Tucson Water
One Water 2100 Master Plan

Technical Memorandum
WATER QUALITY MANAGEMENT

FINAL | March 2022

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Abbreviations

µm	micrometer(s)
µmg/L	micrograms per liter
A.A.C.	Arizona Administrative Code
ac-ft	acre-foot
ADEQ	Arizona Department of Environmental Quality
AFFF	aqueous film-forming foam
AL	action level
ALE	action level exceedance
APP	Aquifer Protection Permit
AZPDES	Arizona Pollutant Discharge Elimination System
CAP	Central Arizona Project
Carollo	Carollo Engineers, Inc.
CAVSARP	Central Avra Valley Storage and Recovery Project
CCL	Contaminant Candidate List
CCPP	calcium carbonate precipitation potential
CCR	Consumer Confidence Report
CCT	corrosion control treatment
CEC	contaminant of emerging concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFU	colony forming units
CT	concentration times time
CTPP	Central Tucson PFAS Project
cVOC	carcinogenic volatile organic compound
D/DBPR	Disinfectants and Disinfection Byproducts Rule
DBCP	1,2-Dibromo-3-chloropropane
DBP	disinfection byproducts
DBPR	Disinfection Byproducts Rule
DMAFB	Davis Monthan Air Force Base
EDB	ethylene dibromide
EDC	endocrine disrupting compound
EPA	United States Environmental Protection Agency
FBRR	Filter Backwash Recycling Rule
FR	Federal Register
GAC	granular activated carbon
GRR	galvanized requiring replacement
GTLO	Get the Lead Out
GWR	Ground Water Rule
GWS	groundwater system

HAA5	haloacetic acids (total of concentrations of 5 selected compounds)
HAB	harmful algal blooms
HAL	Health Advisory Level
HAN	haloacetonitriles
HCFC	hydrochlorofluorocarbon
HK	haloketones
HNM	halonitromethanes
HPC	heterotrophic plate count
IESWTR	Interim Enhanced Surface Water Treatment Rule
IOC	inorganic contaminant
IRIS	Integrated Risk Information System
IX	ion exchange
LCR	Lead and Copper Rule
LCRMR	Lead and Copper Rule Minor Revisions
LCRR	Lead and Copper Rule Revisions
LRAA	locational running annual average
LSI	Langelier Saturation Index
LSL	lead service line
LT1ESWTR	Long-Term 1 Enhanced Surface Water Treatment Rule
LT2ESWTR	Long-Term 2 Enhanced Surface Water Treatment Rule
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDBP	Microbials and Disinfection Byproducts
mg/L	milligrams per liter
mgd	million gallons per day
mL	milliliter(s)
MPN	most probable number
MRDL	maximum residual disinfectant level
MRDLG	maximum residual disinfectant level goal
mrem	millirem (milli-roentgen equivalent man)
MRL	minimum reporting limit
NA	not applicable
NCOD	National Drinking Water Contaminant Occurrence Database
NDBA	nitrosodibutylamine
NDEA	N-nitrosodiethylamine
NDMA	N-nitrosodimethylamine
NDPA	N-nitrosodi-n-propylamine
NDPhA	N-nitrosodiphenylamine
NOM	natural organic matter

NPDES	National Pollution Discharge Elimination System
NPDWR	National Primary Drinking Water Regulations
NPYR	nitrosopyrrolidine
NSDWR	National Secondary Drinking Water Regulations
NTU	nephelometric turbidity unit
PAG	Pima Association of Governments
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/L	picocuries per liter
PFAS	per- and poly-fluoroalkyl substances
PFBS	perfluorobutane sulfonic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFU	plaque-forming unit
PHA	provisional health advisory
ppb	parts per billion (micrograms per liter)
PPCP	pharmaceuticals and personal care products
ppm	parts per million (milligrams per liter)
ppt	parts per trillion (nanograms per liter)
PQL	practical quantitation limit
RAA	running annual average
RDX	Research Department eXplosive
RTCR	Revised Total Coliform Rule
RWS	recycled water system
S.U.	standard units
SCP	Salinity Control Program
SDWA	Safe Drinking Water Act
SHARP	South Houghton Area Recharge Project
SHPS	Snyder Hill Pump Station
SMCL	secondary maximum contaminant level
SOC	synthetic organic compounds
SVOC	semi-volatile organic compounds
SWTR	Surface Water Treatment Rule
TAMA	Tucson Active Management Area
TARP	Tucson Airport Remediation Project
TCE	trichloroethene

TCR	Total Coliform Rule
TDS	total dissolved solids
TKN	Total Kjeldahl nitrogen
TL	trigger level
TOC	total organic carbon
TON	threshold order number
TT	treatment technique
TTHM	total trihalomethanes
TUc	chronic toxic unit
UCMR	Unregulated Contaminant Monitoring Rule
USBR	United States Bureau of Reclamation
UV AOP	ultraviolet light-hydrogen peroxide advanced oxidation process
VOC	volatile organic compound
WET	whole effluent toxicity
WQARF	Water Quality Assurance Revolving Fund
WQP	water quality parameter
WQZ	water quality zone
WRF	water reclamation facility
WTP	water treatment plant

Technical Memorandum

WATER QUALITY MANAGEMENT

Executive Summary

Introduction

Tucson Water, the water department of the City of Tucson, serves 722,000 customers over a 390-square-mile service area. The potable water distribution system includes over 200 production or standby groundwater wells; approximately 300 million gallons of water storage; and over 4,600 miles of pipelines. The recycled water system includes another 15 million gallons of storage and 160 miles of pipelines supplying irrigation water to golf courses, parks, schools, and select residences around the city; providing water for surface flow in a normally-dry riverbed to reinvigorate desert habitat through the Santa Cruz River Heritage I project; and replenishing groundwater through aquifer recharge projects.

"One Water" conveys the concept that all water is a valuable resource and can be considered part of a community's water portfolio. While surface water and groundwater can supply drinking water to communities, after the water is used and treated, it can replenish surface waters, be recharged to groundwater, be used as recycled water for landscape irrigation and other non-potable uses, or be purified for drinking water. Stormwater can also be collected and used for groundwater replenishment or landscape irrigation. In all uses of water, the quality must be adequate for the desired use. This technical memorandum presents water quality data for Tucson Water's current resources and relates that data to current and projected regulations for different water types and uses. Tucson Water conducts over 14,000 water quality tests each year (see Figure ES.1). This memorandum will help guide the water quality monitoring program so Tucson Water continues to supply high quality water to Tucson Water customers into the next century and beyond.

Water Quality Challenges

The foremost challenges to Tucson's water quality are related to evolving regulations and to potential and future changes to Central Arizona Project (CAP) water deliveries and Tucson Water's operations. Tucson Water is meeting all existing Federal and State regulations, but new regulations for emerging contaminants could add monitoring and/or treatment requirements or restrict the use of some water supplies. The U.S. Environmental Protection Agency's Lead and Copper Rule Revisions, which go into effect by 2024, will add monitoring and communication requirements beyond existing lead and copper compliance activities. Water received from the CAP could continue to increase in salinity, increasing basin-wide salt loading and affecting the quality of water delivered to customers. Introducing remediated groundwater into the recycled water system will alter the water quality characteristics of supplies distributed by that system.

