Pima County
2019 Annual Stormwater Report

July 2018 – June 2019
AZPDES Permit No. AZS000002

PIMA COUNTY

September 30, 2019

Annual Stormwater Report

Prepared in cooperation with:
Regional Wastewater Reclamation Department
Department of Transportation
Regional Flood Control District
Development Services
Pima Animal Care Center
Pima Association of Governments

Stormwater Management Program
Pima County Department of Environmental Quality
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EXECUTIVE SUMMARY

Introduction

This report describes activities performed and data collected for Pima County's Arizona Pollutant Discharge System (AZPDES) Permit No. AZS000002 between July 1, 2018 and June 30, 2019. This permit authorizes Pima County to discharge stormwater from a municipal separate storm sewer system (MS4) to waters of the United States.

This report is the ninth annual report prepared under the new state permit issued on June 16, 2011 and effective on July 18, 2011, herein referred to as the 2011 MS4 permit. Under the previous EPA MS4 permit issued on February 14, 1997, fourteen annual reports were prepared.

Certification

Pima County's principal executive officer signs and certifies this annual report was prepared by qualified personnel to properly gather and evaluate the information submitted (Part 2).

Stormwater Management Program (SWMP)

Best management practices (BMPs) were implemented in accordance with the SWMP during the reporting period. Information for the SWMP is found in the following parts: Narrative summary of SWMP activities (Part 3 and Appendices), Numeric summary of SWMP activities (Part 4), Evaluation of SWMP (Part 5), and Modifications to SWMP (Part 6).

Wet Weather Monitoring

Water quality samples were collected from the five Monitoring Sites (Part 7). Storm event records were recorded and summarized (Part 8). Analytical results for the water quality samples (Part 9), the water quality assessment (Part 10) and the estimate of annual pollutant loadings (Part 11) document the quality of surface water flows.

Expenditures and Proposed Budget

A summary of the annual expenditures and the proposed budget are summarized (Part 12).

Conclusions

Pima County implemented the SWMP and Wet Weather Monitoring Program. Activities included maintenance of the roadways and drainage systems. Inspections were performed at 40 outfalls, 106 construction sites, 86 post construction sites, 10 County Facilities and 20 private industrial facilities. The public reported 1,197 environmental complaints. All were inspected or referred to another jurisdiction. These inspections resulted in 201 Notices of Violation and 175 remediated sites. Ten stormwater samples were collected at five monitor sites. Review of the water quality results for 133 parameters shows copper, silver, *E. coli* and pH were outside Arizona's Surface Water Quality Standards (SWQS). Copper was higher than SWQS twice and E coli was high four times. The copper, silver and pH are not considered issues as there is either an existing control measure to reduce the concentrations or the occurrence was isolated. A public outreach campaign is planned for two watersheds to reduce E coli concentrations. The remaining 102 parameters met the established SWQS.

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1. General Information

A. Name of Permittee: Pima County

B. Permit Number: AZS000002

C. Reporting Period: July 1, 2018 - June 30, 2019

D. Name of Stormwater Management Program Contact: Marie Light

Title: Principal Hydrologist

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E. Name of Certifying Official: Carmine DeBonis Jr.

Title: Deputy County Administrator for Public Works

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F. Scope of Permit

The physical components within the permit area include 2,339 miles of roadway, 58.6 miles of storm drains and appurtenances that collect and convey runoff from precipitation events, with lengths reported by Pima County Department of Transportation (PDOT) and Regional Flood Control District (RFCD), respectively. The permit area is unincorporated Pima County within the Santa Cruz River watershed (Figure 1-1, blueish-green area). In both rural areas and metropolitan areas, runoff collects in ephemeral stream channels and infiltrates into alluvial deposit in the valley (USGS, 1973). Flows in ephemeral stream channels occur in response to rainfall events that are larger than 0.2 inches. Most runoff infiltrates within Pima County.

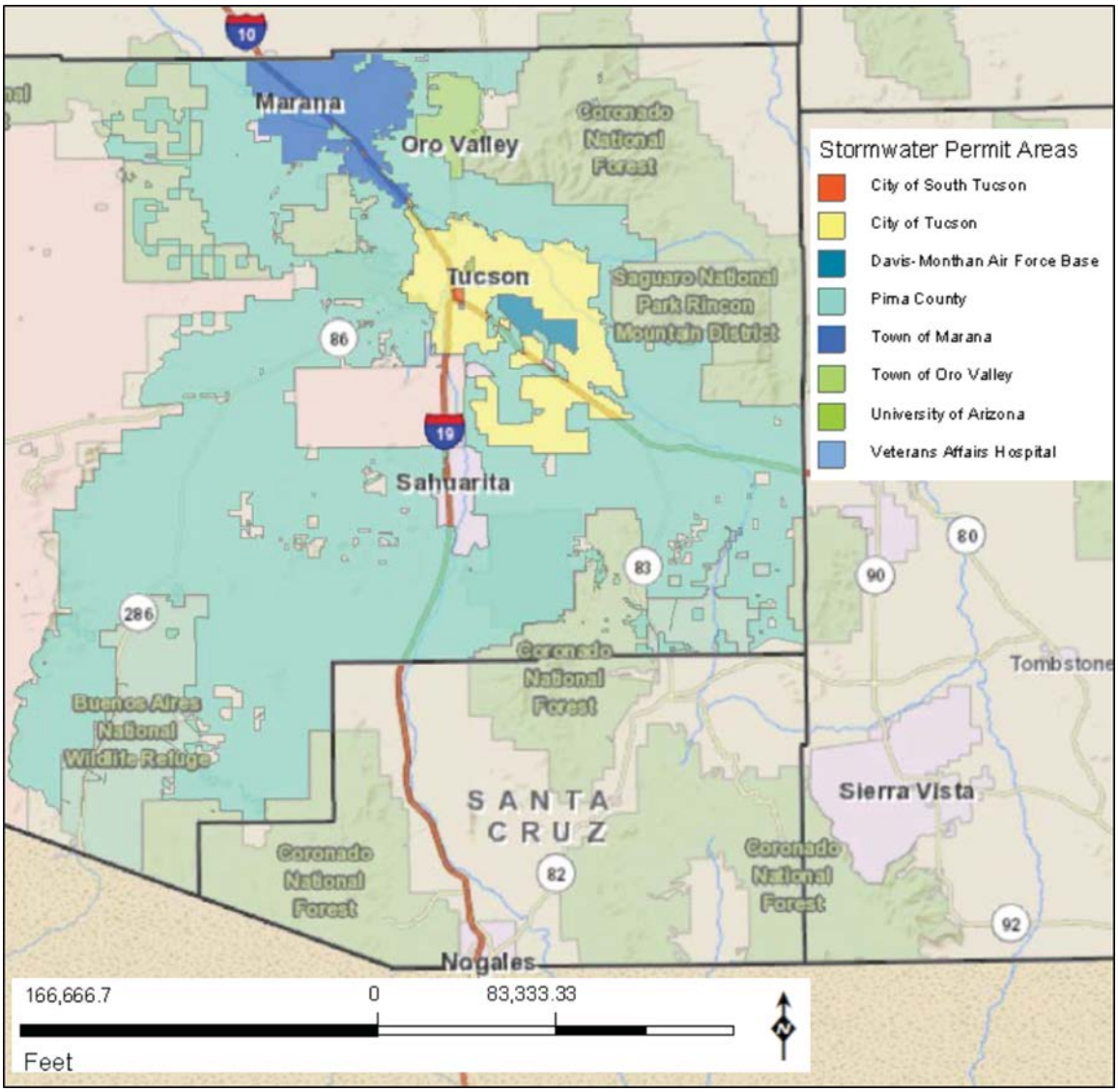

Figure 1. 2019 AZPDES Permit Area Map

Managements Activities

Management of the program includes coordinating with Pima County departments that conduct stormwater inspections at construction projects, maintain roadways and drainageways, purchase open space to conserve land and managing stormwater operations between six county departments. Pima County collaborates with local jurisdictions, businesses, educational institutions, and interested members of the public to engage the public in restoring and maintaining the integrity of surface waters in the county. Education and training include teaching techniques to keep water clean and using stormwater as a resource for landscape irrigation and other beneficial uses. Staff works with individuals ranging from novices to professionals as well as kids to great grandparents.

Field Activities

Pima County inspects outfalls, construction sites, industrial facilities, and reported environmental complaints that could lead to illicit discharge detection and elimination. To characterize water quality, Pima County collects water samples at five monitor sites representing low density residences, medium density residences, high density residences, commercial and industrial land uses.

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Annual Report Certification and Legal Authority

Written by: **Date:**

Marie Light — 09-25-2019

Marie Light
Principal Hydrologist

Reviewed by: **Date:**

R Grimaldi — 9.26.19

Richard Grimaldi
Deputy Director, Department of Environmental Quality

R Grimaldi — 9.26.19

Ursula Nelson FOR
Director, Department of Environmental Quality

Approved by:

I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

9/29/19

Carmine DeBonis Jr.
Deputy County Administrator for Public Works

September 29, 2019

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2. Narrative Summary of Stormwater Management Program

Pima County's municipal separate storm sewer storm drain system consists of 2,339 miles of roadways, 58.6 miles of storm drains, and infrastructure collecting runoff into drainageways or discharging runoff to ephemeral stream channels. Pima County utilizes a Public Awareness Program and a Public Participation Program to invest in behaviors protecting the quality of stormwater as it flows through the county. The public is encouraged to report illegal dumping and unusual environmental conditions to remove materials in washes or on land that could be transported into a wash during rainfall events. Management of Pima County Facilities includes maintenance of infrastructure and acquisition of property to prevent stormwater pollution. Inspections of Industrial Facilities and Construction Sites also reduce stormwater pollution. Post Construction activities include inspections once construction is completed at a site as well as implementation of Green Infrastructure and Low Impact Development (GI/LID) to prevent flooding and stormwater pollution.

A. Public Awareness

The public awareness program involves on-going education of the public and businesses, and contributes to environmental and stormwater educational events. Pima County DEQ staff delivered the keep-stormwater-clean message using literature, promotional materials, presentations, and assistance to business. A wide range of literature provided to the public includes 48 types ranging from bookmarks, booklets, brochures, posters, stickers, bags and fact sheets (Appendix A). Literature is being prepared in both Spanish and English as the demographic population is 35% Hispanic or Latino.

<u>Conferences, Seminars and Presentations</u>
Pima Community College requests PDEQ staff to provide a three-hour presentation for students in the class *Building/Construction Technology 265 Sustainability*. The presentation provided on September 27, 2018 addressed the application of Low Impact Development and Green Infrastructure to achieve sustainable water use. Pima County presents requested information once each year to classes ranging between 5 and 20 registered students.

Staff presented Low Impact Development strategies to the Western Coalition of Arid States Fall Conference "Living in the Bullseye of Drought", which had about 150 registered participants from the southwest as well as to the Pima County Local Drought Impact Group. The forth presentation in this fiscal year covered stormwater compliance for the construction industry at Pima County's Utility Coordination Committee designed to keep utility construction coordinated.

Pima County Department of Environmental Quality organized and marketed two training sessions with Arizona Chapter of Associated General Contractors for Tucson in late January and early February 2019 held at Pima County's Water Campus. Thirty-one people registered for the two-day Erosion Control Coordinator Training and included 7 Pima County staff members and 24 non-county participants, one of whom came from Cochise County. The Refresher Course had 13 registrants.

MS4s within Pima County. ADEQ and the construction industry met four times at the Stormwater Management Working Group (SWMWG) hosted by Pima Association of Governments (PAG) to develop a stormwater message for the area. PAG won a grant through ADEQ 604(b) Funding for Watershed Planning and implemented a project to install pet waste stations in cooperation with the Pima County. Pima County Natural Resources, Parks and Recreation (NRPR) developed the design of the stations and provided the materials for the stations. Staff from the Pima Animal Control Center built the pet waste stations. NRPR installed 30 along The Loop and 20 in public parks. PAG provided the stickers carrying the message "Scoop it. Bag it. Trash it." (Figure 2).

