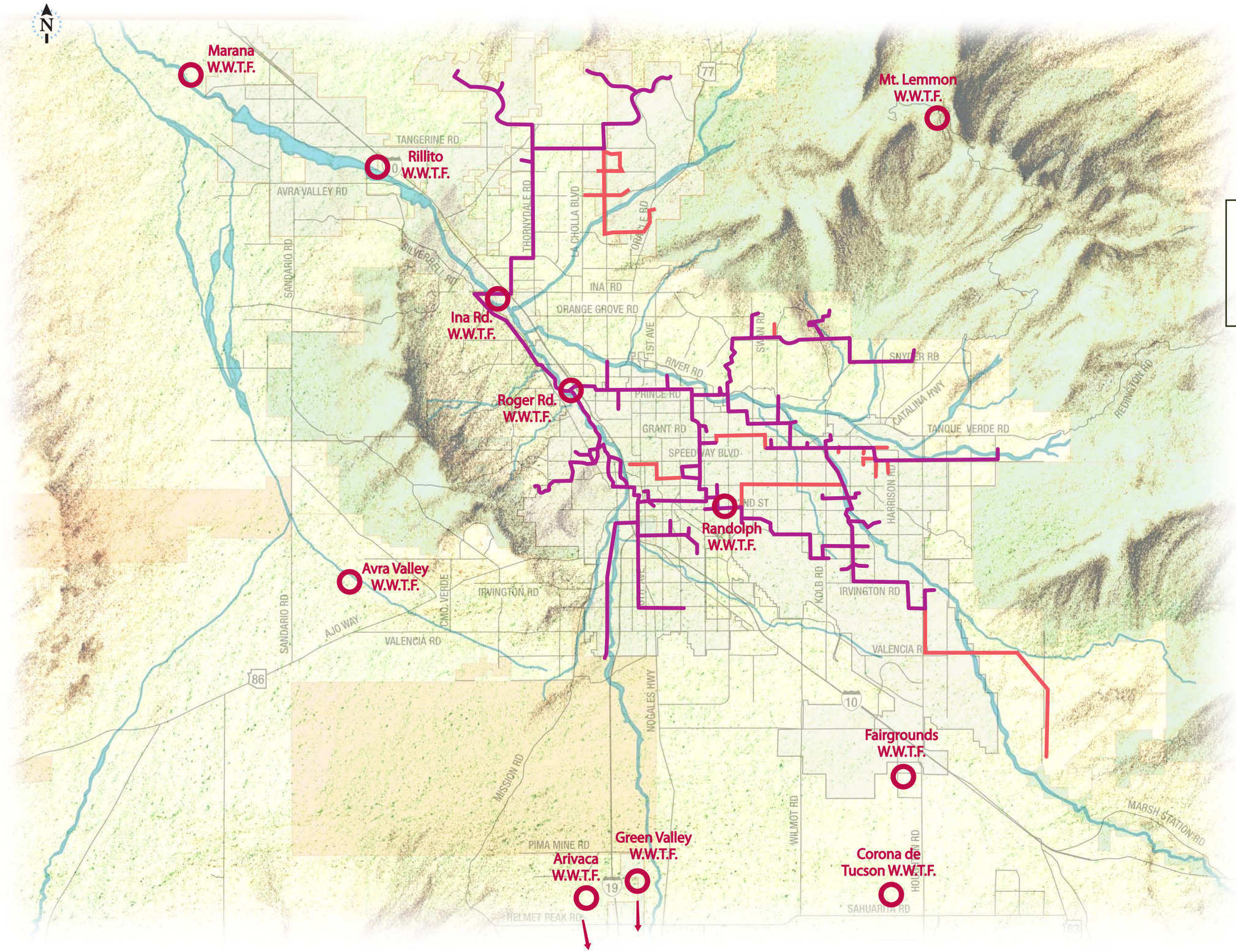
In areas with shallow groundwater, the technique of using short-term irrigation with groundwater to establish vegetation until the root system can directly reach the water table has been used for Bingham Cienega in the San Pedro Valley and the Pantano Jungle restoration along Cienega Creek. Through floodprone land and open space acquisitions, the County acquires exempt wells and groundwater rights that can be used for this type of onsite environmental restoration and enhancement on the lands the County has acquired.

Wastewater Effluent and Reclaimed Water

Municipal effluent is a renewable water supply that grows steadily along with the population generally increasing in volume as potable demand increases. This renewable water is treated and used to replenish the aquifer in constructed or managed recharge projects, discharged to the riverbed where it incidentally sustains riparian habitat, or recycled for irrigation purposes as "reclaimed water" through Tucson Water's reclaimed water system (see Figure 6.1). Reclaimed water provides a sustainable alternative to pumping groundwater for non-potable uses including irrigation of turf, landscaping, and restoration areas.

Tucson Water operates a regional reclaimed facility to produce reclaimed water from secondary effluent. Reclaimed water is delivered through filtration at the Tucson Sweetwater Reclaimed

Wastewater Treatment Facilities and Reclaimed Lines



Wastewater Treatment Facility

Existing reclaimed pipeline

Proposed reclaimed pipeline

Figure 6.1

Water Treatment Plant and at the County's Randolph Park Water Reclamation Facility, and through recovery of water from effluent recharged at the City's Sweetwater recharge basins. Metropolitan and the sub-regional wastewater reclamation facilities currently generate 72,572 acre-feet of effluent each year, 94% from regional facilities, and 6% by eight sub-regional facilities (Tables 6.1 and 6.2).

Table 6.1: Metropolitan Wastewater Facilitates, Effluent Generated 2007[34]

Facility	Effluent (acre-feet/yr)	Discharge Modes
Ina Road	27,864	Surface Water Release (some onsite Reuse)
Roger Road	37,751	Surface Water Release (some onsite Reuse) 13,268 acre-feet Delivered to Tucson Water Reclaimed System
Randolph Park	2,610	Re-use – 2610 acre-feet Delivered to Tucson Water Reclaimed System
Total	**68,225**	

Table 6.2: Sub-Regional Reclamation Facilities, Effluent Generated 2007

Facility	Demand (acre-feet/yr)	Discharge Modes
Green Valley WRF	2,386	Percolation, Delivery to Re-use
Avra Valley WRF	1,558	Percolation, Re-use onsite, Discharge
Marana WRF	213	Surface Water Discharge & Re-use onsite
Corona de Tucson WRF	145	Percolation, Evaporation
Arivaca Junction WRF	42	Percolation, Evaporation, Delivery to Re-use
Mt. Lemmon WRF	3	Spray Field, Percolation
Rillito Vista WRF	-	Percolation, Evaporation
Fairgrounds WRF	-	Percolation, Evaporation
Total	**4,347**	

In addition to the CEP, the Board of Supervisors has directed that the highest and best use for the County's effluent is for the natural environment (Resolution, Appendix D). Recharge and aquifer replenishment with effluent can potentially be accomplished through projects that also meet the water needs of the environment. Multi-purpose projects provide the environment with necessary water and provide recreational and educational opportunities for the community.

Opportunities to maximize the use of reclaimed water were explored in a previous reclaimed water technical paper which included the following recommendations:[35]

[34] City of Tucson and Pima County. Riparian Protection Technical Paper, Water and Wastewater Infrastructure, Supply and Planning Study, Phase I, May 2009.

[35] City of Tucson and Pima County. Water and Wastewater Infrastructure, Supply and Planning Study, Phase II, Reclaimed Water Technical Paper, April 2009.

1. Prioritize reclaimed customers.
2. Overcome financial barriers to expansion of the reclaimed system.
3. Overcome regulatory barriers through policy and rule changes.
4. Pursue multiple-benefit public projects.
5. Consider use of reclaimed water with the broader context of sustainability.

Conserve to Enhance Conservation Program

Supplemental funding may become available in the future to support environmental restoration through the Tucson Environmental Water Banking Program. This program seeks to implement an innovative water conservation mechanism known as "Conserve to Enhance," as recently proposed by the University of Arizona's Water Resources Research Center.[36] Conserve to Enhance stipulates that individuals who are motivated to conserve water for environmental purposes could implement onsite water conservation measures and dedicate the cost savings of their reduced water use to local conservation projects. The Tucson Environmental Water Banking Program is a pilot program building on the Conserve to Enhance idea and will provide a direct link between water conserved at a particular home or business and on-the-ground restoration at a local Santa Cruz River site. The long-term goal is to scale up the reach of the project to generate sufficient funds to purchase and transport water or treated effluent to riparian protection and restoration efforts in the basin.

Legal Issues and Water Rights

Surface Water Rights

As discussed in the Phase II Stormwater Management White Paper, the State of Arizona uses a bifurcated system for allocating water rights, differentiating groundwater from surface water. The state's regulations regarding surface waters rights and the use of water resources are contained in Title 45 of the Arizona Revised Statutes. In Arizona, surface water is defined as:

> *"… the waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwater, wastewater or surplus water, and of lakes, ponds and springs on the surface." A.R.S § 45-101(9)*

Arizona governs the use of surface water in accordance with the prior appropriation doctrine, which dictates that surface water rights are allocated using a first in time, first in right methodology. This means that a water user who first applied "X" amount of stream flow to a beneficial use has priority to that amount of surface water from the stream over any later water user. This prioritization of use is critical during periods of drought or when a particular surface water source is over allocated.

Even though, for all practical purposes, the surface water in the Santa Cruz River has been appropriated by existing claims, it is still possible to file an application to appropriate surface water from the Santa Cruz River if a user can show a diversion and beneficial use. Any new diversion will have a "junior" priority attached to that water. Surface water rights can also be obtained through real property acquisitions so long as the property title includes the water right as part of the deed.