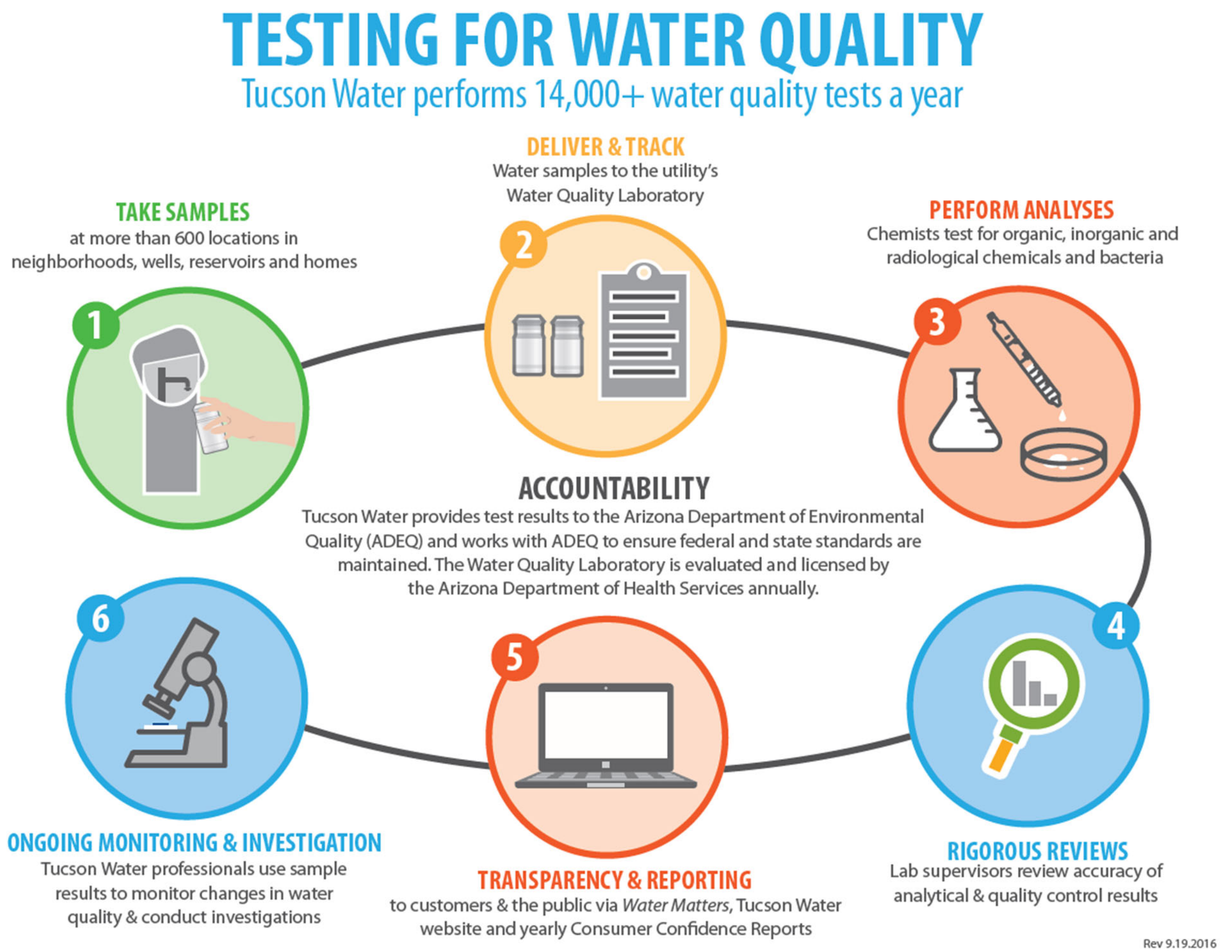

Figure ES.1 Tucson Water Quality Monitoring Facts

Meeting the Challenges

Due to effective planning, diligent water quality monitoring, and strategic infrastructure investments, Tucson Water is well-positioned to meet the water quality challenges the utility faces. The Sentry Program has monitored contaminants of emerging concern (CECs) for over 14 years and helps Tucson Water track and proactively manage contaminants that may be regulated in the future. Lead and copper concentrations in the drinking water distribution system are already very low, a testament to the success of Tucson Water's "Get the Lead Out" program and mitigation of corrosion concerns in the distribution system. Recharge and recovery of CAP water has ensured that salinity of the recovered water has climbed only gradually over time. By sending remediated groundwater from the Tucson Airport Remediation Project (TARP) into the recycled water system, the average quality of water distributed by that system should improve for several key parameters, including salinity and emerging contaminants. Tucson Water is committed to ensuring the quality of water for all of the various uses of Tucson's water resources and is taking the steps now to maintain that quality.

1.0 Introduction

"One Water" conveys the concept that all water is a valuable resource and can be considered part of a region's or utility's water portfolio (see Figure 1). While surface water and groundwater can supply drinking water to communities, after the used water is treated, it can replenish surface waters, be recharged back to groundwater, be used as recycled water for landscape irrigation and other non-potable uses, or be purified for drinking water. Stormwater can also be collected and used for groundwater replenishment or landscape irrigation. In all uses of water, the quality must be adequate to the desired use. This technical memorandum presents water quality data for Tucson Water's current resources and relates that data to current and projected regulations for different water types and uses. The focus is primarily on potable water and recycled water. While stormwater is also a valuable resource, its high volume over relatively brief and infrequent periods in the desert and wide variations in quality have historically made it a more difficult resource to capture and use. Innovations in stormwater management and increasing pressure on water resources mean that use of stormwater is projected to increase, but existing data is minimal and thus is not examined in detail here.

Figure 1 Tucson Water's One Water Resource Portfolio

The first section provides an overview of Tucson Water's resource portfolio and distribution system. In Section 2, potable water quality is examined. Existing federal and state regulations for chemical and microbial contaminants are summarized, as are potential future regulations and requirements for monitoring unregulated contaminants. Colorado River water conveyed through the Central Arizona Project (CAP) aqueduct and recharged in Avra Valley is a major water supply for Tucson Water and differs significantly from the native groundwater. When it is recharged, the CAP water blends with the native groundwater; the recovered CAP water quality is summarized in the section. Tucson Water's compliance with existing drinking water regulations is presented next, and potential implications of future regulation of currently unregulated contaminants are also examined.

Section 3 presents data on water quality and regulations related to recycled water. A major component of improving the quality of water supplied through the recycled water system will be the introduction of treated water from the Tucson Airport Remediation Project (TARP) groundwater remediation facility. While this treated water was supplied to the potable system for nearly three decades, changing water quality in that portion of the aquifer led to the decision to discontinue serving the treated water as drinking water and instead route the water to the recycled water distribution system and to the Santa Cruz River, the latter of which commenced on November 2, 2021. Water quality requirements at other points of compliance for the recycled water system are also considered.

Finally, Section 4 summarizes conclusions and recommendations related to water quality.