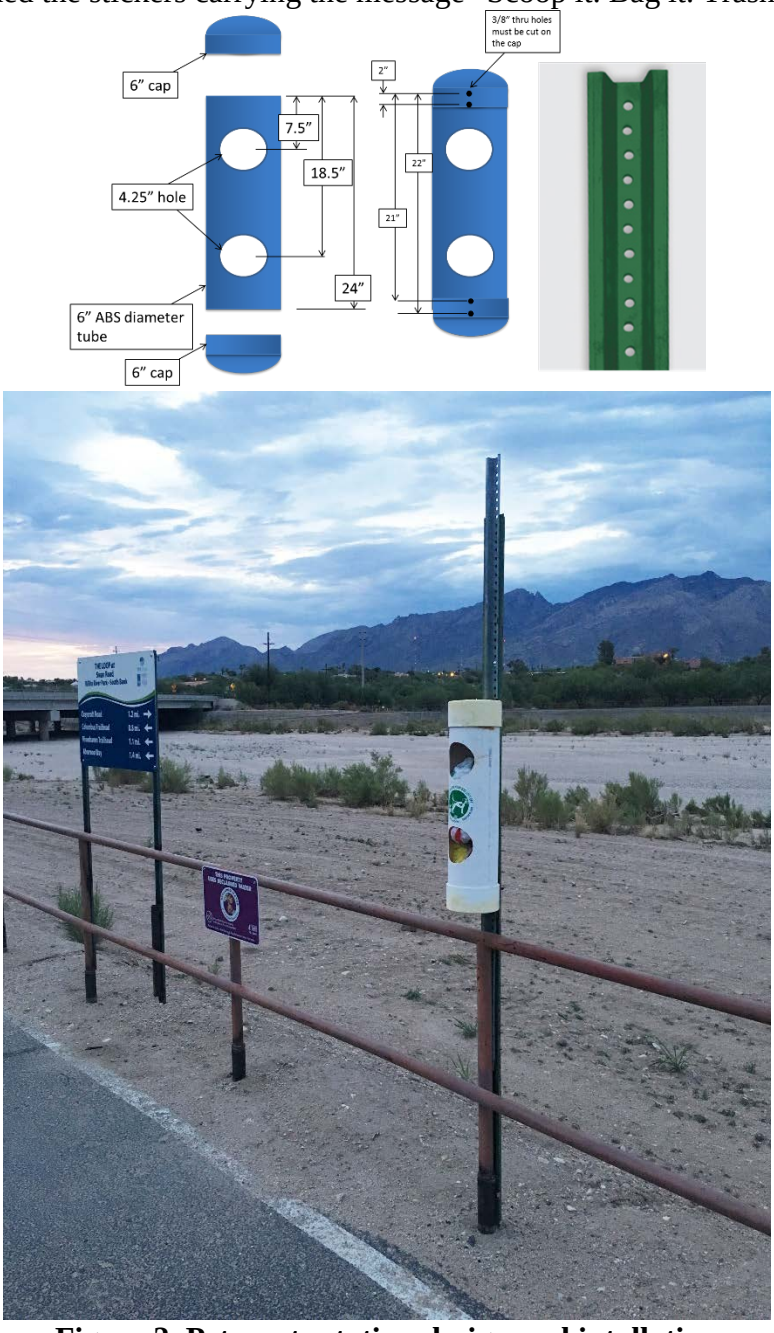

Figure 2. Pet waste station design and intallation

The slogan "Clean Water Starts with Me" was used for the ninth consecutive year to increase familiarity with the successful message. Artwork and style matches the imagery used by the local jurisdictions in school programs. During the February 26, 2019 Sahuarita SciTech Festival, PAG distributed bottles with that logo to students that answered stormwater questions correctly.

Pima County coordinates with PAG to develop the Green Infrastructure Prioritization Tool. Pima County Regional Flood Control District provided the LiDAR layer showing where stormwater flows across the land. This fiscal year PAG add more data layers, such as a park score index to enhance data driven decision making when selecting green infrastructure locations.

Pima County Department of Environmental Quality contracted for a phone survey in May 2019 to assess the public's attitudes towards stormwater, their trash disposal behaviors, and perceived value of uses near a wash. The results were finalized in a report (FMR Associates, 2019) and the results were presented to Pima County, Town of Oro Valley, City of Tucson, Town of Marana and PAG staff working on air and water quality public outreach in early July 2019. Half of the participants understand the stormwater flows to a river or wash and the remainder believe it flows to the groundwater, treatment plants, canals or are unsure where the water goes. The highest perceived uses of land near a wash are to reduce floods and recharge groundwater. Two thirds of respondents indicated green infrastructure is used at home or their business. 90% of respondents indicate there is a serious (44%) or moderate (46%) problem with pollutants entering storm drains in Tucson. Three quarters know to contact a governmental agency if they witness someone dumping trash or chemicals into a storm drain or wash.

Business Assistance Program

Activities in the Business Assistance Program help local businesses comply with applicable environmental requirements (Table 2). Pima County DEQ staff assists businesses in the completion of permit applications, clarifies the complex regulations, identifies potential violations, informs businesses about pollution prevention methods and makes suggestions on reducing stormwater discharges to stay in compliance. Free literature is provided upon request.

Table 1. Summary of Business Assistance Program

Type of Assistance	Number
Telephone/E-mail inquiries	150
DEQ office assistance visits	25
Letters/information mailed	20
Educational literature distributed	6,868
Seminars/presentations given	6
Number of times stormwater website or LID website was visited	1,026
Number of times website for Water & Wastewater Infrastructure, Supply & Planning Study	622
Number of times Pima County's Comprehensive Plan Pima Prospers website was visited (chapters containing stormwater management, rainwater harvesting or LID) was visited	2,159

B. Public Participation

Engaging the public in substantive actions to reduce pollutants from entering stormwater is key to long-term success. Members of the public clean trash from roadways and drainageways, recycle or dispose of hazardous materials at the Household Hazardous Waste Facility and report environmental issues to Pima County DEQ.

Adopt-a-Roadway Program
Volunteers in Pima County's Adopt-a-Roadway program clean up roadways and public lands. The program had 357 clean-up events over a total length of 580 miles. Volunteers removed 6,934 bags from the adopted roads (Appendix B).

Antifreeze, Batteries, Oil and Paint (ABOP) Program
Pima County contracted Tucson Recycling & Waste Services on June 1, 2013 to operate the County's landfills and transfer stations. Recycling of antifreeze, batteries, oil and paint (ABOP) occurs at Catalina Transfer Station, Ryan Transfer Station, and Sahuarita Transfer Station. Additionally, used oil is recycled at the Ajo Landfill. Recycling is free and participants are encouraged to be careful with their containers during transport. Tucson Recycling & Waste Services tracks the number of batteries and gallons of paint and they recycle the oil and antifreeze with Arizona Waste Oil Services Inc. who provides an annual estimate of the amounts (Appendix C).

Environmental Complaints
The public and businesses are encouraged to fax, phone or e-mail information about environmental complaints to Pima County DEQ. Each complaint is inspected or, if the location of the complaint places it within another jurisdiction, the complaint is referred to the responsible jurisdiction. Additional information about the inspection and potential enforcement process is described in the next section on illicit discharge detection and elimination activities.

C. Illicit Discharge Detection and Elimination Activities

Pima County DEQ receives complaints from the general public, elected officials, regulators, and local governments identifying potential sources of pollutants that could endanger public health or the environment. Each complaint within Pima County's jurisdiction is inspected to determine if a pollutant has entered the environment and if so, the severity of the problem. The complaint is tracked until it is closed (Appendix D) or is escalated to the enforcement action of a Notice of Violation (NOV). NOVs are closed when the pollutant has been abated (Appendix E).

The number of complaints filed within Pima County's jurisdiction during this fiscal year was 1,197, with 140 complaints related to liquids flowing in the MS4. 90.1% of these complaints were inspected within 3 days, which meets the permit requirement of 80%. These complaints led to 201 Notices of Violation (NOVs), six of which were related to liquid discharges. All six were resolved within 53 days of receiving the complaint meeting the permit requirement of closing 80% of the cases within one calendar year of the original enforcement action. Of the remaining 195 NOVs, 169 cases were closed within the year, 22 cases remain open, and 4 are in escalated enforcement

processes such as assessment of penalties, referral to Pima County Attorney's Office, an order to show cause with the court, or contempt of court.

Illicit discharges of liquids to the MS4 are relatively rare due to the high visibility of the ephemeral stream system and the high likelihood that a liquid illicit discharge will be seen and tracked to the source. The most common impact to ephemeral streams is dumping solid waste in a remote location (61%). These types of events are reported by the public as an environmental complaint. Pima County takes the extra step of inspecting 100% of the 40 identified outfalls within the permit area to assess if liquid illicit discharges are taking place (Appendix F-1). This is over and above the permit requirement of inspecting 20% each year. While 23 are rated major outfalls based on size, none have a high priority due to the lack of illicit liquid discharges. In addition, both the Pima County Department of Transportation (PDOT) and Regional Wastewater Reclamation Department (RWRD) document when spills occur within the county at County Facilities (Table 2); this year no spills were reported for either department.

D. County Facilities

Management of County Facilities includes preparing an inventory of County Facilities, GIS mapping of the MS4 features, maintaining roadway and drainageway infrastructure, drainageways, acquiring land to conserve open spaces, inspecting facilities for implementation of Pollution Prevention Plans and training staff directly involved in stormwater activities. All activities are preventive measures to keep stormwater clean.

Table 2. Spills within Permit Area

Date	Depart-ment	Location	Town-ship-Range-Section	Description	Response
None	PDOT	-	-	-	-
12/05/18	RWRD	8740 E Glenhurst Pl	12 13 25NE	Hydraulic oil leaked onto asphalt private driveway	Absorbent material applied to spill area. Soiled material was removed with bags. Area was washed down with water by pressure washer.

PDOT = Pima County Department of Transportation
RWRD = Pima County Regional Wastewater Reclamation Department

County Facility Inventory and Spill Prevention

Pima County owns or operates 17 facilities with the potential to discharge pollutants to receiving waters and which do not already have an environmental permit from ADEQ (Appendix G). One

has a No Exposure Certificate and thirteen have a site specific Pollution Prevention Plan. The facilities have been inspected to verify the plans are being implemented.

When the permit was first issued, a wide net was cast to assess all County Facilities for potential to discharge pollutants to stormwater. Aside from the seventeen noted above, fifteen facilities are permitted with Arizona Department of Environmental Quality water permits such as Aquifer Protection Permits (APP) and Arizona Pollutant Discharge Elimination System (AZPDES). An additional sixteen facilities were found to be outside the permit area or do not discharge pollutants either because no chemicals are used at the site or chemical use occurs within a structure.

Proper use and storage of chemicals is regulated within Pima County through enforcement of local requirements (environmental nuisance, solid waste, and liquid waste requirements) established in Title 7 of the Pima County Code (Pima County, 2011b). Contractors hired to maintain Pima County landscaped areas and public right-of-ways are required to follow spraying protocols established by State of Arizona rules and manufacturer's recommendations.

GIS Mapping

The layers of Pima County's Geographic Information System (GIS) facilitate the management of stormwater (Appendix H).

Infrastructure Maintenance

Roadways

Pima County Department of Transportation (PDOT) maintains 2,339 miles of roads and the drainageways in the road right-of-ways. The types of roadway maintenance include sweeping, shoulder repairs, pothole repairs, grading and blading, sidewalk and curb repair, street surface repairs and litter and debris removal (Appendix I).

Drainageways

Pima County RFCD maintains 450 miles of drainage, excluding the major water courses of the Santa Cruz River, Rillito River, Pantano Wash and Cañada Del Oro Wash. RFCD prioritizes 150 miles for inspection, and inspects the identified outfalls (Appendix F) and drainage reaches. They then follow up with grading; spot litter, debris, weed control; sediment removal; mowing; and spraying vegetation where needed (Appendix J).

Land Conservation

Land has been purchased under the 1997 Open Space Bond Program (OSBP), the 2004 Conservation Acquisition Bond Program (CABP) and the Flood Prone Land Acquisition Program (FLAP) to conserve land (Appendix K). The 1997 OSBP and 2004 CABP protect the region's most prized natural and cultural resources (Pima County, 2011d). The FLAP preserves land in floodways (Appendix N).

Training staff directly working on stormwater control measures

Pima County DOT conducts weekly training for staff in the field that addresses technical as well as safety and stormwater topics. Pima County Regional Wastewater Reclamation (RWRD) expanded their training program to provide safety and stormwater training for all field staff.

E. Industrial and Commercial Facilities

The Industrial Facilities Inventory is based on ADEQ's list of facilities that filed for the 2010 Multi-Sector General Permit (2010 MSGP) and facilities which need to file a Notice of Intent for the 2010 MSGP. Facilities located within the permit area and which have the potential to discharge to a Pima County roadway or drainageway were added to the inventory (Appendix L-1). Stormwater inspections are designed to evaluate consistency with the ADEQ's 2010 MSGP and compliance with Pima County ordinances. The Site Inspection Report form was modified to incorporate the 2010 MSGP and Pima County 2011 MS4 permit. Of the 52 industrial facilities, ten were inspected during this fiscal year (Appendix L-2). All industrial facilities permitted during the last five years were inspected. Facilities with the potential to release hazardous substances are also identified (Appendix L-3).

F. Construction Sites

Activities reducing pollutants to stream channels include plan reviews, issuance of air quality permits and Floodplain Use Permits, construction site inspections, and staff training.

Plan Reviews

Pima County Development Services Department (DSD) reviews plans before issuing construction permits or building permits. These plans must conform to requirements for Pima County Buffer Overlay Zone (BOZO), grading standards (GS), setback requirements for BOZO and GS, hydro seeding and revegetation, Hillside Development Overlay Zone and surface stabilization (Appendix M). Pima County DSD staff or their delegates inspect the sites to verify the construction is proceeding according to approved plans.

Pima County Permits

Septic Systems

All new septic systems within Pima County undergo pre-construction design approval, percolation testing, and post-construction installation approval. Septic system failure or exfiltration of water from these systems into the Pima County MS4 rarely occurs. Potential surface discharges from a septic system are regulated under Pima County Code Title 7 §7.21.025.A.

Floodplain Use Permit (FLUP)

Pima County RFCD issues FLUPs for specific improvements within the regulatory floodplain or erosion hazard area (Appendix N). The permits are required prior to beginning construction in areas were flows exceed 100 cubic feet per second or where sheet flooding occurs.

Pima County Air Quality Activity Permits

Pima County requires air quality activity permits, called fugitive dust activity permits, for trenching operations, road construction, and land stripping or earthmoving activities that disturb one acre or more. Each permit requires the construction site operator to take reasonable precautions to control fugitive dust emissions from the site. Proper dust suppression techniques

prevent the deposition of windblown dust that may later become entrained in stormwater and reduces tracking from construction sites.

Construction Site Inventory and Inspections

Pima County DEQ prepares a construction site inventory based on ADEQ's list of operators filing for the 2013 Construction General Permit (CGP) as well as identification of sites that need to file an NOI for the 2013 CGP. A total of 106 projects obtained Notices of Intent (NOI) during the fiscal year. A total of 179 inspections were conducted at 93 construction sites. Some projects did not receive a stormwater inspection as the site was inactive, an NOT had been filed, or were only inspected routinely under the requirements of the 2013 Construction General Permit (Appendix O-1).