[36] Schwarz and Megdal, 2007; Schwarz and Megdal, 2008; Megdal *et al.*, 2009

Under the Arizona variant of prior appropriation law, stormwater is not subject to appropriation if it is comprised of short-lived flows that are "spread over the ground and not concentrated or confined" in those bodies of water found in A.R.S. § 45-101(9).[37] Thus, in Arizona, it is legal to harvest rainwater before it reaches a "natural channel," where it becomes subject to appropriation. Keep in mind that the construction and use of a stormwater detention basin does not, in and of itself, require a surface water right. Rather, the act of putting the contained stormwater to beneficial use triggers the need for a surface water right.

Subject to constraints from the prior appropriation doctrine described above and the water quality permitting requirements described below, stormwater harvesting has the potential to provide an additional water source for recharge, irrigation, riparian and wildlife preservation, and recreational purposes.

Groundwater

A previous Phase II white paper entitled, "Riparian Protection" [38] discussed shallow groundwater areas and use of that water to sustain riparian habitat. Relatively small differences in shallow groundwater elevations can be of great significance ecologically, particularly in the first several feet below land surface. It is crucial to realize that maintaining hydroriparian vegetation is dependant upon preserving the near-surface water in these areas.

Well water sometimes has high nitrates or elevated total dissolved solids, typically in agricultural and former agricultural areas. Use of groundwater at former agricultural fields as a temporary irrigation source for restoration projects is sometimes the best solution, particularly if the water is from poor quality non-potable or irrigation wells and effluent or reclaimed water is not available.

Effluent Agreements and Ownership

Multiple legal instruments define the ownership and delivery of effluent within the region, including; the 1979 City/County IGA; the 2000 Supplemental IGA; the Southern Arizona Water Rights Settlement Act (SAWRSA), the CEP Agreement; the City/County Wheeling Agreement; and multiple agreements between the City and other water providers in the region.

Effluent Agreements and Allocation

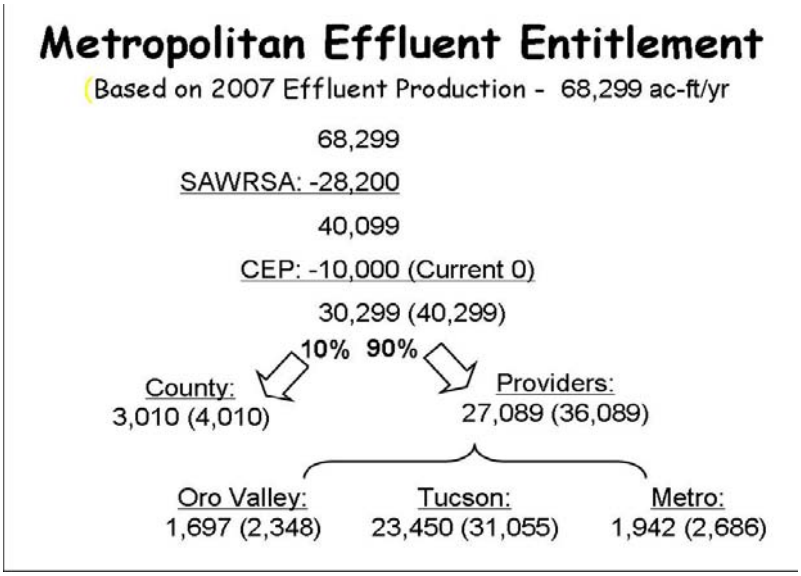
1979 IGA and 2000 Supplemental - Effluent is allocated among various entities based on local IGAs and SAWRSA. The 1979 IGA transferring the City sewer system to the County allocates 90% of the effluent generated from Metropolitan Wastewater Treatment Facilities to the City and 10% to the County. Tucson Water has entered into additional agreements with other water providers to grant them control of the effluent generated by providing potable water within their service areas. Tucson has existing agreements with Metro Water and the Town of Oro Valley

[37] *Espil Sheep Co. v. Black Bill & Doney Parks Water Users Ass'n,* 16 Ariz. App. 201, 492 P.2d 450 (1972) (citing *Doney v. Beatty, 124 Mont. 41, 200 P.2d 77(Mont. 1950)*).

[38] City of Tucson and Pima County Riparian Protection Technical Paper, Water and Wastewater Infrastructure, Supply and Planning Study, Phase II, May 2009

and pending agreements with Flowing Wells and Spanish Trail. These water providers also contribute a proportional share of CEP and SAWRSA obligations.
The 1979 IGA also provided for the City to use all or part of the effluent from County sewer treatment plants to settle or satisfy litigation with the Tohono O'odham Nation. In 1982, SAWRSA resolved litigation on behalf of all water users within the Tucson Active Management Area, in part, by delegating 28,200 acre-feet of the region's annual effluent supply to the Secretary of the Interior to use in meeting the Secretary's obligations under the settlement.

Under the 1979 IGA and 2000 Supplemental, effluent is allocated as shown below:



Conservation Effluent Pool - The 2000 City/County Supplemental IGA stipulates that up to 10,000 acre-feet of effluent known as the CEP shall be made available for riparian projects that are a part of a habitat conservation plan or that are mutually agreed upon by the City and County. Similar to the SAWRSA volume, the CEP is effluent, which is deducted from the effluent total prior to calculating the share for the County and the municipal providers. Currently, none of the CEP has been dedicated for a designated environmental project. A CEP agreement to establish a decision-making process for developing projects is being prepared for the City and County governing bodies for approval.

Under the terms of the 2000 Supplemental Agreement, CEP effluent is available at the wastewater facility to project operators at no charge; should CEP allocations be delivered through the reclaimed system, the CEP and reclaimed water are available at a rate that is about half the standard retail rate for reclaimed water.[39] This CEP rate includes the actual cost of treatment at the City's reclaimed water plant as well as the cost to wheel the water through the City's reclaimed water distribution system. Each of the entities holding an effluent entitlement (except the Secretary of Interior) contributes proportionately to the CEP (Table 6.3). So, about 70% of the CEP is derived from the City's effluent allocation. These volumes do not accrue annually. The CEP is not the only legally allocated effluent currently available for the environment in Tucson; effluent from outlying facilities could also potentially be used for

[39] City of Tucson and Pima County. Water and Wastewater Infrastructure, Supply and Planning Study, Phase I, May 2009.

environmental restoration projects. The Board of Supervisors has directed that the highest and best use for the County's share of effluent is for the natural environment (see Appendix D).
Wheeling Agreement – Under the Wheeling Agreement approved in 2003, the County gets access to the existing Tucson Water Reclaimed Distribution System pipelines to delivery County reclaimed water produced at the Randolph Park WRF. The County pays for Tucson Water's pipeline distribution operation and maintenance (O&M) costs, but does not pay for the pipeline capital repayment, treatment capital repayment or treatment O&M. The current wheeling rate is $96 per acre-foot, compared to the standard reclaimed rate of $697/acre-foot. The County is responsible for the costs of extending the reclaimed lines if existing lines do not extend to the proposed site. The County delivers its reclaimed water through the City reclaimed distribution system to numerous county facilities including KERP, Swan Wetlands Ecosystem Restoration Project, and the Old West Branch Preserve.

Projected Effluent Allocations

As summarized in Chapter 2 of the Phase I report, potential changes to future effluent availability could occur. Tucson Water has entitlement to a large volume of municipal effluent and may be able to develop agreements to lease or purchase the Secretary of the Interior's effluent entitlement as well as those of others in the future.

Updated projections of wastewater generation were described in the Phase II Reclaimed Technical White Paper. These projections indicate that effluent produced at the metropolitan wastewater treatment plants in 2030 could reach 95,286 acre-feet per year. Of this, Tucson Water projects it would have an annual entitlement of approximately 43,000 acre-feet. Projected 2030 effluent entitlements for metropolitan effluent are shown in Table 6.3. Table 6.4 provides effluent volumes for the outlying treatment facilities.

Table 6.3: Effluent Entitlements 2007 and 2030[40]

	2007 Effluent Entitlements (acre-feet)	Effluent (percentage)	2030 Effluent Entitlements (acre-feet)	Effluent (percentage)
Tucson Water	31,055	46	43,813	46
Pima County	4,010	6	5,709	6
Town of Oro Valley	2,348	3	3,152	3
Secretary of Interior	28,200	41	28,200	30
Metro Water	2,686	4	4,413	5
Conservation Effluent Pool	0	0	10,000	10
Total	**68,299**	**100**	**95,287**	**100**

[40] City of Tucson and Pima County. Water and Wastewater Infrastructure, Supply and Planning Study, Phase II, Reclaimed Water Technical Paper, April 2009.

Table 6.4: Projected 2030 Sub-Regional Effluent Volumes

Sub-Regional Treatment Facilities	2030 Effluent Production (acre-feet)
Avra Valley	2,633
Corona de Tucson	2,946
Fairgrounds (to be connected to SEI)	0
Green Valley (includes Arivaca)	4,033
Marana	4,973
Mt Lemmon	3
Rillito Vista	14
Southlands	14,775
Sub-Regional Total	**29,377**

The County's policies identify goals for increased use of effluent for environmental restoration and protection of certain sensitive groundwater dependent ecosystems such as the Cienega Creek. Effluent's role in augmenting water supplies, mitigating drought impacts and preserving environmental amenities is expected to increase significantly in the future. The County's role in managing the regional wastewater system and the City's role in treating and delivering reclaimed water is the key to a coordinated, countywide approach to effluent reuse including use for the environment.

VII. Discussion

Water Resource Perspective

Water is one of, if not the most, complicated issues in Arizona. Water rights and ownership are a tangled web of water laws, competing interests and regulatory issues. Simply put, no long-term solution to any water issue, including providing water for the environment, can stand the test of time without the input of all the relevant stakeholders. The concept of limited local water supply may not be new, but in the last decade or so has the need to plan for new supplies begun to emerge along with the recognition that there is regional a finite supply of water from the Colorado River in the west and within Arizona.