1.1 System Description

Tucson Water relied on groundwater as the only source of drinking water delivered to customers up to the 1990s when Colorado River water became available with the construction of the CAP. After water quality challenges during direct treatment and delivery of CAP water in 1992-1994, which are well documented, Tucson Water returned to serving only groundwater as drinking water for several years. In 1997, the utility began recharging CAP water into the aquifer in Avra Valley. By 2001, Tucson Water also commenced recovery of a blend of recharged CAP water and native groundwater to begin serving renewable water supplies. Related to the One Water concept shown in Figure 1, when CAP water, which is surface water from the Colorado River, is recharged in large basins west and south of Tucson, it becomes groundwater in a physical and regulatory sense. At the recharge facilities, CAP water blends with native groundwater and is then recovered. As more and more CAP water is recharged to the ground, the native groundwater makes up a decreasing proportion of the recovered water. Section 2.3 discusses the water quality implications of this water management strategy. The vast majority of drinking water supplied to Tucson Water customers today is recharged and recovered CAP water. Tucson Water has also developed an extensive recycled water system that supplies non-potable water for irrigation to golf courses, schools, and some residences, in addition to other uses, such as groundwater recharge and environmental restoration projects. More detail on this system is given in Section 3, including the planned introduction of treated water from TARP to the recycled water system. Figure 2 shows Tucson Water's water supply portfolio for 2020, with nearly two-thirds of the total supply from recharged and recovered CAP water and the remainder from native groundwater, remediated groundwater (from TARP), and recycled water.

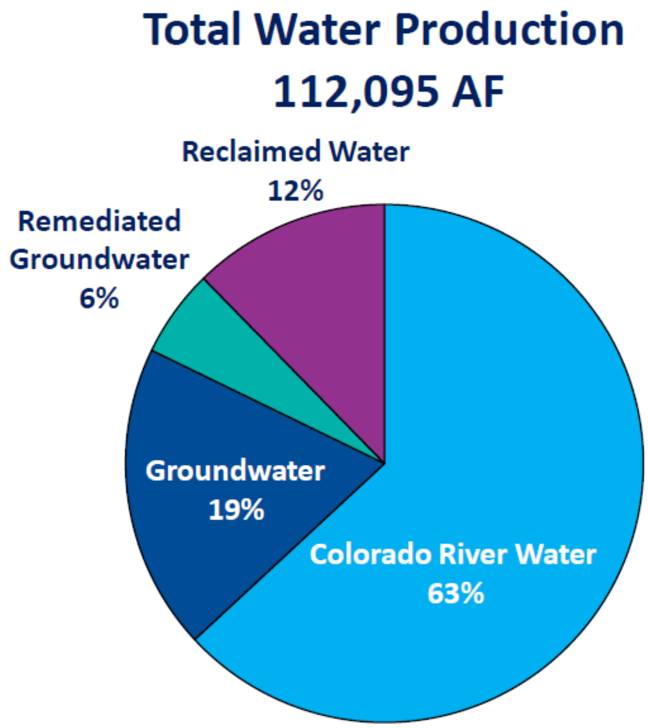

Figure 2 Water Production for the Tucson Water Service Area

2.0 Potable Water Quality

2.1 Drinking Water Regulations

Drinking water quality in the United States is governed by legislation enacted by the federal and state governments. Statutes, more commonly known as laws, direct the appropriate government agency to develop and publish regulations or rules to implement the requirements of the law. Standards specify the amount or concentration of a particular constituent that is legally allowed in drinking water. At the federal level, the United States Environmental Protection Agency (EPA) is primarily responsible for developing and enforcing drinking water regulations, whereas state health departments typically regulate drinking water quality at the state level.

Any drinking water regulations promulgated by a state are required to include standards that are at least as stringent as those imposed by comparable federal regulations; states may implement regulations in addition to those mandated by federal statutes or standards that are more restrictive than federal ones. In Arizona's case, however, state law prohibits state agencies making regulations stricter than those of the federal government unless approved by the state legislature. Federal regulations specify requirements and the process by which states may assume major responsibility, or primacy, for implementing and enforcing drinking water regulations. The Arizona Department of Environment Quality (ADEQ) has adopted federal drinking water regulations to maintain Arizona's primacy enforcement authority of the Safe Drinking Water Act. Although ADEQ has delegated authority for administration of the Safe Drinking Water Act Provisions and State drinking water rules to some county agencies, Tucson Water projects are not delegated and must be sent to ADEQ.

2.1.1 National Primary and Secondary Drinking Water Regulations

The Safe Drinking Water Act (SDWA) of 1974 and its amendments (1986 and 1996) provide a regulatory framework that specifies how National Primary Drinking Water Regulations (NPDWR) are developed, promulgated, and implemented. Elements of this regulatory framework require that EPA periodically review existing NPDWRs for continued protection of public health, evaluate potential risks associated with unregulated contaminants that are known to occur in drinking water supplies, and monitor the occurrence of contaminants in drinking water supplies.

The NPDWRs established by the EPA are legally enforceable primary standards applicable to all potable water systems and intended to protect the public from consuming water containing contaminants that present a risk to human health. The regulations set maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), and treatment technique requirements for a total of 94 contaminants. As shown in Figure 3, the number of contaminants regulated has increased dramatically from the original 22 listed in 1975 and 1976.

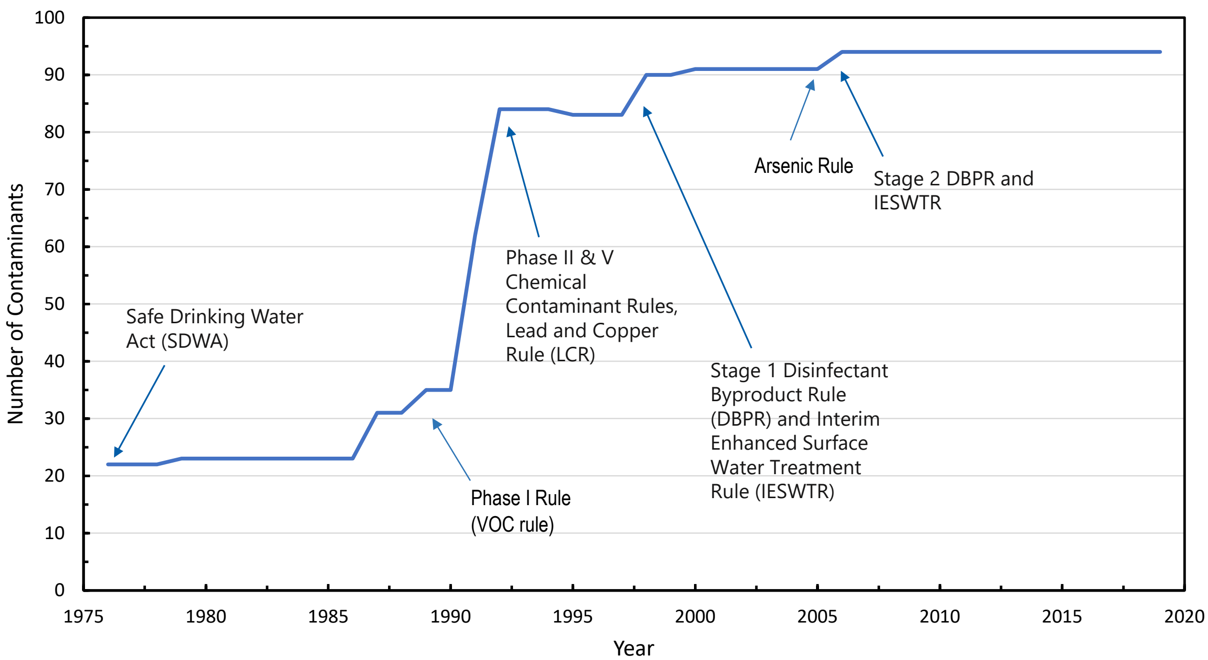

Figure 3 Water Quality Regulations and Drinking Water Standards

Secondary regulations are not legally enforceable and function as guidelines for water utilities to provide aesthetically pleasing drinking water and avoid cosmetic effects such as tooth discoloration. Taste and odor, for example, are aesthetic issues, as opposed to health issues, and secondary drinking water regulations are therefore applicable. The secondary standards set secondary MCLs for a total of 15 compounds that do not present a health risk at such levels.