The average number of days for a construction site to return to compliance if it was out of compliance was 15.5 days. Three sites took longer than one month to return to compliance during the fourth quarter of 2019 and remained in compliance since.

G. Post Construction

After construction has been completed, an inspection is performed to track the effectiveness of the new construction and if the site has been properly cleaned of temporary sediment and erosion control measures. The post-construction site inventory (Appendix P-1) identifies which sites have been inspected and copies of the site inspection reports show how well the projects are functioning (Appendix P-2). Post-construction inspections are typically conducted within one year after the completion of the project; however, some post-construction inspections had been delayed due to staff vacancies in the fiscal year 2017/2018.

The completion of the project is determined by the date of which the notice of termination (NOT) is submitted to the Arizona Department of Environmental Quality. Post-construction inspections ensure that post-construction stormwater controls are adequate, complete and maintainable. Post-construction inspections also encompass the verification of compliance with specific Pima County ordinances. These ordinances confirm that retention/detention basins do not cause an environmental nuisance, proper disposal of used oil and the removal of construction debris and temporary stormwater controls.

H. Non-filer Reporting

Pima County requests entities provide a copy of the NOI Certificate for activities appearing to qualify for a Construction General Permit or a Multi-Sector General Permit. If an NOI has not been obtained, the name, address and contact information are submitted to the Surface Water Monitoring and Assessment office in Phoenix's main office. Sometimes in the process of making a request, a construction site manager will obtain an NOI, which shifts the status from being a non-filer to a filer. Between July 1, 2018 and June 30, 2019, Pima County reported one non-filer to ADEQ.

3. Numeric Summary of Stormwater Management Program Activities

Table 3. Numeric Summary of Stormwater Management Program Activities

Control Measures (number, unless specified otherwise)	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**
Illicit Discharge Detection and Elimination Program (See Appendix D, E & F for details)					
1. County Employee Training					
Training sessions (non-stormwater discharges, IDDE program)	9	2	0	1	3
Employees attending training	14	7	0	1	11
2. Spill Prevention (Appendix D & E)					
County Facilities identified with hazardous materials	11	34	34	34	17
Spills in outside areas @ County Facilities w/ hazardous materials	0	3	4	0	1
Facility assessments completed	17	17	17	17	17
Date of last review of Site Specific Pollution Prevention Plan (materials handling and spill response procedures)	06/30/15	05/23/16	5/23/16	5/23/16	6/18/19
3. Outfall Inspections (Appendix F)					
Outfalls inspected[2]	40	40	40	40	40
Priority Outfalls identified to date	40	40	40	40	40
Priority Outfalls inspected	40	40	40	40	40
Dry weather flows detected	0	1	0	0	0
Dry weather flows investigated	NA	1	NA	NA	NA
Major outfalls sampled during dry weather flows	0	0	0	0	0
Illicit discharges identified	0	0	0	0	0
Illicit discharges eliminated	NA	NA	NA	NA	NA
Amount of stormwater drainage system inspected	33%	33%	33%	33%	33%
Storm drain cross-connection investigations	0	0	0	0	0
Illicit connections detected	0	0	0	0	0
Illicit connections eliminated	NA	NA	NA	NA	NA
Corrective/enforcement actions* initiated w/in 60 days of identification	395	355	265	296	201
Cases* resolved w/in 1 year of original enforcement action (%)	374	314	230	267	175
Environmental complaints received from public	1,330	1,162	1,097	1,225	1,197
Environmental complaints responded to (%)	100%	100%	100%	100%	100%
Responses** initiated within three (3) business days of receipt	92%	93%	94%	80%	91%
County Facilities (See Appendix G, I & J for details)					
1. Employee Training					
Training events (Part 3 for dates & topics)	1	2	2	1	2
Staff trained	8	7	6	1	14
2. Inventory, Map, or Database of County Owned/Operated Facilities					
Facilities on inventory	43	43	34	32	17
Date identification of Higher Risk facilities completed	-	-	-	-	-
Date prioritization of County Facilities completed	-	-	-	-	-
3. Inspections					

Control Measures (number, unless specified otherwise)	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**
Miles of MS4 drainage system prioritized for inspection	150	150	150	150	150
Miles of MS4 drainage system visually inspected	238	238	238	238	238
Higher Risk County Facilities*** inspected [no high risk]	0	0	0	0	0
Higher Risk County Facilities*** needing improved stormwater controls	NA	NA	NA	NA	NA
4. Infrastructure Maintenance					
Linear miles of MS4 drainage system cleaned each year	175	175	175	175	175
Street and intersection sweeping (miles)	2,740	5,317	2,854	1,324	1,495+
Catch basins identified to date	996	1,092	1,121	968	1,125
Number of retention/detention basins cleaned	56	55	58	54	55
Catch basins cleaned	0	0	0	0	0
Amount of waste collected from catch basin cleaning (tons)	0	0	0	0	0
Industrial & Commercial Sites Not Owned by the County (See Appendix L for details)					
Training events for county staff	12	1	1	1	1
County staff trained	183	4	1	1	2
Facilities on priority list	51	50	52	62	60
Industrial facilities inspected	12	9	10	3	18
Corrective/enforcement actions initiated on industrial facilities	12	9	8	2	10
Cases resolved w/in 1 year of original enforcement action (%)	0	1	2	0	3
Construction Program Activities (See Appendix M & O for details)					
Training events for county staff (Part 3.A for topics)	5	3	1	1	7
County staff trained	34	27	2	1	29
Construction/grading plans submitted for review	50	62	92	86	75
Construction/grading plans reviewed	50	62	92	86	75
Construction sites inspected	39	129	150	68	93
Corrective/enforcement actions initiated on Construction Sites	29	89	75	34	31
Corrective/enforcement actions resolved on Construction Sites	23	89	75	34	31
Post Construction Program Activities (Appendix P)					
Post-construction inspections completed for Post Construction	56	89	79	30	86
Corrective/enforcement actions initiated for Post Construction	4	16	7	4	0

* Enforcement actions and cases resolved are all environmental complaints where the property owner was initially unresponsive.

** Responses are for cases associated with liquid discharges to the MS4.

*** High risk facilities have been permitted with an MSGP. All reporting, including inspections and improvements are reported pursuant to the facility MSGP.

NA Not applicable

4. EVALUATION OF STORMWATER MANAGEMENT PROGRAM

Activities of the Stormwater Management Program (SWMP) include control measures to reduce discharges in stormwater through public awareness and public involvement programs, maintenance of roadways and drainage ways, and investigation of illicit connection and illegal dumping, new development and significant redevelopment programs, industrial facility inspections, construction site inspections, and enforcement actions. Water quality data from five monitor points documents runoff quality. Inspections at construction sites and industrial facilities maintain awareness of the importance of following Stormwater Pollution Prevention Plans. Regular inspections and business assistance is needed to maintain surface water quality consistent with state SWQS and AZPDES permits.

Update of Recommendations

Recommendations with from previous annual reports have been continued. Completed recommendations are no longer reported on and additional analyses were implemented this year to improve the program. A summary is described below.

1. Assess Effectiveness of Environmental Complaint Enforcement.

PDEQ frequently issues NOVs for solid waste on private property and wildcat dumping on public land in the Upper Santa Cruz watershed and the Brawley watershed. The average annual number of enforcement cases is declining by about 23 cases each year. The general trend is significant as the annual number of NOVs in 1996 reached nearly 900 and fell in fiscal year 2019 to 201.

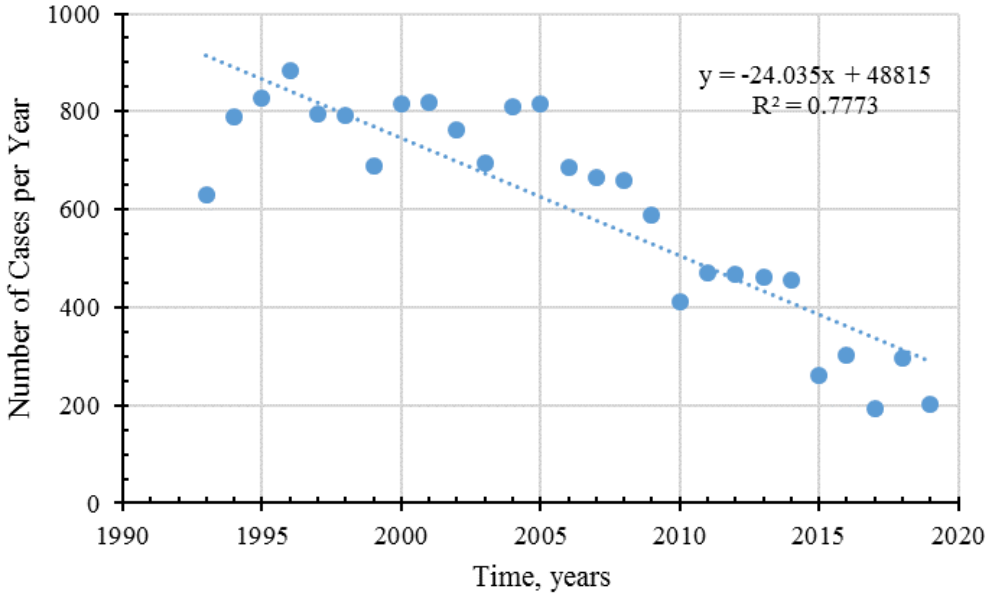

Figure 2. Number of Enforcement Cases related to Pollutants Exposed to Rain of Runoff

2. Evaluate water quality and pollutant loadings by season

Eight years of water quality data have been collected under the new permit. Full sets of analytes are collected in both seasons, when water is available. The monitor points have six to seven summer samples, and four to seven winter samples. The data shows summer samples have higher copper, silver and *E. coli*. The elevated metals are likely associated with more particulates carried by higher velocity flows. Elevated *E. coli* may be associated with more growth of pathogens during the high summer temperatures.

3. Calculate acres of five land uses within new permit area to facilitate evaluation of pollutant loading estimates by land use.

The areas of the five land uses within the new permit area have been calculated. The MS4 is dominantly Low Density Residential. This trend did not change in fiscal year 2019.

Table 4. Land Use Area within Unincorporated Pima County

Land Use	Area (square miles)	Percent
High Density Residential	5.7	0.29%
Commercial	5.9	0.30%
Industrial	21.2	1.08%
Medium Density Residential	160.0	8.17%
Low Density Residential	1,766.7	90.16%

4. Develop outreach program to address elevated copper and E. coli at selected monitor site watersheds.

Due to legislation enacted in California and Washington in 2010 mandating the reduction of copper in brakes, the brake manufacturing industry agreed to phase out copper in brakes over a fifteen years (Copper Development Industry, 2013). As a nationwide program has been implemented to address this issue, an outreach program for copper will not be implemented, though relevant information will be provided to interested parties. The copper concentrations in the stormwater samples are less frequently above the Surface Water Quality Standards and are also lower in magnitude. This trend is expected to continue.

5. Improve compliance activities for construction projects.

Construction managers for non-compliant construction projects averaged 15.5 days to return to compliance. Three facilities took longer than one month to return to compliance during the fourth quarter of 2019. One facility remained in compliance throughout the remaining part of the fiscal year. When a non-compliance condition was observed at the other two facilities, the facilities returned to compliance within two weeks.

6. Improve compliance at post-construction projects.

All post-construction inspections showed the sites were in compliance this year.

A. Evaluation of Fiscal Year 2019 Stormwater Management Program

The Stormwater Management Program has made significant progress and has a high level of success in restoring and maintaining the chemical, biological and physical integrity of the surface waters flowing in Pima County's permit area. The written summary evaluates public education and outreach, public involvement and participation, IDDE, County Facility pollution prevention and good housekeeping practices, residential and commercial control measures, industrial facilities and construction sites.

1. Program Progress

Pima County developed a series of documents describing the procedures to be used in various activities impacting stormwater quality and identified in the 2011 MS4 Permit. The current date for the Standard Operation Procedure (SOP) is included.

- STW-001 SOP for Stormwater Inspection at a Construction Site (December, 2014)
- STW-002 SOP for Stormwater Post Construction Inspection (June, 2017)
- STW-003 SOP for Industrial Facility Inspection (December, 2014)
- STW-004 SOP for Illicit Discharge Detection and Elimination Inspection (June, 2017)
- Sampling and Analysis Plan for Stormwater Management Program (September, 2015)
- Pima County Stormwater Management Program (September, 2015)
- Stormwater Control Measure Field Manual (December, 2014)
- Stormwater Training Program (December, 2014)
- Template for Pollution Prevention Plan for Pima County Facilities (June 2016)

2. Program Successes

During the permit cycle, the following successes are attributed to Pima County's Stormwater Management Program and Regional Flood Control District.

- Organized Celebrate World Water Day by Keeping Washes Clean that included a day where citizens were invited to clean up a wash, a TV interview, two fact sheets and a website article.
- EPA Factsheet for Improving Community Resiliency with Green Infrastructure credited Pima County for using GI for flood control and drought management.
- Referral of 254 stormwater-related complaints to other jurisdictions functioning to clean up citizen reported environmental contamination.
- Partnered with University of Arizona's Wet Water Education for Teachers to expand outreach to youth audiences.
- Trained 45 children at Littlestown Community Center how to properly dispose of trash.
- Water conservation radio program to encourage the public to use stormwater to irrigate native plants to save on water utility bills, and potentially electricity bills if the native trees are planted to shade buildings.
- Pima County published the *Low Impact Development and Green Infrastructure Guidance Manual* on March, 2015 describing how stormwater harvesting features effective in the semi-arid climate of Pima County can be implemented at the neighborhood scale.
- The Pima County Board of Supervisors amended Title 18 (Zoning) to include Stormwater Harvesting Systems on March 17, 2015.