To date, the cost of water has been largely determined by the cost of the infrastructure, operations, maintenance, power, and administration needed to deliver the water. There was no commodity cost associated with the water. With new sources there may be commodity costs, and the cost of gaining physical access to the water may be so high that the new acquisitions may force water providers and users to reevaluate the old ways of looking at costs and the economics of water use. With finite supplies the price of water could get "bid up" very high. In the future the cost of the water, and the agreements needed to obtain it, will affect all water uses. As the cost of the supplying water rises and demand exceeds supply, users and providers will have to look at our water budget and examine potential cuts, re-allocations, and efficiencies. Priorities will change and low-priority uses will suffer. Providing water for the

environment will be much more likely to survive if there is a commitment to this from all the stakeholders regionally as well as within the larger water community of Arizona.

Environmental Resources Perspective

Groundwater pumping, floodplain development, habitat loss due to erosion and other human impacts have significantly altered the environmental function of watercourses in the County. Mechanisms to relieve stress on aquifers and protect ecosystem, including land acquisition and conservation easements to prevent development and preserve habitat, regulation and land-use planning to protect watersheds, and restoring aquifers that once supported flowing stream, will require a stakeholder agreement. A thorough stakeholder process for allocating water to the environment will be needed to ensure permanent solutions to secure water.

The STAT for the SDCP adopted ecosystem function goals for the riparian element of the SDCP that cover all unincorporated Pima County. These take a holistic approach to preserving and restoring the region's riparian and aquatic resources. STAT prioritized the protection of self-sustaining riparian and aquatic ecosystems over the creation of new or enhanced areas:[41]

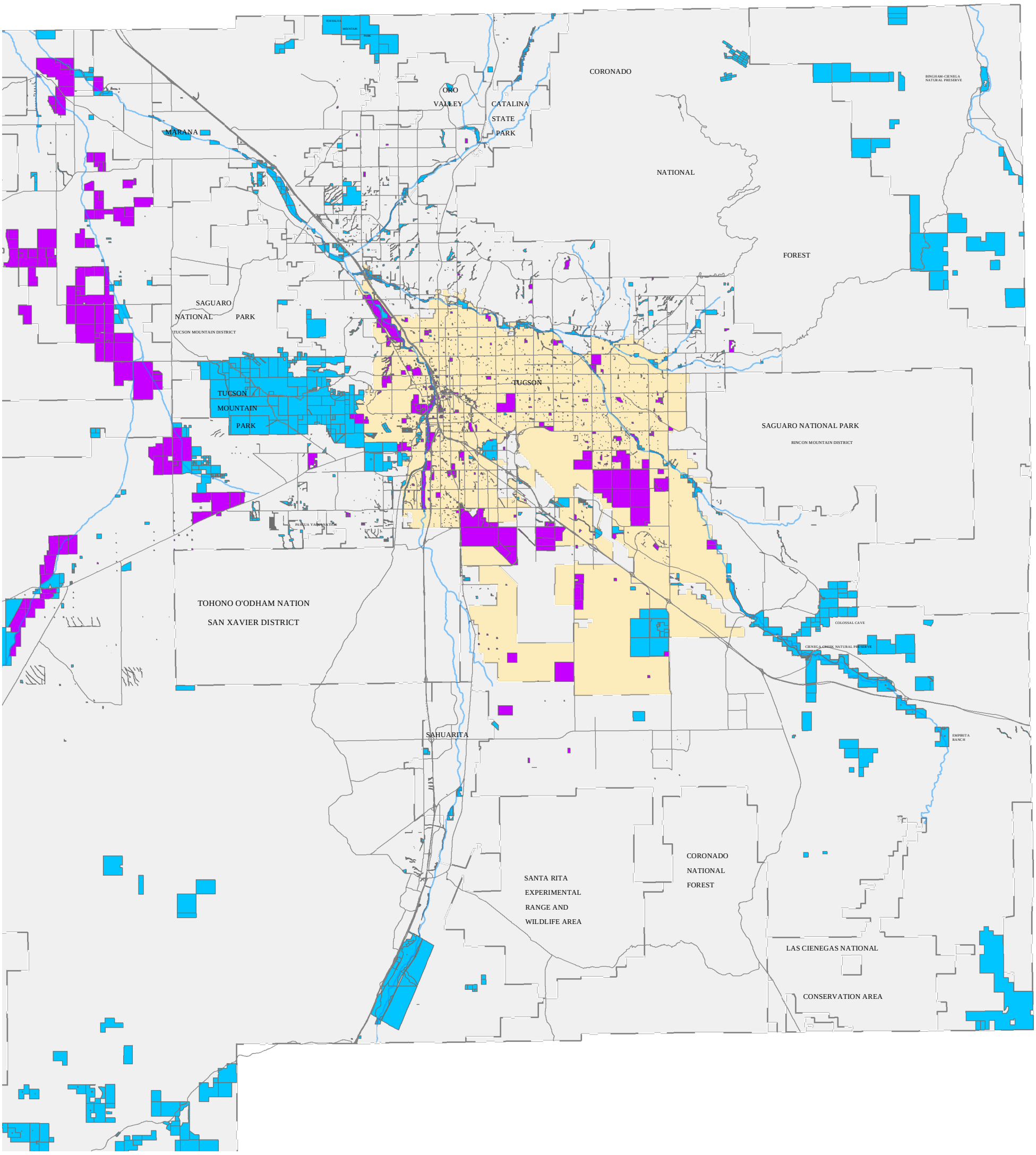
- Protect functioning riparian systems that are self-sustaining over those that need continual inputs;
- If plantings are to be used, then re-vegetation is favored in areas where perpetual irrigation will not be needed; and
- Focus re-vegetation efforts on self-sustaining habitat for wildlife use and augmenting existing habitat.

STAT also have adopted guidelines for regional use of effluent and reclaimed water for environmental benefits. Of particular concern to STAT is maintaining habitat in the effluent dominated Santa Cruz River by maintaining some effluent flow, a difficult issue given the future water needs for the community and the value of effluent to its owners.

There is strong community support for habitat or ecosystem restoration in the County. Public input on proposed City and County habitat projects indicated community support for establishing and maintaining native vegetation, incorporating water harvesting, and slowing stormwater flow in river channels to allow greater recharge, and vegetation establishment to support native and migratory wildlife.

There are major opportunities for restoration projects in the County. These projects are most feasible where land is available; where renewable water is available as either stream flow, rainwater, or reclaimed water;; and where hydrogeologic conditions are favorable. The City and County have a significant inventory of land that may be suitable for environmental restoration and enhancement (see Figure 7.1). These lands can be evaluated for suitability for restoration as upland and riparian habitat. Acquisition of lands with shallow groundwater, springs and intermittent or perennial springs is one of the priorities of the County's Open Space Bond Program. By controlling groundwater pumping or removing surface water diversions, flow could be restored to many of the region's springs and streams with previous intermittent or perennial flow.

[41] Shaw, William, Chairman, Science Technical Advisory Team, February 21, 2006 memorandum to C.H. Huckelberry

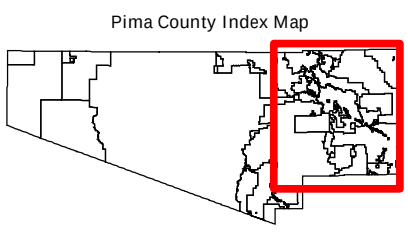


Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

Scale 1:340,000

Pima County Index Map



Index Map Scale 1:5,250,000

- City Of Tucson (67,209 acres)
- Pima County (95,892 acres)
  *Incuding FCD Deeded Parcels
- Major Streets
- Jurisdiction Lines
- Major Washes