The primary and secondary drinking water standards are presented in Table 1 and Table 2, respectively. All 94 contaminants regulated under the NPDWR are presented in Table 1, and the 15 contaminants regulated under the National Secondary Drinking Water Regulations (NSDWR) are presented in Table 2. Tucson Water's available data on the maximum detected concentrations of regulated organic chemicals, inorganic compounds, radionuclides, microorganisms, and disinfection byproducts is available in Appendix A for 2016-2018.

Table 1 National Primary Drinking Water Standards (as of 1/5/2021)

Contaminant	Regulation	MCL or TT(1) (ppm)(2)	MCLG (ppm)(2)
Organic Chemicals			
Acrylamide	Phase II	(TT)	Zero
Alachlor	Phase II	0.002	Zero
Atrazine	Phase II	0.003	0.003
Benzene	Phase I	0.005	Zero
Benzo(a)pyrene (PAHs)	Phase V	0.0002	Zero
Carbofuran	Phase II	0.04	0.04
Carbon tetrachloride	Phase I	0.005	Zero
Chlordane	Phase II	0.002	Zero
Chlorobenzene	Phase II	0.1	0.1
2,4-D	Phase II	0.07	0.07
Dalapon	Phase V	0.2	0.2
1,2-Dibromo-3-chloropropane (DBCP)	Phase II	0.0002	Zero
o-Dichlorobenzene	Phase II	0.6	0.6
p-Dichlorobenzene	Phase I	0.075	0.075
1,2-Dichloroethane	Phase I	0.005	Zero
1,1-Dichloroethylene	Phase I	0.007	0.007
cis-1,2-Dichloroethylene	Phase II	0.07	0.07
trans-1,2-Dichloroethylene	Phase II	0.1	0.1
Dichloromethane	Phase V	0.005	Zero
1,2-Dichloropropane	Phase II	0.005	Zero
Di(2-ethylhexyl) adipate	Phase V	0.4	0.4
Di(2-ethylhexyl) phthalate	Phase V	0.006	Zero
Dinoseb	Phase V	0.007	0.007
Dioxin (2,3,7,8-TCDD)	Phase V	0.00000003	Zero
Diquat	Phase V	0.02	0.02
Endothall	Phase V	0.1	0.1
Endrin	Phase V	0.002	0.002
Epichlorohydrin	Phase II	(TT)	Zero
Ethylbenzene	Phase II	0.7	0.7
Ethylene dibromide	Phase II	0.00005	Zero
Glyphosate	Phase V	0.7	0.7
Heptachlor	Phase II	0.0004	Zero
Heptachlor epoxide	Phase II	0.0002	Zero
Hexachlorobenzene	Phase V	0.001	Zero
Hexachlorocyclopentadiene	Phase V	0.05	0.05
Lindane	Phase II	0.0002	0.0002
Methoxychlor	Phase II	0.04	0.04
Oxamyl (Vydate)	Phase V	0.2	0.2
Pentachlorophenol	Phase II	0.001	Zero
Picloram	Phase V	0.5	0.5

Contaminant	Regulation	MCL or TT(1) (ppm)(2)	MCLG (ppm)(2)
Polychlorinated biphenyls (PCBs)	Phase II	0.0005	Zero
Simazine	Phase V	0.004	0.004
Styrene	Phase II	0.1	0.1
Tetrachloroethylene	Phase II	0.005	Zero
Toluene	Phase II	1	1
Toxaphene	Phase II	0.003	Zero
2,4,5-TP (Silvex)	Phase II	0.05	0.05
1,2,4-Trichlorobenzene	Phase V	0.07	0.07
1,1,1-Trichloroethane	Phase I	0.2	0.2
1,1,2-Trichloroethane	Phase V	0.005	0.003
Trichloroethene	Phase I	0.005	Zero
Vinyl chloride	Phase I	0.002	Zero
Xylenes (total)	Phase II	10	10
Inorganic Substances			
Antimony	Phase V	0.006	0.006
Arsenic	Arsenic Rule	0.010	Zero
Asbestos (fibers/L > 10 μm)	Phase II	7 million fibers/L	7 million fibers/L
Barium	Phase II	2	2
Beryllium	Phase V	0.004	0.004
Cadmium	Phase II	0.005	0.005
Chromium (total)	Phase II	0.1	0.1
Copper	LCR	(TT) AL=1.3	1.3
Cyanide	Phase V	0.2 (as free cyanide)	0.2
Fluoride	NPDWR	4	4
Lead	LCR	(TT) AL = 0.015	Zero
Mercury (inorganic)	Phase II	0.002	0.002
Nitrate (as N)	Phase II	10	10
Nitrite (as N)	Phase II	1	1
Selenium	Phase II	0.05	0.05
Thallium	Phase V	0.002	0.0005
Radionuclides			
Gross Alpha	Radionuclides Rule	15 pCi/L	Zero
Beta and photon radioactivity	Radionuclides Rule	4 mrem/yr	Zero
Radium-226 + Radium-228	Radionuclides Rule	5 pCi/L	Zero
Uranium	Radionuclides Rule	0.030	Zero

Contaminant	Regulation	MCL or TT[(1)] (ppm)[(2)]	MCLG (ppm)[(2)]
Microorganisms			
Cryptosporidium	LT2ESWTR	(TT) oocyst/100L	Zero
Fecal coliforms and *E. coli*	TCR	MCL[(3)]	Zero
Giardia lamblia	SWTR	(TT) cyst/100L	Zero
Heterotrophic plate count (HPC)	SWTR	(TT) CFU/mL	NA
Legionella	SWTR	(TT) #/mL	Zero
Total coliforms	TCR	5.0 percent[(4)] #/mL	Zero
Turbidity	SWTR	0.3 NTU[(5)]	NA
Viruses	SWTR	(TT) #/mL	Zero
Disinfectant Byproducts			
Bromate	Stage 1 DBPR	0.010	Zero
Chlorite	Stage 1 DBPR	1	0.8
Haloacetic Acids (HAA5[(6)])	Stage 2 DBPR	0.060[(7)]	NA[(8)]
Trihalomethanes (total)	Stage 2 DBPR	0.080[(7)]	NA[(8)]
Bromodichloromethane	Stage 1 DBPR	-	Zero
Bromoform	Stage 1 DBPR	-	Zero
Chloroform	Stage 2 DBPR	-	0.07
Dibromochloromethane	Stage 1 DBPR	-	0.06
Dichloroacetic acid	Stage 1 DBPR	-	Zero
Monochloroacetic acid	Stage 2 DBPR	-	0.07
Trichloroacetic acid	Stage 2 DBPR	-	0.02
Disinfectant Residuals			
Chloramines (as Cl_2)	Stage 1 DBPR	4[(9)]	4[(10)]
Chlorine (as Cl_2)	Stage 1 DBPR	4[(9)]	4[(10)]
Chlorine dioxide (as ClO_2)	Stage 1 DBPR	0.8[(9)]	0.8[(10)]