- The Pima County Comprehensive Plan *Pima Prospers* was adopted on May 19, 2015 and includes LID in land management and water resource management (Appendix R).
- Pima County Regional Flood Control District published the *Design Standards for Stormwater Detention and Retention Basins* in June, 2014 and was approved by Pima County Board of Supervisors on December 15, 2015. The manual represents a fundamental shift away from conveying runoff to a small number of downstream points through hydraulically efficient infrastructure toward retaining and using the runoff as close as possible to the source of the runoff for beneficial use.
- The Pima County Subdivision and Development Standards (May, 2016) encourages stormwater harvesting within the right-of-way using the Design Standards for Stormwater Detention and Retention as well as the *Low-Impact Development and Green Infrastructure Guidance Manual*.
- The Arizona American Society of Landscape Architecture (AZ ASLA) awarded Pima County and the other co-authors the "Honor Award" for the *Low-Impact Development and Green Infrastructure Guidance Manual* and associated *Case Studies*.
- The Pima County Board of Supervisors passed two resolutions 2017-39 and 2017-51 to align its operational efforts to meet the Unites States' commitment to the Paris Agreement on Climate Change. The fifth of six activities includes installing Low Impact Development feature and trees on County properties and rights-of-way (Pima County, 2017).
- The Pima County Green Infrastructure Plan was approved on September 5, 2018 and includes 43 projects to be built by 2025.
- Three of five wet weather monitoring sites were equipped with automatic samplers by the 2019 monsoon season. Operation of the samplers allows stormwater samples to be collected at multiple sites at the same time. This benefit has become increasingly important as more rainfall occurs during evening hours. The new equipment includes flow measurement devices from which the data will enable the calculation of the unit hydrograph to characterize watershed response to rainfall events.
- Pima County organized and advertised two trainings by the Arizona Chapter of Associated General Contractors in early 2019 where 44 people registered to take either the Erosion Control Coordinator Training or the Refresher course.
- Pima Animal Care Center and the Natural Resources, Parks and Recreation partnered with Pima Association of Governments to install 50 pet waste stations along The Loop and public parks in fiscal year 2019.

3. Reduction of pollutants to and from the MS4

The control measures implemented in the stormwater management program include Public Awareness and Public Participation; Anti-freeze, Batteries, Oil and Paint Program; Public Reporting and Response; Infrastructure Maintenance; Land Conservation and Enforcement actions.

a. Public Awareness and Public Participation

Outreach activities provide environmental literature and 6,868 pieces were collected by members of the public at libraries, public events and private events reaching a wide range of people with information specific to their interest. A phone survey conducted in May 2019 assessed the public's attitudes toward Low Impact Development and the public's perspective toward land use around

water courses. The information will be used to refine the outreach message to implement the LID Guidance Manual at the neighborhood scale.

Public participation included volunteers in Pima County's Adopt-a-Roadway program to clean up roadways and public lands. The program had 357 clean-up events over a total length of 580 miles. Outreach activities reduce the amount pollutants entering the MS4.

b. Anti-freeze, Batteries, Oil and Paint Program

The Pima County ABOP program collected 25,980 gallons of anti-freeze, oil and paint as well as 230 batteries. This recycling prevents the disposal in a landfill or from being dumped in the desert.

c. Public Reporting and Responses

Pima County received 1,197 complaints, with 140 relating to liquids discharging to the MS4 and responded to 90.1% within three days. Inspections effectively addressed most of the complaints and 201 resulted in an enforcement action of Notice of Violation (NOV). The 6 NOVs relating to liquid discharges were all closed within 53 days, which reduces the amount of pollutants entering stormwater.

d. Infrastructure Maintenance

Roadway maintenance swept 1,494.8 miles to remove sediment from streets and repaired roads which stabilized the surface reducing erosion (Appendix I). Drainageway maintenance includes clearing vegetation, mowing, removal of trash, and channel maintenance at 2,201 locations. The infrastructure maintenance reduces the amount of pollutants leaving the permit area.

e. Land conservation

Pima County has invested over $213.7 million to conserve 61,279 acres thereby preserving the natural landscape and reducing erosion that would contribute a pollutant to stormwater.

f. Environmental Complaints

The number of environmental complaints that require enforcement has declined from nearly 900 in 1996 to 201 in 2019. The consistent effort to teach proper contaminant handling methods or recycling strategies and firm enforcement for those who do not comply has resulted in a cleaner environment.

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5. Stormwater Management Program Modifications

ADEQ issued the new 2011 MS4 permit on June 16, 2011. A new Stormwater Management Program was developed to meet the provisions of the 2011 MS4 permit. Below are the identified changes to the stormwater management program.

1. **Addition of New Control Measures**
   No additional control measures were added during the last year.

2. **Addition of Temporary Control Measures**
   No additional temporary control measures were proposed.

3. **Increase of Existing Control Measures**
   ISCO auto-samplers were installed at three wet weather monitor sites enabling staff to collect more samples at the same time and log when flows first arrive at the sampling site. An additional 50 pet waste stations were added to The Loop and public parks to reduce the amount of *E. coli* entering the MS4. Other control measures were maintained.

4. **Replacement of Existing Control Measures**
   Existing Control Measures were not replaced.

5. **Modifications to SWMP**
   The 2015 Stormwater Management Plan has formed the basis for the County activities. The SWMP will be updated in fiscal year 2019/2020 to address recommendations from the 2019 audit with ADEQ of the Pima County Stormwater Management Program.

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6. Monitoring Locations

Five monitor sites are sampled each summer and winter season for field parameters, microbiology, metals, nutrients, toxic organic pollutants, volatile organic compounds (VOCs), semi-VOCs, PCBs and pesticides, as identified in the permit. Water quality data from each site is intended to characterize the water chemistry of runoff from five land uses, namely low density residential, medium density residential, high density residential, commercial and industrial. Results may also be used to identify and eliminate illicit discharges. The data is evaluated to assess the effectiveness of control measures to reduce the discharge of pollutants.

Table 5. Monitor Site Locations

Site No.	Receiving Water	Monitor Site Location Information				
		Location	Latitude Longitude	Elevation (famsl*)	Drainage Area (acres)	Dominant Land Use
1	Unnamed wash, tributary to Rillito River	Calle Esplendor/ Calle Barril	32°17'46.1" -110°54'30.6"	2642	2.2	Residential Low Density
2A	Unnamed wash, tributary to Rillito River	Ruthrauff Road/La Cholla Blvd.	32°17'32.6" -111°00'42.6"	2275	9.5	Residential Medium Density
3	Valley View Wash	Valley View Rd/ Sunrise Drive	32°18'22.9" -110°54'38.8"	2709	7.5	Residential High Density
4	Valley View Wash	Valley View Rd/ Sunrise Drive	32°18'23.0" -110°54'38.8"	2710	60.1	Commercial
5	Unnamed wash, tributary to Tucson Diversion Channel	4101 S. Country Club Rd	32°10'27.5" -110°55'34.1"	2542	48.4	Industrial

* famsl – feet above mean sea level

All sites have an adjacent weather station with a tipping bucket rain gage and remote data collection equipment using Pima County's Automated Local Evaluation in Real Time (ALERT) system. Flow is measured using a depth gage and channel characteristics or the bucket method. When sampling the stormwater, a pH meter with a temperature sensor is used to collect pH. For deep sampling locations, a dipping pole is used to collect the water samples.

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7. Storm Event Records

Summer storms in Pima County typically have a short duration and high intensity. Winter storms are generally longer in duration and less intense. The extended event duration in the winter may result in a delay from the time rainfall begins and runoff begins that is greater than one hour. Although permit and guidance documentation indicates the first sample is to be collected within an hour of the start of rainfall, storm runoff may not begin until several minutes or hours after the initial rainfall. In this case, first flush is collected when runoff begins.

During the reporting period there were 72 rainfall events, of which 28 had rainfall 0.20 inches or higher (Table 6). All sites qualified for sampling in both the summer and winter. Many summer rainfall events occurred within the 72-hour limitation and were not representative (NR). Heavy rainfall in short time intervals also caused dangerous conditions (DC).

The annual rainfall at the monitor sites ranged from 13.1 to 15.2 inches, all of which are above the annual normal rainfall of 11.59 inches (National Weather Service Forecast Office, Tucson, AZ, 2011).

Table 6. Storm Event Records for Monitor Sites

Season	Date	Site #1	Rainfall (in)	Site #2	Rainfall (in)	Site #3	Rainfall (in)	Site #4	Rainfall (in)	Site #5	Rainfall (in)
S	06/16/18	NF	1.02	NF	0.99	NF	1.02	NF	1.02		
S	07/05/18		0.16				0.16		0.16		
S	07/07/18			NF	0.23						
S	07/08/18		0.19		0.08		0.19		0.19		
S	07/09/18				0.12						0.12
S	07/10/18		0.08		0.04		0.08		0.08		
S	07/11/18										0.04
S	07/12/18									SC	0.55
S	07/13/18				0.12						
S	07/14/18				0.04					-	0.24
S	07/15/18	NF	0.28		0.19	NF	0.28	NF	0.28		
S	07/23/18		0.04				0.04		0.04		
S	07/24/18										0.16
S	07/25/18										0.04
S	07/30/18	AOS	0.63			SC	0.63	AOS	0.63	-	0.43
S	08/01/18			DC	0.71						0.19
S	08/06/18		0.04				0.04		0.04		
S	08/07/18									-	0.24
S	08/08/18				0.08						0.12

Season	Date	Site #1	Rainfall (in)	Site #2	Rainfall (in)	Site #3	Rainfall (in)	Site #4	Rainfall (in)	Site #5	Rainfall (in)
S	08/10/18	AOS	0.47		0.08	SC	0.47	SC	0.47		0.08
S	08/11/18	NR	0.63			NR	0.63	NR	0.63		
S	08/14/18										0.08
S	08/18/18		0.04				0.04		0.04		
S	08/22/18			SC	0.51						
S	08/23/18		0.04				0.04		0.04		
S	08/24/18	DC	0.39	-	0.87	DC	0.39	DC	0.39	-	1.14
S	09/01/18		0.04				0.04		0.04		
S	09/03/18	TD	0.20	-	1.34	TD	0.20	TD	0.20	-	1.46
S	09/04/18				0.15						
S	09/06/18	DC	0.35			DC	0.35	DC	0.35		
S	09/19/18	SC	0.55	-	0.55	-	0.55	-	0.55	-	0.74
S	10/01/18	-	0.28	-	0.56	-	0.28	-	0.28	-	0.40
S	10/07/18		0.16		0.03		0.16		0.16	-	0.67
S	10/12/18	-	0.32	-	0.40	-	0.32	-	0.32	-	0.27
S	10/13/18	-	0.90	-	0.35	-	0.90	-	0.90	-	0.51
S	10/13/18			-	0.24					-	0.24
S	10/13/18			-	0.39						
S	10/14/18			-	0.87						
S	10/16/18	-	0.28	-	0.39	-	0.28	-	0.28	-	0.31
S	10/16/18				0.04						
S	10/21/18			-	0.20					-	0.24
S	10/23/18	-	0.63		0.08		0.63		0.63		0.12
W	11/30/18		0.19		0.19		0.19		0.19		0.23
W	11/30/18				0.04						
W	12/06/18		0.12		0.16		0.12		0.12		0.12
W	12/07/18	AOS	0.40		0.12	SC	0.40	AOS	0.40	SC	0.31
W	12/07/18			SC	0.27						
W	12/25/18		0.11		0.12		0.11		0.11		
W	12/26/18				0.04					-	0.24
W	12/27/18	TD	0.24	-	0.35	TD	0.24	TD	0.24		
W	12/28/18									-	0.32
W	01/01/19	TD	0.20	-	0.20	TD	0.20	TD	0.20	-	0.31
W	01/01/19				0.04						
W	01/02/19										0.04
W	01/06/19	AOS	0.67		0.12	-	0.67	SC	0.67	-	0.87

Season	Date	Site #1	Rainfall (in)	Site #2	Rainfall (in)	Site #3	Rainfall (in)	Site #4	Rainfall (in)	Site #5	Rainfall (in)
W	01/06/19			-	0.71						0.04
W	01/10/19		0.03				0.03		0.03		
W	01/13/19				0.04						0.03
W	02/03/19			-	0.55					-	0.44
W	02/04/19	SC	0.63	-	0.23	-	0.63	-	0.63		0.19
W	02/06/19			-	0.20						0.08
W	02/14/19	-	0.47			-	0.47	-	0.47	-	0.32
W	02/15/19		0.16	-	0.47		0.16		0.16		
W	02/18/19		0.08		0.08		0.08		0.08		0.16
W	02/21/19		0.04				0.04		0.04		
W	02/22/19	-	0.51	-	1.07	-	0.51	-	0.51	-	0.51
W	02/22/19	-	0.31		0.07	-	0.31	-	0.31	-	0.63
W	03/12/19	-	0.36	-	0.39	-	0.36	-	0.36		0.16
W	03/12/19	-	0.39		0.08	-	0.39	-	0.39		
W	05/11/19		0.04		0.04		0.04		0.04		0.19
W	05/12/19	-	0.40			-	0.40	-	0.40		0.04
W	05/20/19		0.03				0.03		0.03		0.04
Summer total			7.72		9.65		7.72		7.72		8.39
Winter Total			5.38		5.58		5.38		5.38		5.27
Annual total			13.10		15.23		13.10		13.10		13.66

NR – Not representative
SC – Sample collected
IS – Insufficient sample for analytical method
IF – Insufficient flow for sample collection
NF – No flow
DC – Dangerous Conditions
TD – Technical Difficulty (Refer to Part 3H for details)
midN – rainfall during midnight hours
AOS – Staff monitoring/collecting data at other site
- Sample already collected

The no flow conditions on June 16, 2018 resulted from a rainfall event during the night that was spread out over a seven hour period, which is atypical of monsoon events. While the first rainfall event of the year soaks into the dry soils or is evaporated, this event had runoff that was too thin to collect a sample.