City & County Owned Parcels

8/24/2009

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Figure 7.1

Environmental Projects and Oportunities

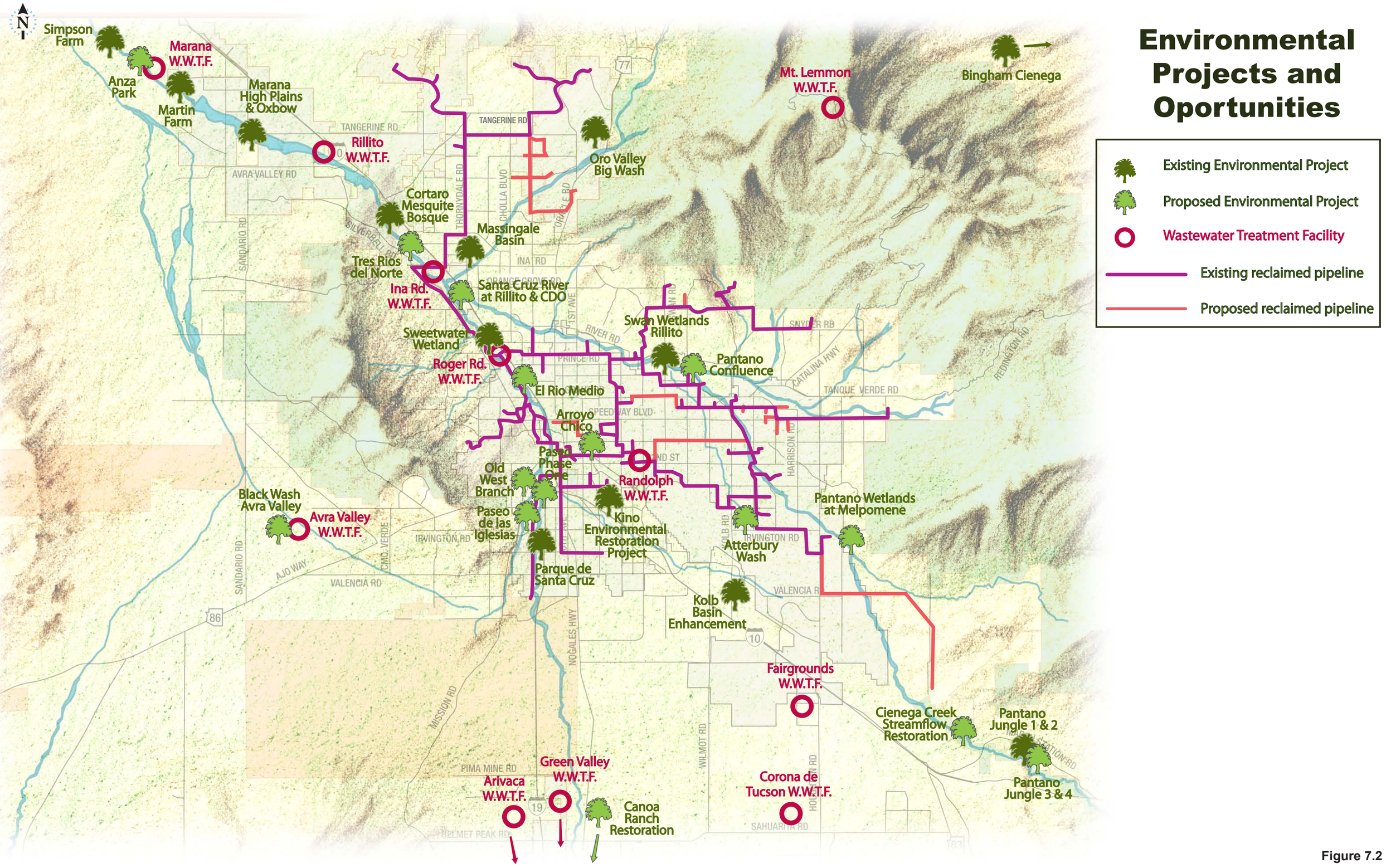


Figure 7.2

Effluent generated by the outlying wastewater treatment facilities also provides opportunities to preserve and restore riparian habitat. While the outlying facilities do not currently have a reclaimed water distribution system, the County owns adjacent land to all the outlying facilities that could be used for restoration (see Figure 7.2).

Assessing and Evaluating Environmental Restoration

Providing water for environmental restoration entails addressing a number of considerations including water availability, water ownership, water quality considerations, type of habitat to be restored, the level of restoration desired, opportunity versus need, and cost.

Evaluating Environmental Gain – The Best Buy

The most critical issue in accomplishing environmental restoration in the desert is water availability. In order to balance the water needs for individual restoration projects with the ability to commit appropriate water supplies, it is important to match each project with the least expensive water supply of suitable quality that is physically available for use at the restoration site. Cost, competing demands, variations in quality, and complexity of capture or delivery variously affect the primary water resources in the City/County area: groundwater, CEP, reclaimed water, secondary effluent, stormwater and harvested rainwater.

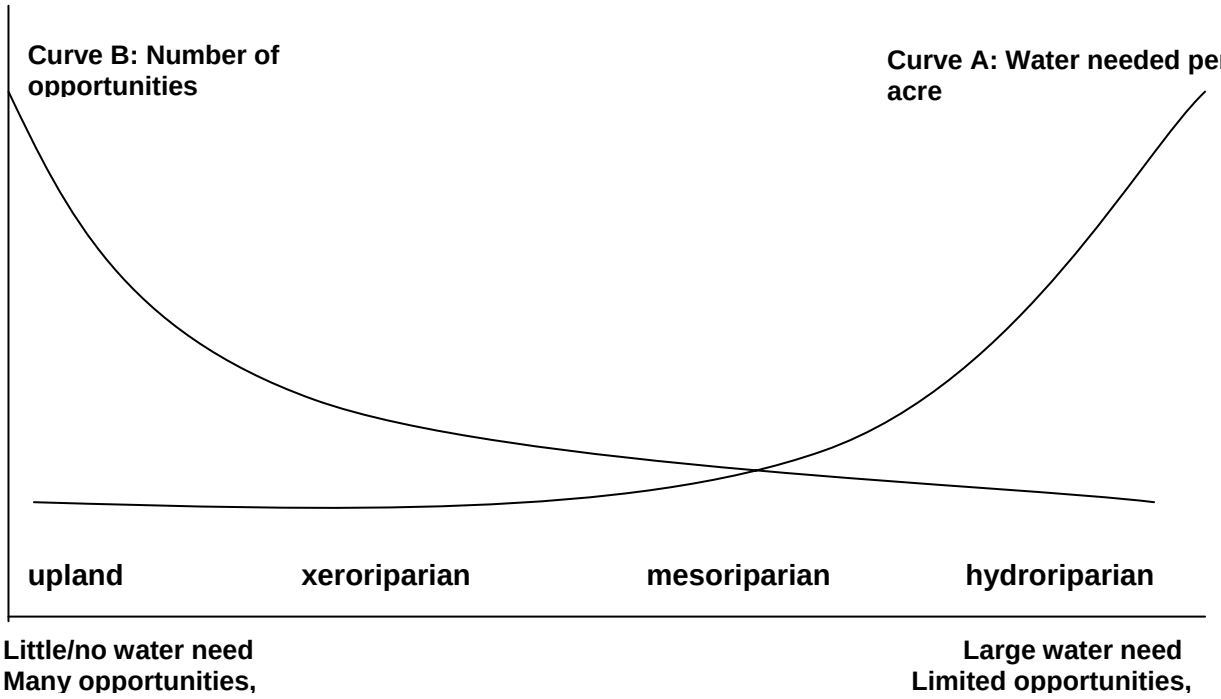
While it is not possible to return all riparian habitats to pre-20th century conditions, due to irreversible patterns of development, water level decline, and cost; it is, therefore, necessary to identify the locations, habitat types, and aerial extent of restoration that is both possible and feasible in the short term. Such an assessment should include both determination of what is driving the need for the environmental project and an emphasis on taking advantage of opportunities. The following diagram presents a schematic framework for evaluating riparian restoration priorities in a comprehensive and efficient manner. It takes into account both determination of needs and assessment of opportunities. By taking such an approach we maximize the potential for obtaining the most environmental gain for the least cost of developing those dedicated water supplies that are available for restoration.

As shown in Figure 7.3 schematic diagram, restoration projects occur along a continuum from those that require little or no supplemental developed water (such projects are supported by natural rainfall, ephemeral stream flow, stormwater use, or water harvesting, with some irrigation for plant establishment) to hydroriparian restoration projects that depend on a permanent year-round or seasonal commitment of water. This is illustrated by the horizontal line on the diagram. This line also represents a continuum relating to project drivers (see Section III) with the most xeroriparian projects often developed in response to opportunity and the more water-intensive projects driven more by regulatory need.

Curve A represents the relative amount of water that would be needed per acre of restoration area (hydroriparian habitat needs much more water per acre then upland habitat) and Curve B indicates the relative number of potential restoration sites and therefore restoration opportunities (hydroriparian habitat is quite rare in this area and difficult to create, while Xeroriparian and upland habitats are more abundant and easier to create). The “opportunity” curve qualitatively corresponds to the relative proportion of xero, meso, and hydroriparian types historically present in this region. The “water per acre” curve roughly corresponds to the number of water sources that might be available for supporting various types/level of restoration. Since rainwater and storm runoff are readily available, there are more opportunities for xeroriparian and upland

projects, where hydroriparian projects would need supplemental irrigation water and there are fewer opportunities based on available potable and reclaimed water infrastructure or groundwater rights. Levels of restoration range from small-scale water harvesting projects that would not need supplemental water (including systems owned and operated by the land owner); to regulatory-driven projects for which even pumped groundwater or other potable sources would be an option if that was the most cost-effective means of establishing and maintaining necessary habitat.

Figure 7.3



Restoration Drivers

A more detailed discussion of how restoration drivers fit into this framework is important to ensure we are fully capitalizing on opportunities while still meeting critical needs for restoration.

For example, xeroriparian restoration can be incorporated into private developments either as a complement to a water-harvesting requirement or mitigation for impacts to riparian habitat. Site retention/detention requirements in both the City and County can provide mechanisms to assist riparian ecosystems. These basins detain and/or retain stormwater runoff, depending onsite requirements. In the past they were often rectilinear basins designed without vegetation, but they can be designed as naturally shaped basins planted with native species. When located adjacent to riparian areas, they can augment the natural riparian environment with additional native plants and wildlife habitat. By passively capturing and using free water this restoration work can be constructed and maintained at minimal cost. Since it is often done in conjunction with a development, park, or other feature with irrigation infrastructure, water for plant establishment will likely be readily available.

While upland and xeroriparian restoration are the most efficient restoration projects, they benefit a more limited range of vulnerable species. They often occur within urban areas or relatively dense development, which typically deters use by the more vulnerable (and typically human-shy) wildlife. Nevertheless, restoration in urban areas does provide habitat for smaller and more urban-adapted wildlife, as well as stormwater management, urban heat island mitigation, and carbon sequestration. These areas also have aesthetic and economic value to humans. Since restoration in urban areas can be done at a small scale, can be implemented in conjunction with new development or redevelopment, is relatively inexpensive, and can often be supplemented in the short-term by landscape irrigation systems, this type of restoration should be done whenever and wherever the opportunity arises. The City and County should review existing policies and regulations and identify opportunities to:

1. Increase the incidence of water harvesting in both private developments and public infrastructure projects.
2. Develop retention/detention standards that allow these areas to be better utilized as mini-restoration sites, including maintenance standards and siting of basins within a development/project.
3. Develop restoration standards that encourage the creation of higher-value habitat areas without sacrificing the retention/detention function of the basins.

More extensive restoration can occur by incorporating restoration components in necessary capital improvement projects (CIP) that have primary goals other than restoration such as park construction, groundwater recharge, stormwater management or wastewater treatment. CIP projects that have a dedicated water supply – such as an irrigation system – are ideal locations for riparian restoration because the restoration can be conducted efficiently in combination with the multi-purpose project. While restoration associated with these projects has the potential to be much larger in scale and more water intensive (producing meso or even hydroriparian habitat), the number of project opportunities are limited and suitable locations are restricted.