Notes:

(1) Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.
(2) Units are ppm unless otherwise noted.
(3) Routine samples containing fecal coliform or *E. coli* triggers a repeat sampling event. If the repeat sample is fecal coliform-positive, an acute MCL violation occurs. If the repeat sample is negative, another repeat sampling is triggered. If the repeat sample is fecal coliform-positive, an acute MCL violation occurs.
(4) No more than 5 percent of samples total coliform-positive in a month. Every sample that is coliform-positive must be analyzed for fecal coliforms and *E. coli*. If two consecutive samples are total coliform-positive and one is fecal coliform-positive, an acute MCL violation occurs.
(5) Performance standard: no more than 5 percent of monthly samples may exceed 0.3 NTU.
(6) Sum of concentrations of five haloacetic acid species (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, dibromoacetic acid).
(7) Measured as locational running annual average at each monitoring site.
(8) The group itself does not have an MCLG, but some individual contaminants have an MCLG as shown in the table (bromodichloromethane, bromoform, chloroform, dibromochloromethane, dichloroacetic acid, monochloroacetic acid, trichloroacetic acid).
(9) Maximum Residual Disinfectant Level.
(10) Maximum Residual Disinfectant Level Goal.

Abbreviations:
µm = micrometer(s); AL = action level; DBPR = Disinfection Byproducts Rule; CFU = colony forming units; LCR = lead and copper rule; LT2ESWTR = Long-Term 2 Enhanced Surface Water Treatment Rule; mL = milliliter(s); mrem = millirem (milli-roentgen equivalent man); NA = not applicable; NTU = nephelometric turbidity unit; PAH = polycyclic aromatic hydrocarbon; pCi/L = picocuries per liter; ppm = parts per million; SWTR = Surface Water Treatment Rule; TT = treatment technique; TCR = Total Coliform Rule;

Table 2 National Secondary Drinking Water Standards (as of 1/7/2021)

Contaminant	Secondary Maximum Contaminant Level (SMCL) (ppm)(1)
Aluminum	0.05 - 0.2
Chloride	250
Color	15 Color Units
Copper	1
Corrosivity	Non-corrosive
Fluoride	2
Foaming Agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 Threshold Odor Units
pH	6.5 – 8.5 standard units
Silver	0.10
Sulfate	250
Total Dissolved Solids	500
Zinc	5

Notes:
(1) Units are parts per million (ppm) unless otherwise noted.

2.1.2 Chemical Contaminant Regulations

The EPA also issues a series of drinking water regulations intended to protect the public from chemical contaminants such as asbestos, arsenic, and lead that may be present in surface water supplies and from potential intrusion or leaching from buried pipes within the distribution system. These Chemical Contaminant Rules were promulgated in phases, with additional rules further limiting specific chemicals having been promulgated since. The family of regulations that focus on chemical contaminant control includes:

- Phase I, II, and V Rules (Phase II/V Rules, 1989, 1992/93 & 1994)
- Lead and Copper Rule (LCR, 1991)
  - Lead and Copper Rule Revisions (LCRR, 2021)
- Radionuclides Rule (Radionuclide Rule, 2000)
- Arsenic Rule (Arsenic Rule, 2001)

2.1.2.1 Phase II/V Rules

The Phase II/V Rules apply to all public potable water systems and regulate over 65 contaminants within three contaminant groups:

- Inorganic Contaminants (IOC)
- Volatile Organic Compounds (VOC)
- Synthetic Organic Contaminants (SOC)

The Phase II/V Rules establish MCLs, monitoring requirements, and the best available technologies for the removal of the 65 contaminants. Regulation through the Phase II/V Rules provide public health protection through the reduction of chronic risks of cancer, organ damage, circulatory system disorders, nervous system disorders, and reproductive system disorders posed by the 65 contaminants. Table 3 summarizes the contaminants regulated as part of the Phase II/V Rules.

Table 3 Phase II/V Rules Regulated Contaminants

Phase	VOC	SOC	IOC
Phase I, July 7, 1987 (52 FR 25690) Effective: 1989	Benzene Carbon tetrachloride p-dichlorobenzene Trichloroethylene Vinyl chloride 1,1,1-trichloroethane 1,1-dichloroethylene 1,2-dichloroethane		
Phase II, January 1991 (56 FR 3526) Effective: 1992	cis-1,2-dichloroethylene Ethylbenzene Monochlorobenzene (chlorobenzene) o-dichlorobenzene Styrene Tetrachloroethylene Toluene Trans-1,2-Dichloroethylene Xylenes 1,2-dichloropropane	Alachlor Atrazine Carbofuran Chlordane EDB (ethylene dibromide) DBCP (1,2-dibromo-3-chloropropane) Heptachlor Heptachlor epoxide Lindane Methoxychlor Toxaphene PCBs 2,4-D 2,4,5-TP	Asbestos Cadmium Chromium Fluoride Mercury Nitrate Nitrite Selenium
Phase IIB, July 1991 (56 FR 30266) Effective: 1993		Pentachlorophenol Aldicarb Aldicarb sulfone Aldicarb sulfoxide	Barium
Phase V, July 1992 (57 FR 31776) Effective: 1994	Dichloromethane 1,1,2-trichloroethane 1,2,4-trichlorobenzene	Benzo(a)pyrene Dalapon Di(ethylhexyl)-adipate Di(ethylhexyl)-phthalate Dinoseb Diquat Endothall Endrin Glyphosate Hexachlorobenzene Hexachlorocyclo-pentadiene Oxamyl Picloram Simazine 2,3,7,8-TCDD (dioxin)	Antimony Beryllium Cyanide Nickel Thallium

2.1.2.2 Lead and Copper Rule and the Lead and Copper Rule Revisions

The LCR was promulgated by the EPA on June 7, 1991. On January 15, 2021, the LCR was updated with the LCRR, with further actions occurring later in the year that postponed the effective date to December 16, 2021, and the compliance deadline to October 16, 2024. The LCRR varies from the LCR in six key focus areas which will be described in Section 2.4.2.

Under the provisions of the LCR, water systems serving greater than 100,000 people are required to sample household taps from 100 home sites for lead and copper with priority given to sites with higher lead potential such as those served by lead service lines (LSL). If the lead and copper concentrations in the 90th percentile of home tap samples are greater than the 0.015 ppm action level for lead or the 1.3 ppm action level for copper, then the utility must take follow up actions, including increasing monitoring frequency if the utility was on reduced monitoring, conducting a corrosion control treatment study, and conducting a public education program.

The rule also requires utilities to sample entry points and distribution system sample sites (25 sites in Tucson Water's case) for certain water quality parameters including pH, alkalinity, and calcium. These parameters may be used to determine the Langelier Saturation Index (LSI) of water, which is a corrosivity index and is a measure of water's ability to dissolve or precipitate calcium carbonate. This determination will help utilities optimize their corrosion control treatment. Under this regulation, there are two ways in which a utility is considered to have "optimized" corrosion control:

- Demonstrate to regulatory agency that it has performed corrosion control steps "equivalent" to those required by EPA.
- If the difference between the highest level of lead in the source water and the 90th percentile tap samples is less than the practical quantitation level (PQL) for lead (0.005 ppm). That is, the level of lead in the water entering the distribution system must be below the action level, and, optimally, the concentration of lead added through the distribution system itself is less than the PQL.