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8. Water Quality Data from Monitor Sites

The permit requires a full suite of water quality parameters on the first, third, and fifth years of the permit. In the other years a smaller set of analytes are defined. Due to drought conditions and missing samples from a monitor site, the pattern of collecting full suites every other year was difficult to track. To maintain a good data set, a full suite is collected for every event (Table 7).

Table 7. Monitor Site Sample Dates and Type of Sample Set

Site	Summer	Type	Winter	Type
1	09/19/18	Full suite	02/03/19	Full suite
2	08/08/18	Full suite	12/12/18	Full suite
3	07/30/18; 08/08/18	Full suite	12/12/18	Full suite
4	08/08/18	Full suite	01/06/19	Full suite
5	07/12/18	Full suite	12/12/18	Full suite

Analytical Methods in Full Suite:

- SM 9233B E. Coli
- SM4500-CN-BCE Total Cyanide
- EPA 1664A Oil & Grease, Total Petroleum Hydrocarbons
- EPA 624 Acrolein, Acrylonitrile
- EPA 8260 Volatile Organic Compounds (VOCs)
- EPA 625-BNA Semi-volatile Organic Compounds (SVOCs)
- EPA 625-P&PCBS Pesticides and PCBs
- SM 4500-NH3D Ammonia
- EPA 351.2 Total Kjeldahl Nitrogen
- EPA 365.1 Total Phosphorus, Ortho Phosphate
- EPA 353.2 Nitrate-Nitrite
- Hach 8000 Chemical Oxygen Demand
- EPA 200.8 Total Metals, Dissolved Metals
- EPA 245.1 Mercury
- SM 2540C Total Dissolved Solids
- SM 2450D Total Suspended Solids
- SM 5210B Biological Oxygen Demand

The tables summarizing the water quality data and comparing the results to surface water quality standards can be found in Appendix Q-1.

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9. Assessment of Monitoring Data

A. Stormwater Quality

This report is the eighth of a five year permit. Stormwater from all five sites were sampled in the fiscal year and all five sites were sampled for 133 compounds under the expanded list of parameters. Sufficient data has been collected to discern the difference between outliers and trends in the water quality parameters.

B. Surface Water Quality Standards (SWQS)

Analytical results from the sampling period were tabulated along with the applicable SWQS (Part 9). Results higher than SWQS are also reported (Tables 8 through 12, Figures 4 through 8) and discussed. Several parameters, namely Benzo(a)anthracene, Benzo(a)pyrene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, N-nitrosodi-methylamine, Aldrin, Dieldrin, Endrin, 7 PCBs and Toxaphene, have Method Detection Limits (MDLs) that are higher than the Surface Water Quality Standards established for the designated uses of the watersheds draining to the five monitor sites. The MDL used by the primary laboratory has been accepted by ADHS under laboratory license AZO159 for the associated methods, as shown in Appendix Q. MDLs are performed in accordance with 40 CFR, part 136 Appendix B. Alteration of this method is considered a major modification and may not be performed without permission from ADHS and Region 9 EPA so the analytical methods limit the direct comparison of results to SWQSs. Two VOCs, Diethyl phthalate and Di-n-butyl phthalate, used as plasticizers, were detected at very low concentrations. Given there were no other organic compounds detected, the stormwater was likely free of the compounds with MDLs above the SWQSs.

C. Pollutant Concentration Greater than Applicable SWQS

A review of the water quality results indicates a few pollutants are present. Elevated dissolved copper concentration were observed for Sites 2a, 3 and 5 and ranged from 4.3 to 34.3 µg/L. Elevated *E. coli* concentrations were observed for Sites 2, 4 and 5 and ranged from 821 to 6,830 Most Probable Number. Elevated dissolved silver concentrations were observed for Sites 1 and 4, and ranged from 1.5 to 6.0 µg/L. The pH was acidic at Site 4 for the first time since 2011. The dissolved copper and *E. coli* results are similar to previous year's results.

A historical description of the water quality parameters that are higher than the SWQS has been prepared for each wet weather monitor site. The data is tabulated and charts are provided for copper, silver, *E. coli* and pH to illustrate temporal trends.

Water quality monitoring at Site #1, a watershed with low density residential land use, has been monitored 10 times for the full suite of parameters specified in the permit during the last eight years. Four parameters, namely dissolved copper, dissolved silver, *E. coli*, and pH, have been higher, or outside, the Surface Water Quality Standards (Table 8). Monitor results indicate sporadic sources of contaminants that are typically just above the SWQS.

Table 8. Summary of Parameters with Concentrations Higher than SWQS at Site #1

Site ID: 1 Receiving Water: Rillito	Sample Date	Hardness (mg/L)	Copper Dissolved SWQS (µg/L)	Copper Dissolved Result (µg/L)	Result > SWQS?	Silver Dissolved SWQS (µg/L)	Silver Dissolved Result (µg/L)	Result > SWQS?	E.coli Result (MPN)	Result > SWQS?(575 MPN)	pH Result (SU)	Results > SWQS (6.5-9.0)
Summer 2011	07/04/11	67	16	31	Yes	-	-	-	48,840	Yes	6.4	Yes
Winter 11/12	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2012	07/15/12	31	7.6	5.8	No	0.4	<1	No	10	No	7.6	No
Winter 12/13	12/14/12	37	9.2	3.3	No	0.6	2.7	Yes	41	-	8.1	No
Summer 2013	-	-	-	-	-	-	-	-	-	-	-	-
Winter 13/14	11/22/13	26	6.5	4.2	No	0.3	<1	No	10	No	6.9	No
Summer 2014	08/12/14	55	13	5.3	No	1.1	<1	No	487	No	8	No
Winter 14/15	12/17/14	89	21	1.9	No	2.6	<1	No	15,500	Yes	7	No
Summer 2015	09/21/15	58	14	1.5	No	1.3	<1	No	1300	Yes	8.6	No
Winter 15/16	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2016	09/07/16	105	24	2.8	No	3.5	43	Yes	200	No	7	No
Winter 16/17	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2017	-	-	-	-	-	-	-	-	-	-	-	-
Winter 17/18	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2018	09/09/18	70	17	6.1	No	1.7	0.1	No	130	No	7	No
Winter 18/19	02/03/19	48	12	3.7	No	0.9	6.0	Yes	73.6	No	6.7	No

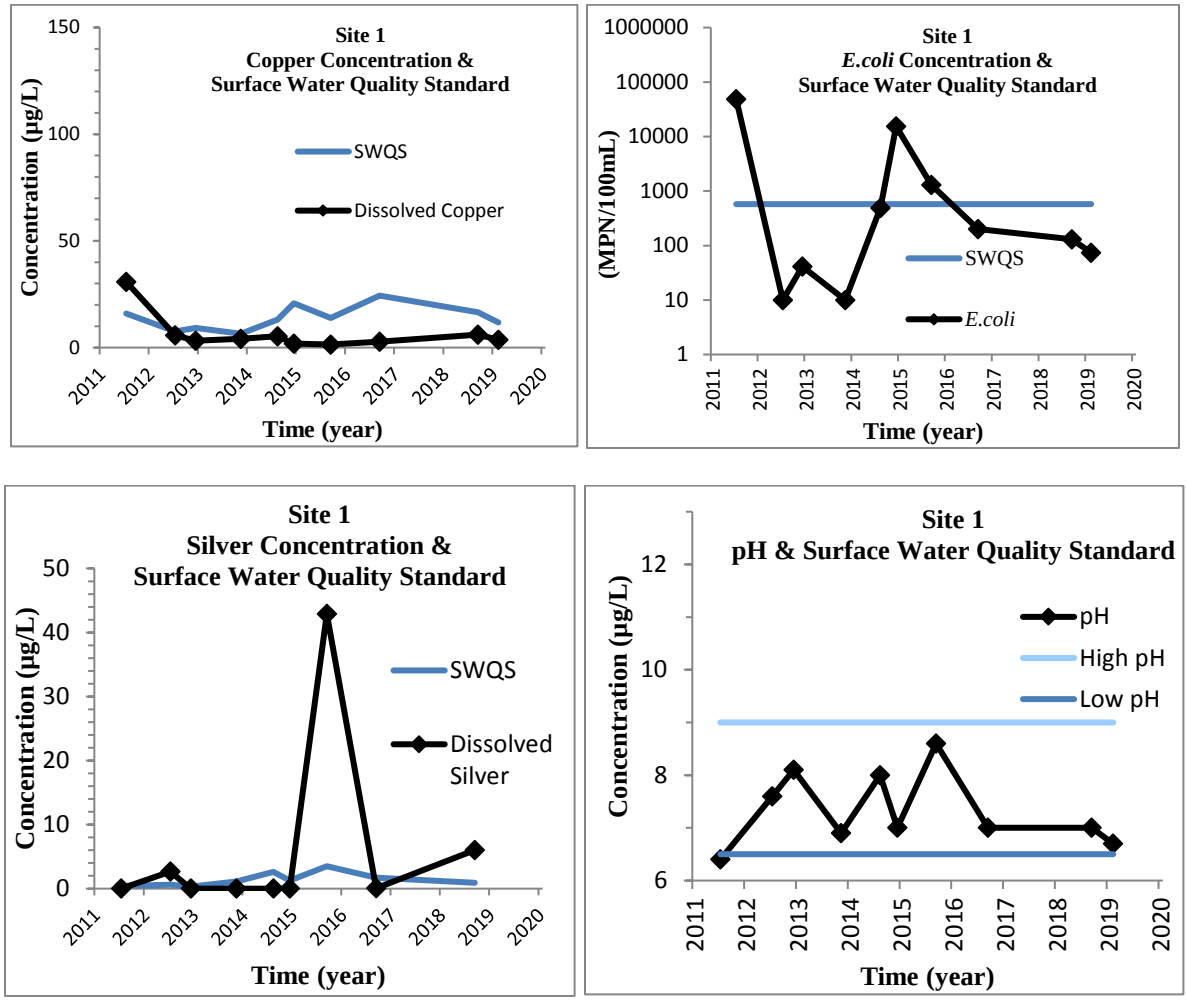

Figure 3. Comparison of copper, silver, pH and *E. coli* Concentration to SWQS at Site #1

Dissolved copper concentrations have been below the SWQS since July 2012. The watershed and road draining to the monitor site has low traffic, which is the anticipated source of copper. *E. coli* concentrations were above the SWQS three times, with two samples occurring consecutively, and the remaining sample events were below the SWQS since 2016. The high *E. coli* concentrations could be related to improper pet waste management or wildlife waste. The site is next to a wash, which acts as a wildlife corridor. Dissolved silver concentrations have been higher than the standard three times and all were isolated occurrences. There was a one-time occurrence of pH that was outside the SWQS and slightly acidic in 2011. The pH remained within standards since 2012.

Further actions are not recommended for this wet weather monitoring site.

Water quality monitoring at Site #2, a watershed with medium density residential land use, has been monitored 13 times for the full suite of parameters specified in the permit during the last eight years. Three parameters, namely dissolved copper, *E. coli*, and pH, have been higher, or outside, the Surface Water Quality Standards (Table 9). With the exception of *E. coli*, monitor results indicate sporadic sources of contaminants that are typically just above the SWQS.

Table 9. Summary of Parameters with Concentrations Higher than SWQS at Site #2a

Site ID: 2 Receiving Water: Rillito	Sample Date	Hardness (mg/L)	$Copper_{Dissolved}$ SWQS (µg/L)	$Copper_{Dissolved}$ Result (µg/L)	Result > SWQS?	$Silver_{Dissolved}$ SWQS (µg/L)	$Silver_{Dissolved}$ Result (µg/L)	Result > SWQS?	*E.coli* Result (MPN)	Result>SWQS?(575 MPN)	pH Result (SU)	Results > SWQS (6.5-9.0)
Summer 2011	-	-	-	-	-	-	-	-	-	-	-	-
Winter 11/12	03/18/12	50.0	12.1	61.0	Yes	1.0	<1	No	30	No	7.5	No
Summer 2012	-	-	-	-	-	-	-	-	-	-	-	-
Winter 12/13	01/26/13	48.9	11.9	6.4	No	0.9	<1	No	4,884	Yes	8.7	No
Summer 2013	08/22/13	147.0	33.4	8.2	No	6.2	<1	No	19,863	Yes	-	-
Winter 13/14	11/22/13	62.5	14.9	7.5	No	1.4	<1	No	4,884	Yes	6.7	No
Summer 2014	07/05/14	154.0	34.9	14.4	No	6.8	1.14	No	24,810	Yes	6.4	Yes
Winter 14/15	12/13/14	57.7	13.9	11.8	No	1.3	<1	No	14,400	Yes	6.4	Yes
Summer 2015	07/05/15	87.2	20.4	13.0	No	2.5	<1	No	14,100	Yes	8.4	No
Winter 15/16	01/04/16	82.2	19.3	9.0	No	2.3	<1	No	12,000	Yes	8.0	No
Summer 2016	07/28/16	64.3	15.3	19.7	Yes	1.5	<1	No	582	Yes	7.7	No
Winter 16/17	12/17/16	53.5	12.9	11.5	no	1.1	<1	No	19,900	Yes	6.7	No
Summer 2017	07/11/17	54.7	13.2	32.2	Yes	1.1	<1	No	2,010	Yes	7.5	No
Winter 17/18	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2018	08/22/18	73	17.3	21.0	Yes	1.9	ND	No	41.8	No	7.1	No
Winter 18/19	12/07/18	63.4	15.1	12.2	No	1.5	<1	No	6,830	Yes	6.8	No