As long as restoration does not conflict with the goals of a multiple purpose project, restoration should be conducted wherever and whenever the needed water is present and sufficient funds are available to conduct it. For example, where wastewater disposal to land surface and/or recharge is being conducted, this water could be used to support riparian vegetation by maximizing near-surface water application within the legal frameworks governing water quality, water rights, and other potential constraints. Another possibility is to modify landscaping standards associated with parks and other capital projects so that the vegetation supported mimics natural native habitats rather than planting an array of isolated trees and shrubs.

Restoration that requires either a short-term or long-term seasonal or permanent commitment of developed water supplies (e.g.: groundwater, CAP water, effluent, and/or reclaimed water) might also occur in response to regulatory requirements such as, (1) Clean Water Act, Section 404 in-lieu mitigation, (2) ESA compliance, including restoration to support the needs of species covered under an HCP, or (3) temporary augmentation water needed to support existing hydro- and mesoriparian through times of stress.

While a strictly efficiency-driven perspective would argue against using developed water supplies for single-purpose restoration projects, (i.e., projects that do not have any additional public benefit), in cases where restoration is being conducted to comply with regulations, use even of potable supplies may need to be considered to meet the needs of species covered under an HCP or to meet 404 mitigation requirements. Many of these restoration or

enhancement projects might occur in outlying areas where access to potable or reclaimed infrastructure would be problematic. In these cases, the most cost-effective approach may be to pump groundwater to support the restoration. Determining appropriate water supplies would need to be addressed on a case-by-case basis.

In addition to addressing the restoration scenarios above, policy makers should utilize existing resources (CEP), explore partnerships (Tucson Audubon Society CWA Section 404 in-lieu money), and develop additional resources (Conserve to Enhance) to support larger-scale restoration that is more water intensive than can be supported solely by water harvesting. These projects should be conducted in locations that provide specific environmental benefits, and can be single-purpose or multi-purpose projects, but the more purposes they address, the better.

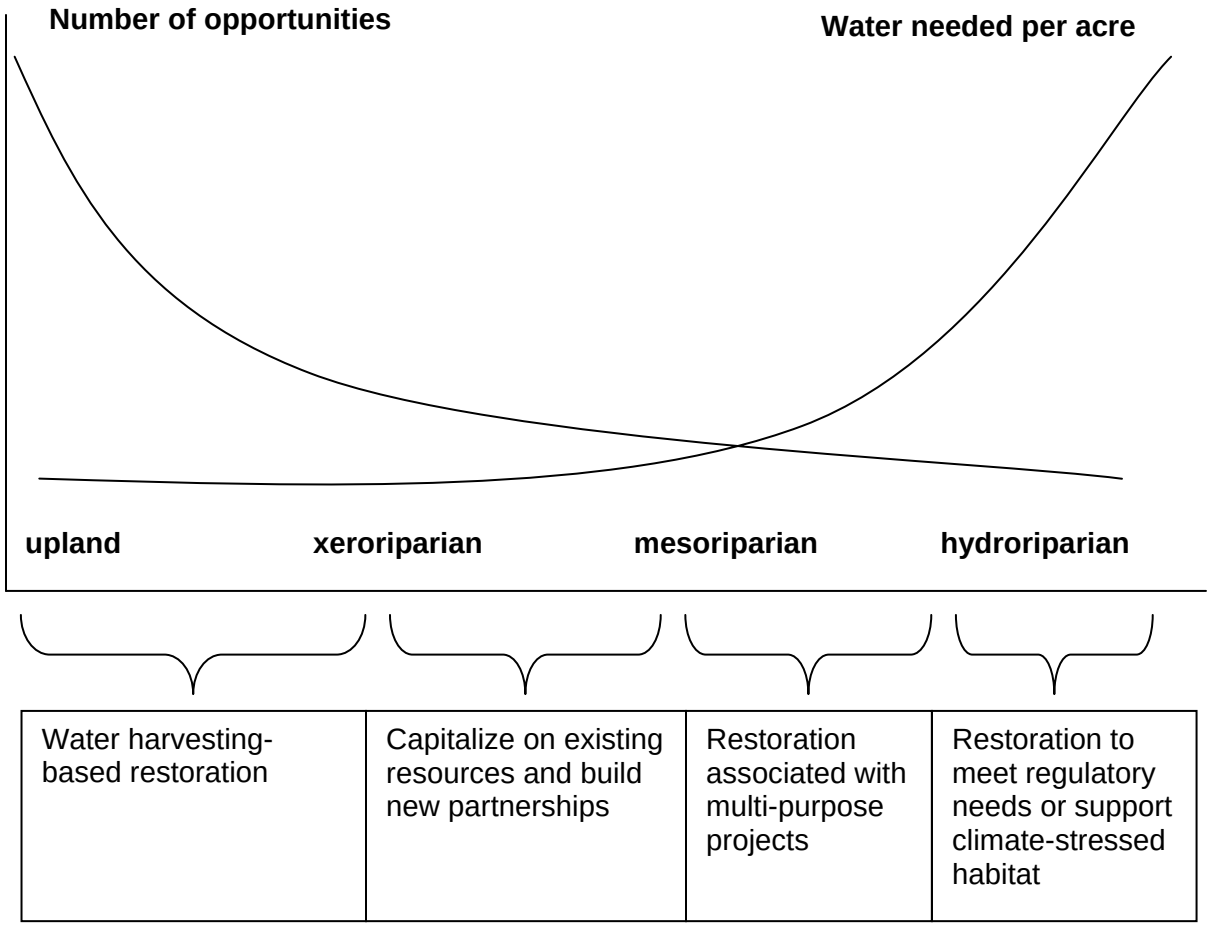
A comprehensive assessment of restoration needs, opportunities, and resources can provide better guidance for identifying and implementing restoration project. A good starting point would be to survey City and County-owned land to identify areas suitable for restoration. Partners could use this survey to identify lands that meet their needs for restoration sites. For example, this survey could be used as part of a planning effort by Tucson Audubon Society to identify lands for future restoration using Section 404 in-lieu money. This assessment should address how CEP could be used most efficiently to aid restoration efforts. If the CEP is directed towards plant establishment rather than a permanent commitment to limited projects, it could be rotated through projects on a multi-year basis, providing establishment water to a sequence of sites until all restoration priorities are accomplished.

We are already seeing climate-related stress in some meso and hydroriparian areas. Section III referred to the need to augment water supply at Agua Caliente Park. Depending on the full extent of regional climate change impacts, this stress may be increasingly felt in more xeric habitats. In light of these anticipated impacts, steps should be taken across all riparian habitat types to increase the resilience of restoration projects to weather higher temperatures and less annual precipitation. Water harvesting basins and associated catchment areas can be designed to increase the volume of rainwater plants get by several orders of magnitude. Constructing these at the time of restoration and planting native riparian species that are particularly drought tolerant would prepare the system for future climate change-based stress. Use of reclaimed water on a temporary basis to help riparian systems through particularly challenging climate periods is another strategy to consider.

Irrigating a portion of restoration areas past the establishment period is another strategy worth examining. Continued irrigation of a small portion of a restoration site (for example, 10% of the vegetation area) would support plants through natural and climate change-based periods of drought and heat stress. The seeds produced in these “seed islands” would inoculate the landscape at and near the site both downwind and downstream, providing a constant source of native seeds. In addition, the area where plants are watered will likely provide denser shade, more reliable fruit and more abundant seeds for wildlife using the site.

In addition to the strategies above, having a supply of water earmarked for conservation purposes would create a pool of water for future ecosystem uses that are as yet unquantified. Figure 7.4 illustrates a further development of the schematic framework, showing possible framework for the allocation of resources including money, water, and effort, for different types of restoration. This framework addresses four types of restoration based on need, availability of opportunities and cost efficiency.

Figure 7.4



Critical Issues

There are no easy answers on how best to provide water for our growing population and economy while meeting quality of life and environmental needs. There are several critical issues that should be considered for implementation of a regional approach to environmental restoration.

Conservation Effluent Pool

Multiple legal instruments define the ownership and delivery of effluent within the region, including; the 1979 City/County Intergovernmental Agreement (IGA); the 2000 Supplemental IGA; the CEP Agreement; the City/County Wheeling Agreement; and multiple agreements between the City and other water providers in the region.

The 2000 Supplemental IGA essentially established the CEP as a bank account of 10,000 acre-feet of effluent annually that can be used for projects promoting habitat conservation plans or jointly approved riparian environmental restoration projects. While CEP water could be permanently dedicated to a project, during times of drought or high demand for reclaimed water the water supply may be discontinued or proportionately diminished. A permanent dedication of

a volume of CEP water to a single project is a permanent withdrawal from the CEP bank account. By developing restoration projects that only need reclaimed water for a shorter establishment period, more projects can be completed over time, and the CEP could be used like an "investment pool" to support a myriad of restoration opportunities instead of a few.
.
The County and City are currently finalizing an intergovernmental agreement that will provide the framework and process for approving the use of CEP water for environmental restoration projects. Prioritizing projects and putting the available CEP bank account to the best use are critical to the success of dedicating water to the environment.

Southern Arizona Water Rights Settlement Act

The Southern Arizona Water Rights Settlement Act (SAWRSA) resolved litigation on behalf of all water users within the Tucson Active Management Area, in part, by delegating 28,200 acre-feet of the region's annual effluent supply to the Secretary of Interior to use in meeting the Secretary's obligations under the settlement.

There are strategic reasons why the Secretary of Interior may find it advantageous to commit effluent to the Santa Cruz River for the long term if full credit for recharge could be provided. By bringing the Secretary and other regional stakeholders into planning efforts for riparian enhancement, it might be possible to achieve long-term water commitment to riparian growth at a minimal cost.

Water Quality and Permitting

Surface water discharges must meet Arizona's Surface Water Quality Standards. ADEQ requires reclaimed water used in a stream ecosystem restoration project to meet water quality standards for an effluent-dependent aquatic habitat. Effluent must meet A+ standards. This approach imposes strict standards that require Whole Effluent Toxicity Testing (WETT) and de-chlorination of reclaimed water prior to discharge. Monitoring for WETT regulates the acute and chronic impact of a discharge on aquatic organisms with the intention of protecting fish and other aquatic wildlife. WETT and dechlorination are appropriate for application to streams where perennial flow occurs and aquatic wildlife are present and for projects for restoration of aquatic wildlife. However, these regulatory requirements have been a barrier to some riparian restoration efforts where reclaimed water would be used.