The Final Lead and Copper Rule Short-Term Revisions and Clarifications (also known as the Lead and Copper Rule Minor Revisions [LCRMR]) were promulgated on October 10, 2007. The compliance date for the rule was April 7, 2008. The LCRMR does not change the action levels for lead or copper; however, it requires utilities to provide a notification of tap water monitoring results for lead to home and building occupants.

In 2021, the LCRR defined a trigger level (TL) of 0.01 ppm for the system's 90th percentile level, additional actions upon system-wide action level exceedance (ALE), and additional actions upon individual tap sample ALE. When the 90th percentile value exceeds the TL, systems are now required to implement additional planning, monitoring, and reevaluation of current corrosion control treatment. When the 90th percentile value exceeds the AL, systems are now required to notify all customers within 24 hours, begin semi-annual sampling, and either install corrosion control treatment (CCT) or re-optimize their system. Lastly, individual tap sample ALE will require 72-hour notice and "find-and-fix" efforts including to identify the lead source and take action to reduce lead levels.

Additionally, multiple components of the LCRR focus on closing compliance loopholes for the LCR. For sampling, prioritization is added to sample site selections through a tiered program. Additionally, fifth-liter sampling is required from homes with LSLs and sampling instructions that recommend aerator cleaning or pre-stagnation flushing prior to sampling are prohibited. An LSL Inventory will also be required, including annual updates. Systems which have LSLs, galvanized requiring replacement, or service lines with an unknown lead status will then also be required to create an LSL Replacement Plan. Partial LSL replacements will no longer be allowed, with the public-side replacement now required when a private-side line is replaced and vice versa. Lastly, communicating lead health risks, providing education materials, and conducting targeted outreach to customers with LSLs further bolsters the LCRR's efforts to get lead out and reduce customers' exposure.

2.1.2.3 Arsenic Rule

EPA published the Final Arsenic Rule on January 22, 2001, which mandated that the arsenic MCL in drinking water would be 10 parts per billion (ppb), a reduction from 50 ppb. It also established an MCLG of zero for arsenic. Due to delays subsequent to promulgation of the final rule, the effective date for compliance by public water systems was postponed until January 23, 2006.

2.1.2.4 Radionuclides Rule

On December 7, 2000, the EPA announced the Radionuclides Rule, which revised the existing standards for radionuclides and established a new standard for uranium. The rule became effective on December 8, 2003, and monitoring requirements were phased in between December 2000 and December 2003. The rule requires systems to determine initial compliance using an average of four quarterly samples, or appropriate grandfathered data under State direction. The requirements of the rule are presented in Table 4.

Table 4 Regulated Contaminants Per Radionuclides Rule

Regulated Radionuclide	MCL	MCLG
Beta/photon emitters(1)	4 mrem/yr	0 mrem/yr
Gross alpha particle	15 pCi/L	0 pCi/L
Combined radium 226/228	5 pCi/L	0 pCi/L
Uranium	0.030 ppm	0 ppm

Notes:
(1) A total of 168 beta particles and photon emitters may be used to calculate compliance with the MCL.

2.1.3 Microbial and Disinfection Byproduct Regulations

Over the past three decades, EPA has promulgated a series of increasingly complex drinking water regulations intended to protect the public from microbial pathogens such as viruses, *Giardia*, and *Cryptosporidium* that may be present in water supplies, and from disinfection byproducts (DBP). The family of regulations that focus on microbial pathogen control includes:

- Surface Water Treatment Rule (SWTR, 1989) & Interim Enhanced Santa Cruz River Treatment Rule (IESWTR, 1998).
- Filter Backwash Recycling Rule (FBRR, 2001).
- Long-Term 1 (LT1ESWTR, 2002) & 2 (LT2ESWTR, 2006) Enhanced Surface Water Treatment Rule.
- Ground Water Rule (GWR, 2006).
- Total Coliform Rule (TCR, 1989) & Revised Total Coliform Rule (RTCR, 2013).

Regulations intended to minimize the formation of DBPs in drinking water include:

- Total Trihalomethane Rule (TTHM Rule, 1979).
- Stage 1 (FR, 1998) & 2 (Stage 2 D/DBP Rule, 2006) Disinfectants and Disinfection Byproducts Rule.

Collectively, these regulations have come to be known as the Microbials and Disinfection Byproducts (MDBP) Rules and are intended to balance the risk-risk tradeoff between health concerns related to exposure to pathogenic microorganisms and exposure to disinfection byproducts. The monitoring and compliance requirements of the MDBP Rules are complex and to a large extent system specific. Based on recognition that simultaneous compliance with the provisions of the MDBP Rules requires a well-planned and highly coordinated approach, EPA has developed a series of guidance manuals to help drinking water providers manage the often-conflicting objectives of these rules.

Notably, some regulations do not apply to Tucson Water, considering the utility does not include surface water treatment in its portfolio. These non-applicable regulations include the SWTR, IESWTR, FBRR, LT1ESTWR, and LT2ESWTR and are described in Appendix A. The remainder of the MDBP rules are described here.

2.1.3.1 Ground Water Rule (GWR)

The GWR was proposed on May 10, 2000, and was published in November 2006. The GWR specifies the appropriate use of disinfection in groundwater and contains other provisions to protect public health. This rule is of importance to Tucson Water because all potable supplies are from groundwater (see note about CAP supplies in Section 1.1). The final requirements of the GWR are:

Sanitary Survey – Water systems will be required to perform a sanitary survey every three years to review the following eight elements:

- Source.
- Treatment.
- Distribution system.
- Finished water storage.
- Pumps, pump facilities, and control.
- Monitoring, reporting, and data verification.
- Water system management and operations.
- Water system operator compliance with state requirements.

Source Water Monitoring – A groundwater system (GWS) with a distribution system TCR sample that tests positive for total coliform is required to conduct triggered source water monitoring to evaluate whether the total coliform presence in the distribution system is due to fecal contamination in the groundwater supply. A GWS that does not provide at least 4-log treatment of viruses must conduct triggered source water monitoring upon being notified that a TCR sample is total coliform-positive. Within 24 hours of receiving the total coliform-positive notice, the system must collect at least one groundwater sample from each groundwater source (unless the GWS has an approved triggered source water monitoring plan that specifies the applicable source for collecting source samples). The GWS must test the groundwater source sample(s) for the presence of one of three State-specified fecal indicators (*E. coli*, enterococci, or coliphage). If the source sample is fecal indicator-positive, this rule requires the GWS to notify the State and the public. Unless directed by the State to take immediate corrective action, the GWS must collect and test five additional source water samples for the presence of the same State-specified fecal indicator within 24 hours. If any one of the five additional source water samples tests positive for the State-specified fecal indicator (*E. coli*, enterococci, or coliphage), this rule requires the GWS to notify the State and the public and comply with the treatment technique requirements, which require the system to take one of four corrective actions discussed in the following section.