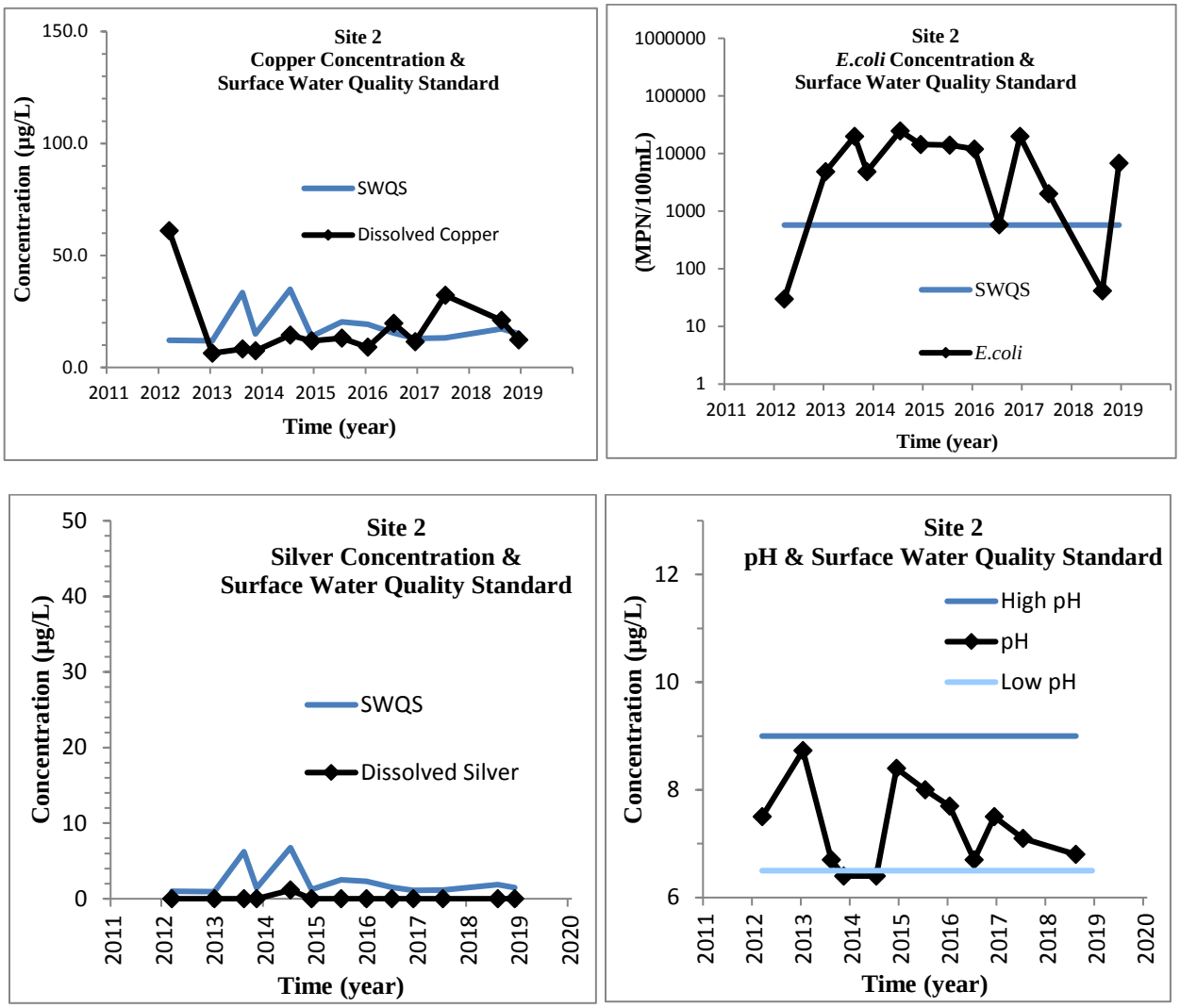

Figure 4. Comparison of copper, silver, pH and *E. coli* Concentration to SWQS at Site #2

The overall trend for water quality at Site #2 shows dissolved copper concentrations are typically below the SWQS. The *E. Coli* concentrations have been consistently higher than the SWQS since the first sampling in 2011. The high E. coli concentrations could be related to improper pet waste management in the medium density residential neighborhood. An outreach program is being developed to educate the neighborhood. Four samples had copper concentrations higher than the standard. Two samples had a pH slightly outside the SWQS indicative of acidic conditions in the second half of 2014. The pH has been in the normal range since 2015.

The prior outreach program was delayed to FY19/20 to allow training of new personnel added to the stormwater management program and for research into a general permit for the Phase I MS4s.

Water quality monitoring at Site #3, a watershed with high density residential land use, has been monitored 13 times for the full suite of parameters specified in the permit during the last eight years. Four parameters, namely dissolved copper, dissolved silver, *E. coli*, and pH, have been higher, or outside, the Surface Water Quality Standards (Table 10).

Table 10. Summary of Parameters with Concentrations Higher than SWQS at Site #3

Site ID: 3 Receiving Water: Rillito	Sample Date	Hardness (mg/L)	$Copper_{Dissolved}$ SWQS (µg/L)	$Copper_{Dissolved}$ Result (µg/L)	Result > SWQS?	$Silver_{Dissolved}$ SWQS (µg/L)	$Silver_{Dissolved}$ Result (µg/L)	Result > SWQS?	*E.coli* Result (MPN)	Result>SWQS?(575 MPN)	pH Result (SU)	Results > SWQS (6.5-9.0)
Summer 2011	09/10/11	50.0	12.1	<1	No	-	-	-	7,701	Yes	6.3	Yes
Winter 11/12	03/18/12	50.0	12.1	21.0	Yes	1.0	<1	No	10	No	7.4	No
Summer 2012	07/20/12	27.4	6.9	10.9	Yes	0.4	<1	No	20	No	7.2	No
Winter 12/13	12/14/12	13.4	3.5	4.7	Yes	1.0	2.3	Yes	63	No	7.5	No
Summer 2013	-	-	-	-	-	-	-	-	-	-	-	-
Winter 13/14	11/22/13	23.5	5.9	8.7	Yes	0.3	<1	No	100	No	7.1	No
Summer 2014	08/26/14	35.9	8.9	13.3	Yes	0.6	<1	No	10	No	-	-
Winter 14/15	01/30/15	27.1	6.8	3.9	No	0.3	<1	No	59	No	6.2	Yes
Summer 2015	07/05/15	28.3	7.08	8.46	Yes	0.4	<1	No	78.6	No	8.5	No
Winter 15/16	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2016	06/29/16	30.9	7.69	8.08	Yes	0.43	<1	No	43.6	No	6.8	No
Winter 16/17	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2017	08/13/17	29.5	12.11	4.9	No	0.98	<1	No	231	No	7.2	No
Winter 17/18	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2018	07/30/18	-	-	-	-	-	-	-	10	No	6.9	No
Summer 2018	08/10/18	50.3	12.17	9.15	No	0.99	ND	No	-	-	6.9	No
Winter 18/19	12/07/18	15.9	4.11	4.29	Yes	0.14	<1	No	249	No	7.9	No

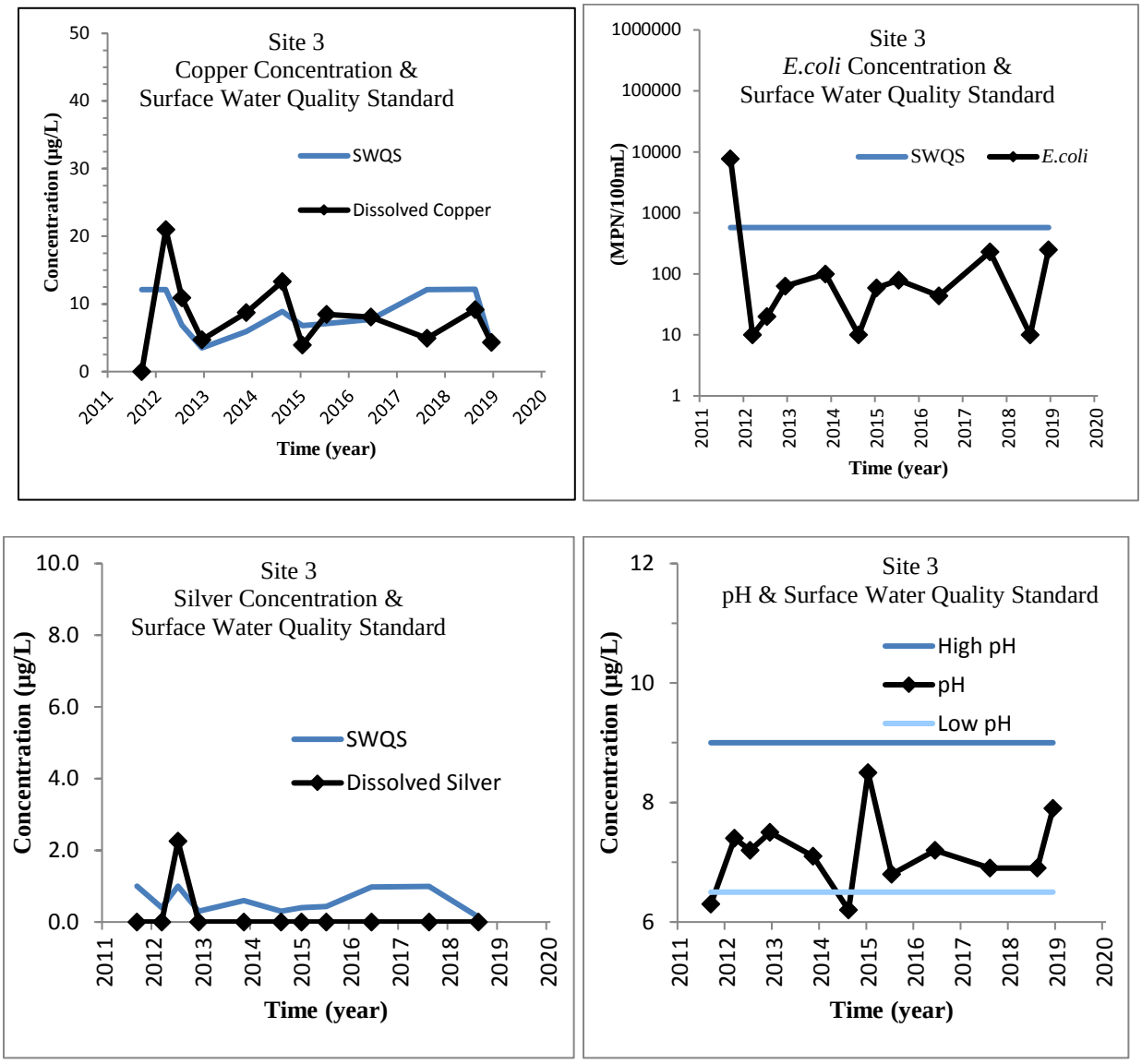

Figure 5. Comparison of copper, silver, pH and *E. coli* Concentration to SWQS at Site #3

The overall trend for water quality at Site #3 shows dissolved copper concentrations were consistently slightly higher than the SWQS until 2017 when the concentrations have consistently been below standards. With the exception of the first sampling event, *E. Coli* concentrations have consistently been below the SWQS, reflective of the neighborhood members taking pet waste management seriously. The dissolved silver concentration was higher than the SWQS once and has been non-detect for all other samples. The pH has been outside the SWQS range twice.

No further actions are recommended for this wet weather monitoring site.

Water quality monitoring at Site #4, a watershed with commercial land use, has been monitored 11 times for the full suite of parameters specified in the permit during the last eight years. Four parameters, namely dissolved copper, dissolved silver, *E. coli*, and pH, have been higher, or outside, the Surface Water Quality Standards (Table 11).

Table 11. Summary of Parameters with Concentrations Higher than SWQS at Site #4

Site ID: 4 Receiving Water: Rillito	Sample Date	Hardness (mg/L)	Copper $_{Dissolved}$ SWQS (µg/L)	Copper $_{Dissolved}$ Result (µg/L)	Result > SWQS?	Silver $_{Dissolved}$ SWQS (µg/L)	Silver $_{Dissolved}$ Result (µg/L)	Result > SWQS?	*E.coli* Result (MPN)	Result>SWQS?(575 MPN)	pH Result (SU)	Results > SWQS (6.5-9.0)
Summer 2011	09/27/11	54.0	10	29.6	Yes	-	-	-	12,997	Yes	7.0	No
Winter 11/12	03/18/12	50.0	12.1	29.0	Yes	1	<1	No	697	Yes	7.4	No
Summer 2012	07/15/12	42.3	10.3	12.9	Yes	0.7	0.2	No	1,789	Yes	7.7	No
Winter 12/13	12/14/12	90.9	21.3	12.7	No	2.7	1.0	No	1,850	Yes	7.8	No
Summer 2013	-	-	-	-	-	-	-	-	-	-	-	-
Winter 13/14	11/22/13	50.0	12.1	16.0	Yes	1	<1	No	1,178	Yes	6.7	No
Summer 2014	08/12/14	35.4	8.7	23.1	Yes	0.5	<1	No	1,850	Yes	7.5	No
Winter 14/15	01/30/15	38.2	9.4	9.5	Yes	0.6	<1	No	249	No	8.5	No
Summer 2015	09/13/15	38.2	9.4	12.6	Yes	0.6	<1	No	384	No	7.9	No
Winter 15/16	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2016	09/07/16	24.5	7.43	7.0	No	0.4	0.63	Yes	3,100	Yes	7.6	No
Winter 16/17	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2017	-	-	-	-	-	-	-	-	-	-	-	-
Winter 17/18	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2018	08/10/18	47.1	11.44	10.5	No	0.88	ND	No	959	Yes	6.6	No
Winter 18/19	01/06/19	16.8	4.3	2.98	No	0.1	1.49	Yes	77.6	No	6.2	Yes