Many ecosystem restoration projects focus on ephemeral streams and enhancing terrestrial species without creating aquatic environments. Use of reclaimed water for start up and establishment of the restoration project is often desirable. However discharge into an ephemeral stream would require WETT testing and dechlorination. One way to encourage riparian enhancement would be for ADEQ to establish a designated use of effluent for "Ecosystem Restoration" in its Surface Water Quality Standards rule, and to modify requirements appropriate for application to ephemeral streams. There is currently a regulatory stakeholders process underway concerning WETT testing and chlorine limits. There are also proposals being developed to revise the Surface Water Quality Standards rule to allow more flexibility for ADEQ to make their Net Ecological Benefit (NEB) determination for riparian restoration projects, which entertain the use of site specific standards (as was done to accommodate the Yuma East Wetlands project), or allow variances.[42]

[42] WISP Reclaimed White Paper, pages 22-23

VIII. Recommendations

The recommendations in this paper fall into three areas: identifying environmental restoration priorities and opportunities, identifying water sources for restoration, and addressing the long-term status of the Santa Cruz River.

Environmental Restoration Priorities/Opportunities

- The City and County continue to preserve existing riparian areas to the maximum extent possible through land acquisition and regulatory land use controls, especially springs and Important Riparian Areas identified in the County's Conservation Land System maps.
- City and County collaborate to help people understand the benefits of healthy ecosystems for themselves and nature, and collaborate to encourage increased support to strengthen protection and maintain existing resources.
- Develop standards that maximize opportunities for small-scale environmental restoration in conjunction with rainwater harvesting and stormwater retention/detention basins within new developments.
- Develop a regional policy that incorporates rainwater harvesting, stormwater detention, non-potable water use, recreation, and ecological amenities to the extent feasible in Capital Improvement Projects budgets, especially in open space areas. For example:

    - Incorporate ecosystem restoration adjacent to wastewater treatment facilities.
    - Explore ways for recharge facilities to support restoration.
    - Retrofit existing large stormwater detention basins to support riparian habitat.
    - Include environmental restoration opportunities as component in all new stormwater management projects, so that optimal amounts of stormwater are retained for reuse before being discharged to the respective stormwater conveyance systems.
    - Incorporate, where possible, rainwater harvesting and ecological amenities into public projects.

- Identify potential future needs for compliance and mitigation for CWA Section 404 and ESA regulations and develop a shared regional policy for addressing those regulatory compliance projects that require a short-term (establishment) or long-term (permanent or seasonal) water supply.
- For existing hydroriparian areas, develop contingency plans for providing supplemental water during times of climate-related stress in a cost-effective manner.
- Continue to pursue opportunities to secure grant funding for environmental restoration, such as from the Arizona Water Protection Fund.
- Explore a regional collaboration with respect to how in-lieu mitigation funds received for compliance with local watercourse protection ordinances could be potentially be used to fund restoration activities. Explore opportunities to expand this partnership to include non-governmental entities that operation mitigation banks and/or undertake restoration activities themselves.
- Continue efforts to evaluate the use of existing County and City-owned lands for suitability for environmental conservation and restoration purposes.

- Work with partners such as Tucson Audubon Society and the University of Arizona to identify long-term water quality implications for restoration areas, such as the impacts of higher salinity of CAP, effluent, and reclaimed water.

- City and County review existing policies and regulations and identify opportunities to:

    - increase the incidence of water harvesting in both private developments and public infrastructure projects,
    - develop retention/detention standards that allow these areas to be better utilized as mini-restoration sites, including maintenance standards and siting of basins within a development/project, and
    - develop restoration standards that encourage the creation of higher-value habitat areas without sacrificing the retention/detention function of the basins.

Water Supply

- The City and County will continue to work to with ADEQ to define environmental restoration as a designated use along with its own set of water quality standards.
- Finalize the CEP and IGA amendments and develop specific criteria defining how the CEP will be managed and allocated to riparian restoration.
- Continue to coordinate with the Water Resources Research Center on the "Conserve to Enhance" concept and support the objective of earmarking saved water for environmental projects.
- Water and water rights obtained through Open Space Bond acquisitions should be dedicated to preservation or enhancement of existing riparian areas connected with those land acquisitions.

Santa Cruz River

- Lobby State Legislators to revised state statutes to make SAWARSA water eligible for 95%-100% credit in managed recharge facilities to order to ensure effluent will remain in the Santa Cruz River downstream of the regional wastewater treatment plants to protect the riparian corridor.
- Secure necessary permits, including 404 Permits, to spread effluent across the river bottom including in former channels in order to increase recharge rates and habitat volume.
- Undertake pilot restoration projects to determine how to maintain riparian habitat along the Santa Cruz River in the event that effluent flows in the river decline or stop.
- Evaluate the feasibility of using recovery wells and effluent recharge credits to maintain habitat value in areas that are not proximate to renewable water supplies, such as the creation of expanded pockets of high quality habitat for migratory birds to supplant narrow, linear effluent flow channel.
- Identify a portfolio of multi-purpose projects using effluent that balances the water needs for direct use, environmental projects, and recharge.
- Develop partnerships and obtain grant funding for multi-purpose projects through the Arizona Water Protection Fund, Bureau of Reclamation, Audubon Society, Arizona Game and Fish department, and others.

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APPENDIX A

Mechanisms to Support Water for Environmental Needs

APPENDIX A

Mechanisms to Support Water for Environmental Needs

Pima County and City of Tucson have a number of potential ways to ensure that environmental needs are met by preserving and protecting existing ecosystems. These include:

- acquiring and protecting land
- acquiring water rights to preserve springs and streams with perennial flows
- requiring private land to be set aside from development via regulatory measures
- evaluating the environmental impacts of future water uses
- land conservation programs

Land Acquisition and Preservation

Land acquisition has been a popular means of protecting natural riparian ecosystems and their watersheds, and publicly-financed land acquisition has consistently received voter support. Land acquisition can protect environmental flows when the majority of the watershed or the groundwater sources are included. Pima County has several land acquisition programs that protect watersheds or portions of watersheds including the Open Space Bond Program and the Floodprone Land Acquisition Program (FLAP). Open Space acquisition protects and preserves the integrity of watersheds thus conserving our water resources. FLAP is an integral part of the District's floodplain management philosophy and is a key tool in the District's efforts to protect public safety, minimize future flood losses, and preserve riparian ecosystems and floodplain functions. FLAP helps to conserve dwindling groundwater resources by removing existing disturbance, preventing future development within the floodplain, and retiring wells to reduce regional groundwater pumping.

Depending on the location, public investments in land acquisition may not be protected against alteration of the surface water flows needed to perpetuate the riparian habitat located on the acquired land. In almost all cases, land acquisition does not secure the underground flows of water that sustain groundwater-dependent streams. State law leaves many groundwater-dependent streams and springs vulnerable.

Water Rights

Pima County also acquires water rights for the environment with land purchases. These rights can, if legally defended by the acquiring agency, protect water needed for the environment or other purposes. Pima County has also sought and obtained new surface water rights from the state to ensure flows cannot be diverted, or to legally allocate or re-allocate flows for wildlife purposes. However, upstream watershed alterations may legally occur that impact the downstream surface flow even though surface water rights may have been acquired, for example upstream mining activities that change watershed boundaries and/or groundwater flow directions.

Pima County and City of Tucson each have effluent water rights. Pima County has a riparian restoration program that uses County-owned effluent for revegetating land with native plants.

City of Tucson currently uses City-owned effluent to support riparian environment at Sweetwater Wetlands, a combination effluent-treatment plant and City park. The County and City also use reclaimed water, delivered through the City's reclaimed water distribution system, for river parks along the Rillito and the Santa Cruz rivers. The City does not have a program for riparian restoration at this time, so it is not using reclaimed water or effluent for its own restoration projects. However, effluent has been used at restoration sites located on city-owned land, conducted by nonprofit organizations

Regulation & Policy

Both City and Pima County also have regulatory programs that restrict development within riparian ecosystems on private lands. These include the Tucson and Pima County floodplain and riparian management ordinance, and City of Tucson's various watercourse ordinances. The Pima County Floodplain and Erosion Hazard Management Ordinance (FPMO) require the preservation of riparian vegetation and corridors found along watercourses, flood-plains, and Important Riparian Area as identified in the Conservation Land System of the SDCP. These regulations ensure that impacts to riparian habitat resulting from development are minimized and the natural functions of the riparian and floodplain systems are maintained. When unavoidable impacts to riparian habitat occur mitigation is required to compensate for the disturbance.

Generally speaking, these restrictions prohibit ground disturbance of certain areas, but do not ensure that the riparian environment will receive water at the appropriate time, frequency or amount needed. In the urban environment, increased surface flows due to increased impervious cover are more often a problem than diminished flows (see previous paper on stormwater). In the rural environment, reduction of surface flow due to diversion is more of a concern.

The floodplain regulations of both City and County have as their primary objective the reduction of hazards to property and persons. Because of this, evaluation of the future impact**s** of development under these ordinances focuses on the infrequent but damaging 100-year flood as a benchmark. Effects on the small flows that are the main water supply to ephemeral stream systems are almost never analyzed. There is generally no basis in local floodplain management ordinances to regulate such flows.

The City does regulate impacts to riparian areas pursuant to the Floodplain Ordinance. Watercourses with a discharge of 100 cubic feet per second or more in a 100-year flood event are included in this regulatory protection. Selected washes meeting this same size criteria are also protected under the Environmental Resource Zone (ERZ) regulations, The City's ,Watercourse Amenity Safety and Habitat (WASH) Ordinance regulates channelized watercourses who main retain riparian values on the former flood plains adjacent to the washes. The City is developing revised regulations for riparian habitat protection which will include an in-lieu mitigation option in cases where on-site mitigation is not possible. These City regulations restrict development of areas with existing riparian vegetation that fall within the regulatory envelopes of the various codes and ordinances that apply. The natural water supply that supports such vegetation is not protected by these regulations however.