Treatment Technique Requirements – The GWR requires a GWS to take corrective action if a significant deficiency is identified during a sanitary survey. Also, the rule requires a GWS to take corrective action if one of the five additional groundwater source samples (or at State discretion, the initial source sample) has tested positive for fecal contamination (i.e., the sample is positive for one of the three fecal indicators and is not invalidated by the State). Corrective action requires one or more of the following steps: correct all significant deficiencies; provide an alternate source of water; eliminate the source of contamination; or provide treatment that reliably achieves at least 4-log treatment of viruses. Furthermore, the GWS must inform the public served by the water system of any uncorrected significant deficiencies and/or fecal contamination in the groundwater source.

Compliance Monitoring – Compliance monitoring requirements are the final defense against viral and bacterial pathogens. All GWS that provide at least 4-log treatment of viruses using chemical disinfection, membrane filtration, or a State-approved alternative treatment technology must conduct compliance monitoring to demonstrate maintenance of the minimum disinfectant residual concentration. Additional State-specified monitoring requirements apply to membrane filtration and alternative treatment.

2.1.3.2 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule

The Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR) was finalized on December 16, 1998 and became effective for public water systems serving more than 10,000 people on January 1, 2002. It establishes MCLs for DBPs and maximum residual disinfection levels (MRDL) for disinfectants. The Stage 1 D/DBPR revised the MCL for TTHMs from 0.1 ppm (100 ppb) under the 1979 Total Trihalomethane Rule to 0.08 ppm (80 ppb). The Stage 1 D/DBPR also establishes an MCL for the sum of five haloacetic acids (HAA5) at 60 ppb, and establishes the MCL for bromate at 10 ppb. MCL compliance is calculated using the running annual average (RAA) of all locations from all monitoring locations across the system, computed quarterly. The MRDL for chlorine is established at 4.0 ppm.

The rule also requires total organic carbon (TOC) monitoring and TOC removal by enhanced coagulation or enhanced softening. The rule further specifies the percentage of influent TOC that must be removed based on the raw water TOC and alkalinity levels, as shown in Table 5.

Table 5 Percentage of TOC Reduction Required Per Stage 1 D/DBPR

Raw Water TOC (ppm)	Raw Water Alkalinity (mg/L as $CaCO_3$)		
	< 60	60 – 120	> 120
> 2.0 – 4.0	35%	25%	15%
> 4.0 – 8.0	45%	35%	25%
> 8.0	50%	40%	30%

Abbreviation:
mg/L = milligrams per liter; ppm = parts per million

The Stage 2 version of the D/DBPR rule was finalized in December 2005 and published in the Federal Register on January 4, 2006. It strengthens the initial requirements of the Stage 1 rule and aims at reducing occurrences of DBP concentration spikes in the distribution system. Utilities are required to conduct an evaluation of their distribution system, known as an Initial Distribution System Evaluation, to identify locations with high DBP concentrations. Once identified, these locations are established as the sampling sites for compliance monitoring.

MCLs for TTHMs and HAA5 remain unchanged. However, the rule requires that MCL compliance be calculated using the locational running annual average (LRAA), i.e., each sampling site must not individually exceed the MCLs. Systems are also required to determine if they have exceeded an operational evaluation level, which is identified using compliance monitoring results. A system that exceeds an operational evaluation level is required to submit a report to their state identifying actions that may be taken to mitigate future high DBP levels.

The MCL for bromate remains at 10 ppb, based upon current alternative technology utilization and upon current understanding of bromate formation as a result of bromide concentrations. EPA is committed to review the bromate MCL as part of a 6-year review to determine whether the MCL should remain at 10 ppb or be reduced to 5 ppb or lower.

Table 6 summarizes the requirements of the Stage 1 and Stage 2 D/DBPRs.

Table 6 Stage 1 and Stage 2 D/DBPR Regulated Contaminants and Disinfectants

Regulated Contaminant	Stage 1 DBPR		Stage 2 DBPR	
	MCL (ppm)	MCLG (ppm)	MCL (ppm)	MCLG (ppm)
TTHM	0.080		Unchanged[1]	
Chloroform		-		0.07
Bromodichloromethane		Zero		Unchanged[1]
Dibromochloromethane		0.06		Unchanged[1]
Bromoform		Zero		Unchanged[1]
HAA5	0.060		Unchanged[1]	
Monochloroacetic acid		-		
Dichloroacetic acid		Zero		Unchanged[1]
Trichloroacetic acid		0.3		0.2
Bromoacetic acid		-		-
Dibromoacetic acid		-		-
Bromate (plants that use ozone)	0.010	Zero	Unchanged[1]	Unchanged[1]
Chlorite (plants that use chlorine dioxide)	1.0	0.8	Unchanged[1]	Unchanged[1]
Regulated Disinfectants	MRDL[2] (ppm)	MRDLG[2] (ppm)	MRDL (ppm)	MRDLG (ppm)
Chlorine	4.0 as Cl_2	4	Unchanged[1]	Unchanged[1]
Chloramines	4.0 as Cl_2	4	Unchanged[1]	Unchanged[1]
Chlorine Dioxide	0.8	0.8	Unchanged[1]	Unchanged[1]

Notes:

(1) Stage 2 DBPR did not revise the MCL or MRDL for this contaminant/disinfectant. However, MCL compliance was updated to be calculated using the Locational Running Annual Average.

(2) Stage 1 DBPR included MRDLs and maximum residual disinfection level goals (MRDLG) for disinfectants, which are similar to MCLs and MCLGs.

2.1.3.3 Total Coliform Rule and Revised Total Coliform Rule

The EPA is required to review and revise, as appropriate, each of the NPDWRs no less often than every six years. In July 2003, the EPA determined that it was appropriate to revise the TCR to provide even greater protection against waterborne pathogens in the distribution system. The EPA proposed specific revisions to the TCR on July 14, 2010, and released the draft Proposed TCR Assessments and Corrective Actions Guidance Manual for comment on August 13, 2010. The final RTCR was signed by the EPA administrator on December 20, 2012 and published in the Federal Register on February 13, 2013. The 1989 TCR remained effective until March 31, 2016. The compliance date for the RTCR requirement was April 1, 2016.

The RTCR establishes an MCL and MCLG of zero for *E. coli*, which is a more specific indicator of fecal contamination than total coliforms. The rule eliminates the MCL and MCLG for total coliform, replacing it with a treatment technique requirement instead. Under the treatment technique requirements, a system that exceeds a specified frequency of total coliform occurrence (greater than 5 percent of samples) or that incurs an *E. coli* MCL violation must assess the distribution system and correct any sanitary defects found. The rule also requires systems to reconsider choices for the analytical methods used to control false positives and negatives.

2.1.4 Secondary Water Quality Issues

Taste and odor compounds and total dissolved solids (TDS) are water quality characteristics that are drinking water concerns. They do not pose a threat to public health but are concerns because of secondary, non-health related issues. Future regulation of taste and odor compounds and total dissolved solids is unlikely, but secondary standards exist for these water quality parameters and are discussed in the following sections.

2.1.4.1 Taste and Odor Compounds

Concentrations of taste and odor compounds in water above a threshold odor number (TON) of 3 can affect consumers' perception of drinking water quality and safety. Taste and odor compounds can lead to reduced water consumption and reliance on bottled water for drinking. T&O-causing compounds can often be removed during the water treatment process using powdered activated carbon, ozone oxidation, filtration with granular activated carbon media, and other methods. However, the optimal treatment approach depends on the constituent(s) producing the adverse T&O.