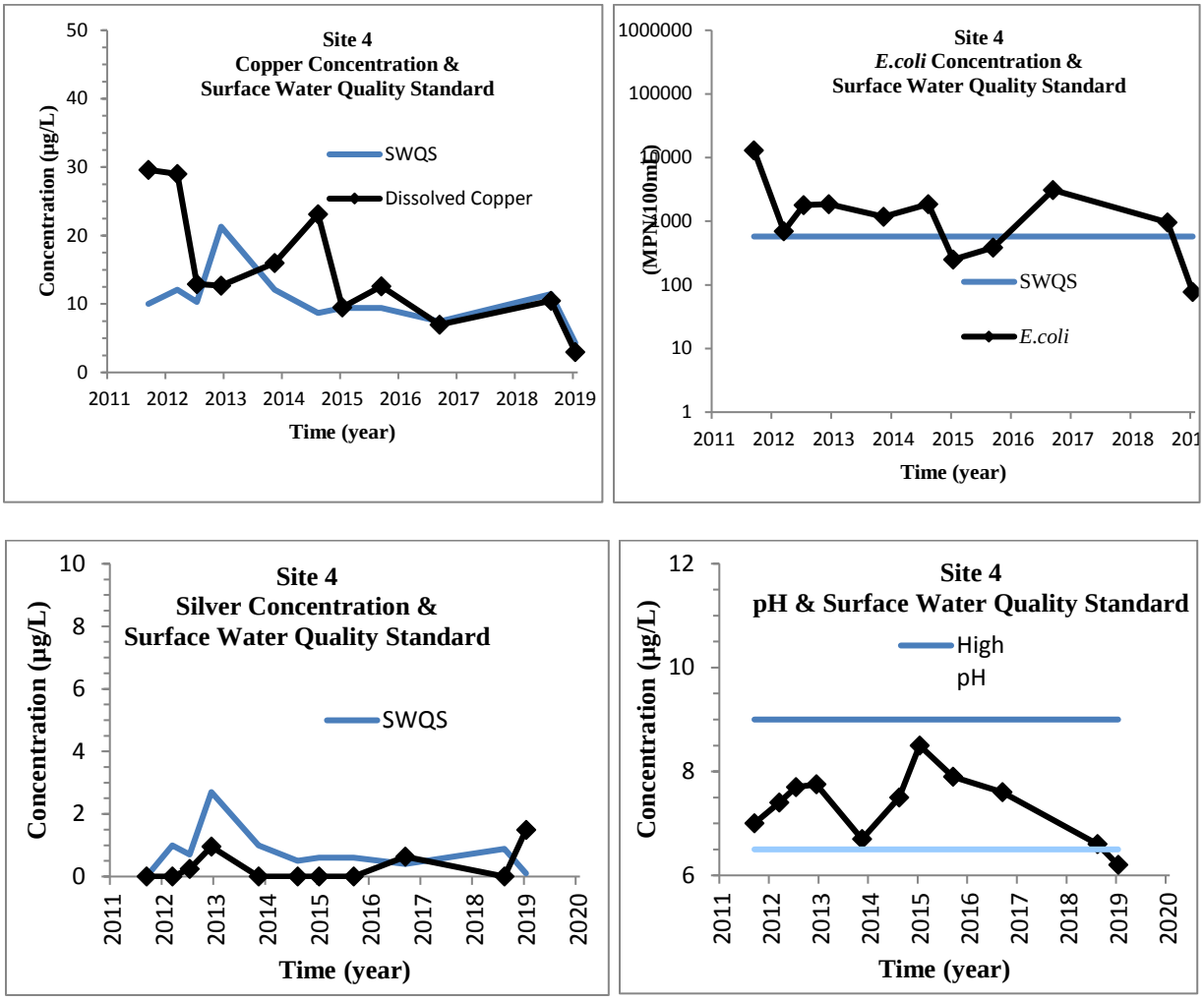

Figure 6. Comparison of copper, silver, pH and *E. coli* Concentration to SWQS at Site #4

The overall trend for water quality at Site #4 shows dissolved copper concentrations have declined over the years such that concentrations have been below the standard since 2016. *E. coli* concentrations have been above the SWQS, with the exception of the 12/14/12, 09/07/16 and 01/06/19 samples. The dissolved silver concentration was higher than the SWQS twice and these samples were non-consecutive. In the most recent sample, the pH was just outside the standard indicating acidic conditions.

An outreach program is being developed to approach the commercial owners about adding pet waste stations as a way of reducing microbiologic pollution in stormwater. The prior outreach program was delayed to FY19/20 to allow training of new personnel added to the stormwater management program and for research into a general permit for the Phase I MS4s.

Water quality monitoring at Site #5, a watershed with industrial land use, has been monitored 14 times for the full suite of parameters specified in the permit during the last eight years. Three parameters, namely dissolved copper, *E. coli*, and pH, have been higher, or outside, the Surface Water Quality Standards (Table 12).

Table 12. Summary of Parameters with Concentrations Higher than SWQS at Site #5

Site ID: 5 Receiving Water: Santa Cruz	Sample Date	Hardness (mg/L)	Copper $_{Dissolved}$ SWQS (µg/L)	Copper $_{Dissolved}$ Result (µg/L)	Result > SWQS?	Silver $_{Dissolved}$ SWQS (µg/L)	Silver $_{Dissolved}$ Result (µg/L)	Result > SWQS?	*E.coli* Result (MPN)	Result>SWQS?(575 MPN)	pH Result (SU)	Results > SWQS (6.5-9.0)
Summer 2011	07/04/11	105.0	24.2	35.0	Yes	-	-	-	242,000	Yes	6.5	No
Winter 11/12	12/03/11	80.0	18.9	33.0	Yes	2.2	<1	No	4,611	Yes	8.5	No
Summer 2012	07/04/12	143.0	32.6	41.2	Yes	6	0.8	No	52	No	7.8	No
Winter 12/13	01/26/13	68.7	16.3	19.8	Yes	1.7	<1	No	4,106	Yes	8.0	No
Summer 2013	07/05/13	185.0	41.5	60.2	Yes	9.3	<1	No	11,199	Yes	7.6	No
Winter 13/14	11/22/13	86.7	20.3	28.9	Yes	2.5	<1	No	3,873	Yes	6.8	No
Summer 2014	07/05/14	466.0	85.9	132.0	Yes	34.9	<1	No	181	No	7.5	No
Winter 14/15	12/13/14	55.6	13.4	17.1	Yes	1.2	<1	No	7,270	Yes	6.8	No
Summer 2015	07/13/15	101.0	23.5	32.9	Yes	3.3	<1	No	450	No	8.4	No
Winter 15/16	01/04/16	112.0	25.9	23.4	No	3.9	<1	No	551	No	6.4	Yes
Summer 2016	08/09/16	175	39.4	12.0	No	8.42	<1	No	6130	Yes	8.7	No
Winter 16/17	12/22/16	55.1	13.3	35.2	Yes	1.15	0.15	No	3080	Yes	7.9	No
Summer 2017	-	-	-	-	-	-	-	-	-	-	-	-
Winter 17/18	-	-	-	-	-	-	-	-	-	-	-	-
Summer 2018	07/12/18	101	23.5	34.3	Yes	3.27	0.1	No	4610	Yes	8.2	No
Winter 18/19	12/7/2018	175	39.4	18.9	No	8.42	0.49	No	821	Yes	7.7	No

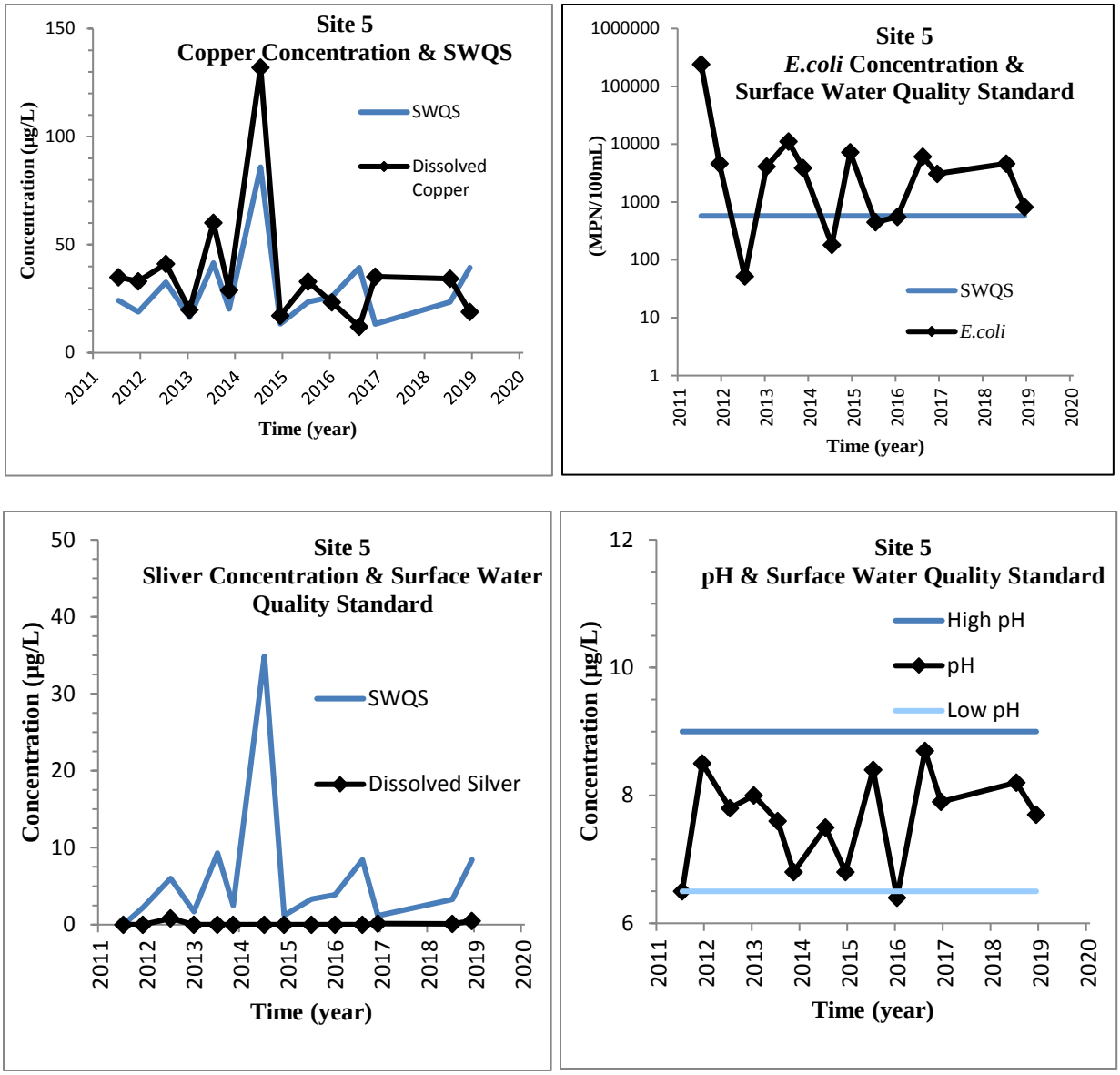

Figure 7. Comparison of copper, silver, pH and *E. coli* Concentration to SWQS at Site #5

The overall trend for water quality at Site #5 shows that dissolved copper was consistently above the SWQS, until 2016 when half are below and half are above. The summer 2014 sample was anomalously high for metals and Total Suspended Solids. Summer concentrations are relatively higher than winter samples indicating seasonal influences. *E. coli* concentrations have been higher than the SWQS seven times in five years. One pH has been outside the SWQS.

The businesses in this watershed use guard dogs to maintain security. The outreach program developed for Site #5 will enhanced to address pet wastes from guard dogs at businesses.

A literature review of copper concentration in runoff provides a frame work to compare ambient copper concentrations with those in urban runoff in Pima County and mining district streams. The ambient surface water quality is established by stream data from Cienega Creek, Davidson Canyon, and Harshaw Creek. Near the confluence of Cienega Creek and Davidson Canyon, the concentration of total copper ranged between 1.0 to 2.2 µg/L from stream samples collected between September 2008 and February 2012 (PAG, 2013). The natural background level of dissolved copper in the Harshaw Creek ranged between 2.01 and 3.59 µg/L (ADEQ, 2003). The runoff data from the five monitor sites shows the dissolved copper concentrations range from 3.3 to 132 µg/L since the new permit became effective in July 2011. During the previous permit the total copper concentrations ranged between 1 and 260 µg/L. The few concentrations higher than 100 µg/L were associated with samples having a Total Suspended Solids concentration greater than 230 mg/L (PDEQ, 2011).

Additional data from mining areas in southern Arizona show the maximum dissolved copper concentration was 130 µg/L in the ASARCO Mission Complex (EPA, 2008) and was frequently above 250 µg/L in the mining districts in Alum Gulch and Humboldt Canyon (ADEQ, 2012). This analysis shows ambient dissolved copper concentrations range from 1.0 to 4 µg/L, while urban runoff ranges between 1 to 132 µg/L and mining areas are typically higher than 130 µg/L.

Sources of copper in stormwater include vehicle brake pads; architectural copper; copper pesticides in landscaping, wood preservatives and pool, spa, and fountain algaecides; industrial copper use; deposition of air-borne copper emissions from fossil fuel combustion and industrial facilities; and vehicle fluid leaks and dumping (TDC Environmental, 2006). The Brake Pad Partnership showed brakes account for 35 to 60 percent of copper in California's urban watershed runoff (Copper Development Association, 2013). A study of runoff from copper roofs and gutters shows first flush concentrations immediately downstream from the roof have a mean greater than 1,340 ug/L for both total and dissolved copper (Michels, et al, 2001). This study noted roofs with the oxidation by-product brochantite release about half as much as cooper roofs exposed to air.