Pima County currently has land use ordinances within the Zoning Code that provide protection and preservation of natural resources. These ordinances require natural open space set-aside, protection of native plants and riparian areas, and environmentally sensitive site design for

development projects. Recently, Pima County has adopted a new policy that requires disclosure of information regarding new groundwater pumping for rezonings, including proximity of new wells to intermittent and perennial streams, springs and shallow groundwater areas.

City of Tucson's water harvesting ordinances promote conservation of potable and reclaimed water resources by substituting rainwater to meet landscaping water demands. Existing Land Use Code requirements address the use of harvested rainwater at a range of sites including the common areas of subdivisions, public buildings, public right-of-way and commercial sites. Additionally, the City adopted the Commercial Rainwater Harvesting Ordinance, which beginning in 2010 will require that each new commercial site meet 50 percent of their landscape water demand using rainwater harvested at the site. This ordinance should also ameliorate some of the other impacts of development, including increased heating of the urban environment, degraded stormwater quality, and increased runoff. Also beginning in 2010, the City will require the building industry to construct all new single family residences with graywater plumbing stub outs in place for future use. This would enable a homeowner to easily add a graywater distribution system to their house, if they so desire. Pima County's rezoning policies now include measures to encourage substitution of renewable water sources for groundwater for the protection of springs and intermittent and perennial streams.

Site retention/detention requirements in both the City and County can provide mechanisms to assist riparian ecosystems. These are large basins detain and/or retain stormwater runoff, depending on site requirements. They are often rectilinear basins designed without vegetation, but can be designed as naturally shaped basins planted with native species. When located adjacent to riparian areas, they can augment the water dependent natural environment with additional native plant species and wildlife habitat.

Both City and County have programs to repair channelized watercourses, but the funding for these programs are geared toward making repairs for public safety, not toward re-constructing them with functionally stable floodplains that could provide water for ephemeral riparian ecosystems. Often the repairs actually speed the loss of runoff from riparian areas.

Other Protection Programs

Sonoran Desert Conservation Plan and Conservation Land System Plan

The purpose of the Sonoran Desert Conservation Plan (SDCP) was to develop a regional plan to address the long-term growth and conservation needs of the full range of natural and cultural resources, while also facilitating economic expansion. The biological goals of the SDCP are designed to conserve critical and sensitive wildlife habitat through protection of corridors, in-stream flow, and water quality. SDCP conservation principles have been integrated into county regulation and policies.

Various efforts to avoid, minimize and mitigate the impacts of urbanization on various plant and animal species and their habitats have already been implemented through the Sonoran Desert Conservation Plan. The Pima County Comprehensive Land Use Plan (CLS) was developed in concert with the Sonoran Desert Conservation Plan (SDCP). The CLS includes guidelines to conserve 95 percent of the riparian areas that will be affected by development. Pima County will institute and formalize new conservation measures through a permit and agreement with the U. S. Fish and Wildlife Service. If approved, the permit and agreement will provide a

comprehensive way for Pima County and the regulated community to achieve compliance with the Endangered Species Act in unincorporated Pima County. In the past, this has been done project-by-project, species-by-species.

City of Tucson Habitat Conservation Plans

To protect natural heritage, balance growth with the natural environment and comply with the Endangered Species Act (ESA), the City of Tucson is preparing two Habitat Conservation Plans (HCPs) for large land areas where future projects or urban growth are expected to occur. HCPs document an area's endangered, threatened, and vulnerable species and describe conservation strategies to mitigate possible future negative impacts to those species.

Mitigation efforts might include setting aside conservation areas, conducting habitat restoration, or utilizing other strategies that benefit the endangered, threatened and vulnerable species in the area. The possible locations, timeframes and associated water use for these mitigation efforts are not known at this time. In general, vegetation restoration efforts will likely be designed to require supplemental water during establishment periods with subsequent weaning of plants from supplemental water. The use of water for riparian-dependent plant and animal species would be confined to areas where appropriate natural water sources are already available.

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1 Sonoran Desert Conservation Plan www.pima.gov/cmo/sdcp

2 Multi-species Conservation Plan www.pima.gov/cmo/sdcp/mscp

3 Sustainable Action Plan for County Operations www.pima.gov/sustainable/aug08actionplan-1.pdf

4 City of Tucson HCP www.tucsonaz.gov/ocsd/HCP.php…….

APPENDIX B

Land Management Projects

Appendix B

Creation, Enhancement, and/or Protection of Beneficial Ecosystem Features Without Addition of Water, Actions by Pima County Government

(Independent of projects that required supplemental water for the environment)

I - Acquisition

A. Floodprone Land Acquisition (with removal of existing or potential developments)
- Over 9480 acres (over $63 million spent)

B. Open Space Acquisition (typically vacant, occasionally ranched)
- Acreage available from Co. Admin or NRPR

II - Property Management to Reduce Environmental Stressors

A. Fencing to protect land, (especially riparian) from livestock, ATVs, etc.
- Empirita Ranch
- Cienega Creek, multiple areas
- Old West Branch Santa Cruz River
- Sopori Ranch (Arivaca area)
- Isabella Lee (at TVC/ACC area)
- Several Santa Cruz River properties
- Numerous Canada del Oro River properties
- Various Open Space Lands

B. Non-Native Vegetation Removal
- SCR & WB Ajo-29 (buffelgrass)
- Cienega Creek, numerous locations (tamarisk and buffelgrass)
- Bear Canyon (arundo)
- Isabella Lee at TVC/ACC (tamarisk & buffelgrass)
- Numerous detention/retention basins and drainageways (by RFCD)
- Numerous parks and trails (by NRPR)

C. Retirement or reduced use/rotation of grazing rights
- Empirita Ranch
- Buckelew Ranch
- Several Black Wash ranch properties
- Numerous others, check with NRPR

D. Erosion Abatement Projects
- Too many to list, check with RFCD & NRPR

E. Retirement and revegetation of abandoned roads and trails
- Pantano River areas

F. Retired or reduced use of groundwater
- Continental Ranch
- Woodland Ranch (Tanque Verde Creek)
- Bingham Cienega
- Sopori Wash
- Canada del Oro in Catalina Area
- Numerous others: Water Rights Team has data on 100’s of capped and retired wells

G. Installation of stock tanks plus fencing-off of natural riparian areas
- Empirita Ranch

APPENDIX C

Science Technical Advisory Team, February 21, 2006. Memorandum

College of Agriculture
School of Renewable Natural Resources

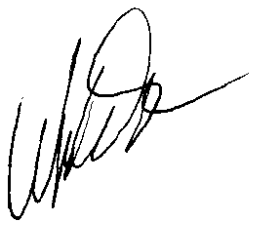
THE UNIVERSITY OF
ARIZONA®
TUCSON ARIZONA

325 Biological Sciences East Building
PO Box 210043
Tucson, Arizona 85721-0043
(520) 621-7255
(520) 621-8801 Fax

Date: February 21, 2006

To: C.H. Huckelberry, Pima County Administrator

From: William Shaw, Chairman, Science Technical Advisory Team



Subject: Effluent for Riparian and Aquatic Ecosystems
Adopted by the Science Technical Advisory Team (STAT), Feb 17, 2006

On June 23, 2000, the STAT adopted the following guidelines to assist the region in the use of effluent and reclaimed water for biological benefits. Overall, the STAT prioritized protecting existing self-sustaining riparian and aquatic ecosystems over the creation of new or enhanced areas:

1. **Protect systems that are self-sustaining over those that need continual inputs.** Based on this belief, the STAT prioritizes substitution of renewable water supplies for groundwater and surface water diversions in areas where high-quality aquatic and riparian ecosystems still exist and where diversion of water is a primary stressor of those systems. For example, previous work has identified the Tanque Verde Valley as an example of an important riparian resource that has been degraded by groundwater pumping. Substitution of reclaimed water for land uses that are diverting water from the aquatic and riparian ecosystems will help relieve this source of biologic stress.

2. **Restore or enhance native riparian and aquatic ecosystems by releasing water to restore local aquifer conditions.** Where ground water pumping is limited and favorable hydrogeologic conditions exist, reclaimed water and secondary effluent can be released to in an area in a manner that restores local aquifer conditions. The STAT believes that where hydrogeologic conditions are suitable, restoring localized shallow groundwater systems and floodplain dynamics will have a greater likelihood of success in creating a sustainable system than construction of artificial wetlands and container plantings or seedings of riparian vegetation.

3. **If plantings are to be used: a) Re-vegetation is favored in areas where perpetual irrigation will not be needed;** Ideally, these projects will be designed to avoid disturbance of existing vegetation and minimize the need for perpetual irrigation and maintenance. Placement in areas where hydrologic conditions are suitable can provide the necessary water. **b) Conflicts with other social objectives should be minimized**; Revegetation sites should be chosen to minimize future conflicts with aesthetic, recreation, or public safety considerations. These other social demands can reduce the value of the plantings

for self-perpetuation and for wildlife use. For instance, pruning and eradication of the understory reduces the utility of areas for most forms of wildlife. **c) Native species appropriate to the site must be used; Using** native species that are adapted to the specific soil, aspect and elevation of the site will assist in establishment and **d) Sites which augment existing high-quality riparian habitats are favored.**

4. **Enhance the ability of secondary effluent or reclaimed water to support aquatic life.** In some cases, improvement of water quality may be necessary to support aquatic species such as fish or other aquatic organisms in the food chain.

5. **Manage riparian and aquatic ecosystems for native species.** In many cases, sites using reclaimed water or secondary effluent will require active management against non-native species and public education about why control efforts are needed. This is particularly true where open water bodies exist. Where open water bodies are proposed, the potential consequences on native species should be considered.