The outreach program was once intended to include vehicle maintenance for brake pads as well as using pads with lower concentrations of copper. Given the brake manufacturing industry has decided to phase out the use of copper in brake pads in fifteen years, the outreach program will not be providing education materials regarding brake pads.

10. Estimate of Annual Pollutant Load

A. Method of estimating Pollutant Load

Estimates of the annual pollutant loadings were calculated using the "Simple Method" (SMRC, 2012). The Simple Method uses analytical water quality data, precipitation and percent impervious cover to estimate pollutant loadings in urban areas. The data collected at five monitor points represent five land uses within the MS4, namely low density residential, medium density residential, high density residential, commercial, and industrial. Pima County calculated the annual pollutant load estimate for each Monitor Site and each land use category within the permit area.

The following sections describe the methods Pima County used to calculate statistics and estimate the seasonal pollutant load. The results are presented and evaluated.

The amount of pollutants are estimated by multiplying the volume of water that runs off from a precipitation event and the concentration of the pollutants. Runoff is estimated as a fraction of the precipitation based on the type of land use permeability. Pollutant concentration is measured by collecting the stormwater samples after a representative precipitation event occurs. The pollutant load equation is as follows:

$$L = P * P_f * R_c * C * A * 0.0446$$

where

L = annual pollutant load (tons)
P = annual precipitation (inches)
P_f = annual precipitation fraction producing runoff (given a value of 0.9)
R_c = runoff coefficient (unitless)
C = concentration (event mean) of a pollutant (mg/L)
A = area of catchment draining to sample point (acres)
0.0446 = correction factor for measurement units

The parameters in the equation above are defined as follows:

- ***Pollutant load (L)*** is the estimate of total amount of a specific pollutant discharged per time period for the drainage area of each monitor site. The time period employed for this report was both annual and seasonal (winter and summer).

- ***Annual Precipitation***[1] ***(P)*** is the total inches of rainfall occurring during the reporting period July 1, 2015 to June 30, 2016. Analysis of available rainfall data for the Tucson metropolitan area shows approximately 52% (or 13.17 cm) of the annual rainfall occurs during the summer season and 48% (or 12.16 cm) of the annual rainfall occurs during the winter season.

[1] The use of average rainfall data for pollutant load calculations de-emphasizes the effect of spatial rainfall variability. This, in turn, makes aggregation of pollutant load estimates less reliable.

- ***Annual Precipitation fraction***[2] ***(P_f)*** is an adjustment factor for the number of storm events producing measurable runoff. A typical value for this fraction is 0.9 (USEPA, 1992).

- ***Runoff coefficient (Rc)*** is a relative measure of imperviousness, or the percentage of rainfall that becomes surface runoff (EPA, 1992). The following equation was used to calculate "*R*" values for each representative land use category associated with an outfall (EPA, 1992):

  $$R = 0.05 + 0.9*Ia$$

  where *Ia* is the percent impervious area within the drainage area of each monitor site.

- ***Event-mean concentration***[3] ***(C)*** of a pollutant is the flow-weighted average of the pollutant concentration for the summer monsoon sample and the winter rain sample.

  $$C = Fs/(Fs+Fw)*Cs + Fw/(Fs+Fw)*Cw$$

  where

  Fs = Flow during summer sample
  Fw = Flow during winter sample
  Cs = Concentration of summer sample
  Cw = Concentration of winter sample

- ***Area (A)*** is the area of the catchment draining to the sample point.

Parameters specific to each catchment, namely *Ia*, *Rc* and *A* were previously derived during preparation of the Sample and Analysis Plan (Pima County, 2012).

The "Simple Method" transforms a complex set of hydrological processes into an empirical equation. This equation is used to provide reasonable estimates of pollutant loads in storm water runoff (Ohrel, 2000). At the same time, by simplifying these processes, the level of uncertainty increases when attempting to distinguish the influences from runoff characteristics such as rainfall intensity, rainfall duration, runoff, first-flush effects concentrating pollutants, land use, and antecedent weather conditions.

Specifically, Schiff (1996) states that "[A]ssumptions based upon extrapolations to un-sampled storms introduces uncertainty because of flow-related variability." For example, he notes the importance of capturing data from representative storm events. Collecting data from the largest storm of the year may result in disproportionately large event mean concentrations and would

[2] A measured value is unavailable for the Sonoran Desert region so EPA's standard value (EPA, 1992) was employed.

[3] Analytical results for the monitored parameters ranged from one to five data points per pollutant. These limited data were used to calculate event-mean concentration ("emc") values. As a result, pollutant load estimates may not be representative of the rainfall events, pollutants, outfalls, seasons, and/or land use categories.

potentially overestimate un-sampled, smaller storms during the time period of interest. Similarly, capturing smaller storm events might underestimate the actual discharge for a given reporting period. Schiff asserts that "[T]he magnitude of bias associated with un-sampled storm events cannot be assessed" because monitoring programs do not often have sufficient temporal sampling procedures to adequately address the issue. Such is the case for Pima County's monitoring program. This is due, in part, to the fact that the County's program is not designed to measure annual pollutant loads at a specific site, or regional pollutant loads for a specific land use.

According to Dixon and Chiswell (1996), most monitoring programs are instead designed to address regulatory compliance, identify sources of pollutants, and evaluate management actions such as the effectiveness of best management practices. Pima County's program focuses on just such information needs.

Schiff identifies the need to better understand the relationships of water quality to antecedent dry periods and rainfall intensity or duration (pollutant transport). Concepts such as "first flush" and "seasonal flushing" are examples of interactions that have yet to be adequately quantified. The following subsections provide seasonal pollutant load estimates for Pima County's Monitoring sites and identified land use categories within the permit area.

B. Results of Calculations

Analytical results, annual rainfall, drainage area and imperviousness were used to calculate pollutant loads for the five monitor sites were tabulated (Table 13). No loadings were calculated for silver and thallium as the concentrations were below the detection limits.

C. Evaluation of Results

The pollutant load estimates[4] should be used for comparative purposes only. For the reasons discussed in subsection 11.B, these values cannot be interpreted as representing actual pollutant loads for the watersheds within the permit area. Furthermore, it would be equally inappropriate to extrapolate these estimates in order to predict potential impacts to receiving water bodies.

[4] The term "pollutant load estimate" does not have the same meaning as the term "pollutant load." The Simple Method should only be used when *estimates* are desired and should not be used when *load* values are required (Ohrel, 2000).

Table 18. Pollutant Load Estimates for Monitor Sites

	Site #1 Low Density Residential		Site #2 Med Density Residential		Site #3 High Density Residential		Site #4 Commercial		Site #5 Industrial	
Annual Rainfall (in)	**13.1**		**15.2**		**13.1**		**13.1**		**13.7**	
Area (acres)	**2.2**		**9.48**		**7.75**		**60.08**		**48.5**	
Impervious (%)	**25%**		**65%**		**85%**		**95%**		**70%**	
Parameter	**Flow-weighted Concen-tration**	**Load (tons)**	**Flow-weighted Concen-tration**	**Load (tons)**	**Flow-weighted Concen-tration**	**Load (tons)**	**Flow-weighted Concen-tration**	**Load (tons)**	**Flow-weighted Concen-tration**	**Load (tons)**
Conventional Parameters										
BOD (mg/L)	9.5	3	17.1	63	10.7	36	5.2	148	8.8	159
COD (mg/L)	218.1	71	142.1	523	142.0	472	57.4	1642	122.2	2209
TDS (mg/L)	172.6	56	147.3	542	116.0	385	66.6	1904	144.9	2620
TSS (mg/L)	264.5	86	175.5	646	106.0	352	22.9	656	284.7	5148
Nutrients										
TN (mg/L)	2.0	0.6	4.9	18.2	4.1	13.7	2.3	64.9	3.9	69.8
NH4 (mg/L)	0.37	0.1	0.67	2.5	1.12	3.7	0.77	22.1	0.32	5.8
TKN (mg/L)	1.37	0.4	0.7	2.5	1.1	3.7	0.8	22.1	0.3	5.8
TP (mg/L)	0.31	0.1	0.7	2.5	0.4	1.2	0.1	3.8	0.6	11.3
Total Metals										
Sb (µg/L)	0.30	0.00	0.47	0.00	0.90	0.00	0.57	0.02	1.46	0.03
As (µg/L)	2.10	0.00	1.27	0.00	1.10	0.00	0.54	0.02	2.83	0.05
Ba (µg/L)	74.76	0.02	68.56	0.25	35.50	0.12	19.29	0.55	115.59	2.09
Be (µg/L)	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00
Cd (µg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Cr (µg/L)	3.24	0.00	2.53	0.01	1.37	0.00	0.73	0.02	6.16	0.11
Cu (µg/L)	4.86	0.00	18.44	0.07	9.15	0.03	5.97	0.17	29.24	0.53
Pb (µg/L)	0.03	0.00	0.28	0.00	0.18	0.00	0.09	0.00	0.79	0.01
Hg (µg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ni (µg/L)	1.26	0.00	0.85	0.00	1.68	0.01	0.48	0.01	1.25	0.02
Se (µg/L)	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.02
Ag (µg/L)	3.18	0.00	0.00	0.00	0.00	0.00	0.90	0.03	0.49	0.01
Th (µg/L)	0.08	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.03	0.00
Zn (µg/L)	1.49	0.00	10.29	0.04	107.00	0.36	35.95	1.03	8.97	0.16
Total		217		1,800		1,267		4,464		10,232

Relative comparisons can be made between outfalls and parameters. The conventional parameters contribute to 99% or greater of the pollutant load for each catchment. TSS is the largest contributor to pollutant load in the low density residential, medium density residential and industrial watersheds. TDS is the largest contributor to pollutant load in the commercial watersheds. COD is the largest contributor to pollutant load in the high density residential watershed. Nutrients contribute less than 2.5% of the pollutant load and metals contribute less than 0.05%. The low contribution of metals is important due to the higher toxicity levels.

D. Limitations of Pollutant Load Estimation Results

The "Simple Method" is an arithmetic equation based on empirical relationships for complex hydrological processes and average pollutant concentrations in storm water runoff. This method can be used to obtain quick and reasonable storm water pollutant load estimates (Ohrel, 2000), but should only be used for planning-level calculations or identifying data-collection needs.

Numerical results presented in Table 18 are pollutant load estimates. Employing event mean concentrations derived from first flush data may result in calculated pollutant load estimates that are higher that the remaining rainfall events.

This type of analysis can be misleading when evaluating potential environmental effects from non-point sources (Silverman et al, 1986). Rainfall events in southern Arizona are sporadic, with loads concentrated into limited periods of time during and after precipitation. Specifically, flow-related variability may introduce uncertainties when extrapolating from sampled to un-sampled rainfall events. Schiff (1996) uses the example of overestimation for data collected from large storms, versus underestimation for data collected from smaller storm events. In the absence of a sufficient temporal sampling program, the error level associated with un-sampled storm events can be substantial, especially when the un-sampled storm events follow the first flush event.

Estimation errors may also be introduced when using average seasonal precipitation values to calculate pollutant loads. For example, smaller runoff volumes (due to low intensity or short duration rainfall events accompanied by extended antecedent dry periods) may produce disproportionately higher pollutant concentrations per sampling event.

Alternatively, dilution from large volume runoffs (accompanied by shorter antecedent dry periods) may produce lower pollutant concentrations per sampling event. Given that the average seasonal precipitation values might not be representative of a specific storm, calculated values for the estimated pollutant loads might in turn be questionable.

Additionally, the monitoring program was not specifically designed to measure pollutant loads. As a result, phenomena such as pollutant build-up, first flush of pollutants, rainfall intensity, duration, and seasonal flushing of pollutants are not adequately addressed by the County's current monitoring program. These phenomena are an unavoidable consequence of the weather conditions and climatology of southern Arizona.

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11. Annual Expenditures

The itemized budget presents total expenditures for activities occurring within all of Pima County (Table 14) for the AZPDES permit.

Table 14. Stormwater Program Costs for Fiscal Year 18/19 & Budget for Fiscal Year 19/20

Activity	Fiscal Year 2018/2019		Fiscal Year 2019/2020	
	Actual Costs	Department Subtotal	Budgeted Costs	Department Subtotal
Environmental Quality		$ 280,000		$ 260,000
AZPDES Stormwater	$ 280,000		$ 260,000	
Regional Flood Control District		$ 5,800,429		$ 7,682,351
Floodplain Permitting (1)	$ 1,536,879		$ 1,732,824	
Engineering Support (2)	$ 676,391		$ 1,387,726	
FEMA/Mapping (3)	$ 1,036,925		$ 1,719,834	
Drainage Way Maintenance	$ 2,550,234		$ 2,841,967	
Transportation		$ 9,778,169		$ 9,427,523
Environmental Planning & Compliance	$ 151,846		$ 193,568	
Pavement Markings	$ 553,807		$ 531,219	
Roadway Maintenance	$ 8,529,903		$ 8,181,912	
Signals & Lighting	$ 542,613		$ 520,822	
Development Services		$ 3,732,366		$ 4,574,282
Development Review	$ 3,732,366		$ 4,574,282	
Regional Wastewater Reclamation		$ 14,218		$ 15,000
Compliance and Regulatory Affairs Office Laboratory Analysis	$ 14,218		$ 15,000	
Stormwater Program Total	$ 19,605,182	$ 19,605,182	$ 21,959,156	$ 21,959,156

(1) Landscaping expenses incorporated.
(2) Permitting and Engineering Support are now budgeted within Floodplain Management.
(3) Long range planning, Basin and Drainage Studies are now budgeted within FEMA/Mapping.

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