Six years after adopting these guidelines, STAT finds progress has been made in using effluent for biological benefits, namely the extension of reclaimed water to the Tanque Verde Valley, the allocation of up to 10,000 acre-feet of Conservation Effluent Pool water, and the commitment of a share of County effluent to riparian projects at the Kino Ecosystem and at Swan Wetlands along the Rillito.

Today effluent is increasingly viewed as an important source to meet increased potable water needs. Insufficient attention has been given to allocating additional effluent to the environment. We urge all local governments and water providers to allocate additional effluent to riparian and aquatic ecosystems in the Sonoran Desert Conservation Plan.

Of particular concern is the effluent-dominated Santa Cruz River. No effluent has been allocated to the river by any effluent owner. While today the river extent and volume is very large, there is no mechanism in place to assure that any effluent flows will be made available to the river as urban demands for effluent re-use grow. Yet it is the single largest, existing riparian "project" owned and managed by local governments and water providers, and should be sustained if possible.

C: Michael Hein, City of Tucson
Michael Reuwsaat, Town of Marana
Mark Stratton, Metropolitan Water District
Gary Hayes, Pima Association of Governments
John Bernal, Pima County Public Works
Carol Erwin, U. S. Bureau of Reclamation
Sherry Barrett, U. S. Fish and Wildlife Service

APPENDIX D

Pima County
Board of Supervisors Resolution
2007-84

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.

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.

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:

- 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.

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.H. Huckelberry
County Administrator

(April 26, 2007)

Attachments

RESOLUTION NO. 2007-__

A RESOLUTION OF THE PIMA COUNTY BOARD OF SUPERVISORS IN SUPPORT OF NEW COUNTY SUSTAINABILITY INITIATIVES

WHEREAS, sustainability is often defined as improving the quality of life for current generations without compromising the resources needed for future generations; and

WHEREAS, Pima County has supported past initiatives to improve and sustain a livable community, including initiatives in the areas of land and water conservation, air quality improvements, cultural resource preservation, urban development guidelines, recreation, public health, affordable housing, and neighborhood reinvestment; and

WHEREAS, the Board of Supervisors adopted the Sonoran Desert Conservation and Comprehensive Land Use Plan in 2001; and

WHEREAS, since 1974, Pima County voters have approved over $230 million in bond funds for land purchases to conserve our natural and cultural heritage; and

WHEREAS, since 1974, Pima County has purchased over 45,000 acres of open space property, and grazing leases for 86,000 acres of open space, which property is managed by the County for conservation purposes; and

WHEREAS, Pima County has begun collecting environmental enhancement fees as a percentage of revenues from particular development projects in order to mitigate development impacts to conservation areas; and

WHEREAS, the Board of Supervisors adopted Pima County Resolution 2003-88 supporting Congressional designation of the Santa Cruz National Heritage Area to promote regional conservation of our natural and cultural heritage areas, and to sustain tourism as a key sector of our regional economy; and

WHEREAS, the Board of Supervisors adopted revisions to the Riparian Mitigation Ordinance in 2005 to avoid and minimize impacts to riparian vegetation on local washes; and

WHEREAS, the Board of Supervisors amended the golf course ordinance to require new golf courses to be irrigated with directly-served effluent, reclaimed water or Central Arizona Project (CAP) water; and

WHEREAS, in 2006 the Board of Supervisors directed staff to begin an update to the Water Resources Element of the Comprehensive Plan to better address land use and water resource planning, and to provide additional information to the Board on riparian resource issues during the review of developments; and

WHEREAS, the Board of Supervisors approved Resolution 2005-124 and 2007-15 opposing mining in biologically important areas of the County that would degrade water quantity and water quality, negatively impact key tourism sites, and compromise quality of life for surrounding residents; and

WHEREAS, Pima County uses effluent, storm water, and reclaimed water for riparian rehabilitation and restoration efforts, as well as recreational facilities; and

WHEREAS, in 2007 the County Administrator directed staff to add energy guidance into this year's update of the Comprehensive Plan; and

WHEREAS, the Board of Supervisors has adopted regulations to prevent and reduce air pollution, protect public health, and restore and preserve the quality of the outdoor air in Pima County; and

WHEREAS, in January, 2007 Pima County was the first county in the state to adopt a Transfer of Development Rights program permitting willing sellers of land with conservation value to sell development rights to owners of land more suitable for more intense development; and

WHEREAS, the Board of Supervisors adopted the Recreation Areas in Residential Subdivisions Ordinance in 2003 to require recreation areas within new subdivisions and to collect fees to benefit the regional park system; and

WHEREAS, the Board of Supervisors in 2007 approved a concept for partnering with Native Seeds/SEARCH to promote the health benefits of eating native foods and the benefits of reduced energy consumption by growing or purchasing locally grown food; and

WHEREAS, voters approved the issuance of a combined total of $25 million in bonds since 1997 to fund Neighborhood Reinvestment projects in high stress areas of Pima County, such as traffic mitigation devices, street lights, park improvements, sidewalks, walking paths, pedestrian bridges, sports facilities, and community buildings, which neighbors report have positively benefited their communities; and

WHEREAS, the Board of Supervisors in 2005 adopted an affordable housing fee to be required for certain new subdivisions that, when combined with $15 million of bond funding approved by voters in 1997 and 2004, provides revenues to an Affordable Housing Trust fund to expand the supply of affordable housing in Pima County; and

WHEREAS, Pima County recognizes that the scientific community has developed a consensus that increasing emissions of carbon dioxide, methane and other greenhouse gases into the atmosphere is affecting the Earth's climate; and

WHEREAS, the Board of Supervisors recognizes and accepts its responsibility to continue implementing and promoting sustainable practices that protect the County's natural and built environment; and

WHEREAS, new sustainable development initiatives for Pima County must address the environmental, economic, and social characteristics of our community;

NOW THEREFORE, BE IT RESOLVED THAT:

1. The Pima County Board of Supervisors supports sustainable development and the continual emphasis on sustaining a livable community.

2. The Pima County Board Of Supervisors supports implementation of a green building initiative and other sustainable initiatives regarding county facilities and vehicles, including the following goals and aspirations:

   a) Shifting to more environment-friendly alternative fuels for its vehicular fleet such that: twenty-five percent (25%) or a minimum of one hundred (100) vehicles of the County's fleet of vehicles, excluding Sheriff patrol vehicles, shall consist of Alternative Fuel Vehicles by 2008. This percentage shall increase to thirty percent (30%) by 2009 and fifty percent (50%) by 2010.

   b) Applying a green purchasing and waste reduction emphasis to all County facilities.

   c) Maximizing County water resource assets including groundwater rights, surface rights and production and use of effluent to sustain and protect the County's natural environment.

   d) Reducing water consumption by fifteen percent (15%) in all County facilities by 2025. Water reduction strategies will include conducting water audits, replacing high water-use fixtures and replacing high water-use decorative landscaping with drought tolerant native landscaping.

   e) Doubling the number of County parks served by reclaimed water by 2018, subject to voter approval of bond funds to extend reclaimed water lines.

   f) Designing and building all new occupied County buildings, including additions over 5000 square feet, for which design is initiated after July 1, 2007, to achieve a minimum of LEED™ Silver certification level.

   g) Maintaining All LEED™ certified County facilities under LEED™ for Existing Buildings and attempting to apply the same standard to all existing facilities.

   h) Applying the above LEED™ criteria to all projects funded through County bonds as a condition of funding and regardless of jurisdictional project sponsorship.

i) Designing and constructing at least one medium size County building with a net zero energy consumption.

j) Adhering to the Renewable Energy Standard adopted by the Arizona Corporation Commission such that fifteen percent (15%) of all County facilities' electrical energy consumption shall be generated from renewable resources by 2025.

k) Maximizing renewable energy resources from the production of methane in County wastewater treatment and landfill operations and use them to offset non-renewable energy needs.

3. Pima County will encourage the construction of new residential, commercial, and industrial facilities employing green building concepts throughout the county by embracing a sustainable development emphasis and by considering:

   a) The creation of incentive-based green building residential and commercial programs.

   b) The incorporation of solar systems, solar orientation of structures, solar access, and smart growth principles into County development planning including exploring the possibility of requiring that that a minimum of fifty percent (50%) of homes constructed after 2010 include direct solar assisted energy through solar hot water or photovoltaic elements.

   c) The amendment of land use regulations to require that all new houses discharging to septic systems also be provided with a grey water reuse system.

   d) The revision of design and construction standards to capture and mitigate storm-water generated on-site for purposes of water harvesting and the incorporation, into the pavement of parking lots and roads, of light-colored permeable materials to reduce heat-island effects, water runoff, and dust emissions.

4. In order to maintain an emphasis on sustainable development initiatives organizationally the County Administrator is hereby directed to:

   a) Appoint a sustainability coordinator from existing staff to identify departments and organizational units within Pima County that contribute to sustainability efforts, establish an organizational structure that facilitates the coordination of efforts between departments and organizational units, and coordinate sustainable policy and initiatives with other jurisdictions.

   5. Appoint an Energy Manager from existing staff to produce a comprehensive County facilities energy plan, track progress of County energy programs, and help facilitate LEED™ implementation.

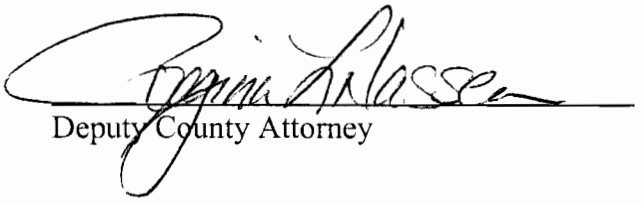
Passed and adopted by the Pima County Board of Supervisors this _____ day of May, 2007.

_____
Chairman, Pima County Board of Supervisors

ATTEST:

_____
Clerk of the Board

APPROVED AS TO FORM:



_____
Deputy County Attorney