2.1.4.2 Total Dissolved Solids

Total dissolved solids are the quantity of salts dissolved in drinking water. TDS include:

- Anions – carbonate, chloride, sulfate, etc.
- Cations – sodium, calcium, magnesium, etc.

TDS are derived from several sources, including natural geologic formations, irrigation return flows, residential sources (human waste, water softeners, food waste), and industrial sources. The potential impacts of high TDS in drinking water are:

- Objectionable mineral taste.
- Color.
- Infrastructure corrosion or scaling (depending on water chemistry).
- Reduced applications for reclaimed water.

No NPDWR exists for TDS, but EPA has issued a secondary standard of 500 ppm. The World Health Organization has established a recommended TDS standard of 1,000 ppm for taste.

2.2 Potential Future Regulatory Requirements

The Safe Drinking Water Act and its amendments require that the EPA reevaluate existing drinking water regulations on a periodic basis and develop and promulgate new standards and regulations as necessary to protect public health. At any given time, there may be many contaminants at various stages of the rulemaking and revision process, such as information gathering, regulation development, public comment, or periodic review. This section summarizes potential future regulations beginning from those closest to new regulation and roughly ordered toward more distant likelihood/timing of regulation.

2.2.1 Proposed Rules

2.2.1.1 Regulatory Determination 4

On February 20, 2020, EPA announced and requested public comment on the preliminary regulatory determinations for eight Contaminant Candidate List (CCL) 4 contaminants. EPA made preliminary determinations to regulate perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water and to not regulate six contaminants (1,1-dichloroethane, acetochlor, methyl bromide [bromomethane], metolachlor, nitrobenzene, and Research Department eXplosive [RDX]).

2.2.2 Contaminants of Emerging Concern and Other Contaminants on the Planning Horizon

Table 7 presents contaminants that may be regulated by the EPA and indicates the approximate probability of regulation. More detail about these contaminants follows.

Table 7 Contaminants on the Regulatory Horizon

Contaminant	Regulatory Framework	Probability(1)
PFAS	2016 reviewed HA; UCMR3; CCL4; UCMR5, 2020 proposal to regulate	Imminent
cVOCs	2011 decision to regulate	Likely
Brominated DBPs	UCMR4; 3rd Six Year Review	Possible
Cyanotoxins	2015 health advisories (HA); UCMR4; CCL4	Possible
Strontium	2014 preliminary decision to regulate	Possible
Chlorate	3rd Six Year Review; Pesticide Office	Possible
Nitrosamines (including NDMA)	3rd Six Year Review	Maybe
Cr(VI)	UCMR3; CCL4	Maybe
1,4-dioxane	UCMR3; CCL4	Maybe
Manganese	UCMR4; CCL4	Maybe
Perchlorate	2011 decision to regulate; NRDC settlement	2020 decision not to regulate (2011 decision withdrawn)

Notes:
(1) "Imminent"—proposed and final MCL expected within 2 years. Based on AWWA Government Affairs (Roberson, 2015); "Likely" – regulation in 5 years; "Possible" – 50/50 chance of final regulation in 5-10 years; "Maybe" – anything can happen.

2.2.2.1 Per and Polyfluoroalkyl Substances

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals consisting of PFOS, PFOA, and many other per- and polyfluoronated chemical compounds. These compounds are manufactured and used in a variety of industries, most notably for stain- and water-repellent fabrics, nonstick products such as Teflon, and aqueous film-forming foams (AFFF), used in fighting aircraft fires. As part of a series of phase-outs, the United States no longer manufactures certain PFAS, including PFOS and PFOA. However, these compounds are still produced internationally and can enter the United States through imported consumer goods.

PFAS have been classified through research as probable human carcinogens and linked to other additional health-related risks such as obesity, immune system suppression, and endocrine disruption. Most notably, the chemical structures of long-chain PFAS make them bioaccumulative in humans and wildlife, and persistent in the environment.

In January 2009, EPA established a provisional health advisory (PHA) of 400 parts per trillion (ppt) for PFOA and 200 ppt for PFOS to assess the potential risk from short-term exposure of these chemicals through drinking water. On May 19, 2016, US EPA released its final Health Advisory Level (HAL) for PFOA and PFOS in drinking water (70 ppt total). On February 22, 2021, the EPA reissued the final regulatory determinations for CCL4, making the determination to regulate both PFOS and PFOA in drinking water. EPA will move forward with the NPDWR development process. On July 19, 2021, the EPA draft CCL5 also incorporated five additional PFAS for consideration and the proposed UCMR5 includes 29 PFAS compounds (see Section 2.2.3).

With Regulatory Determination 4, the EPA has 24 months to propose potential MCLs for PFOA and/or PFOS. In October 2021, the EPA released its PFAS Strategic Roadmap (EPA 2021), which laid out the following priorities and dates:

- **Drinking Water**—MCLs for PFOA and PFOS are to be proposed in Fall 2022 and finalized in Fall 2023. Twenty-nine PFAS are to be measured in 2023-2025 as part of UCMR5.
- **Cleanup**—PFOA and PFOS are to be designated Superfund (CERCLA) hazardous substances by Summer 2023.
- **Toxics**—more toxicity tests for PFAS (particularly new PFAS) are to be conducted under the Toxic Substances Control Act.
- **Monitoring**—EPA Method 1633 can measure up to 40 PFAS in eight environmental matrices and was released in September 2021 (multi-lab validation expected Fall 2022). "Total PFAS" quantification methods are to be developed (2021-2022). The National Lakes Assessment will evaluate PFAS in fish tissue in Summer 2022.
- **Research**—funding is to be directed to treatment, environmental justice, and quantifying toxicity, exposure, and ecological effects.
- **Wastewater**—ambient water quality criteria are to be released in Winter 2022; industrial effluent limits are to be proposed in Summer 2023.

The PFAS Strategic Roadmap emphasizes full consideration of the lifecycle of PFAS and multiple exposure pathways, holding polluters accountable (including enhanced reporting requirements), and preventing future PFAS pollution.

Currently, Arizona follows the regulatory requirements established by the EPA and is not anticipated to establish regulatory or guidance PFAS concentrations that are lower than EPA established concentrations or health advisory levels. Nevertheless, Tucson Water has operational targets for a variety of PFAS compounds in the potable system (Table 8).

Table 8 Tucson Water Operational Targets for PFAS

Parameter	Units	Value
PFOS	ppt	7
PFOA	ppt	11
PFHxS	ppt	7
PFOS + PFOA + PFHxS + PFHpA(1)	ppt	18
PFHxA	ppt	200,000
PFBS	ppt	420

Notes:
(1) When PFOS, PFOA, PFHxS, and PFHpA are present, combined concentrations should not exceed the operational target.
Abbreviations:
PFHxS = perfluorohexane sulfonic acid; PFHpA = perfluoroheptanoic acid; PFHxA = perfluorohexanoic acid;
PFBS = perfluorobutane sulfonic acid

2.2.2.2 Volatile Organic Compounds

The EPA announced in February 2011 that it plans to regulate a group of up to 16 carcinogenic VOCs (including eight currently regulated compounds and eight unregulated compounds) with one NPDWR. The proposed Carcinogenic VOC Rule (cVOC Rule) would regulate a group of contaminants together, acknowledging the cumulative and potentially synergistic effects of exposure to multiple contaminants. The EPA also indicated they would reduce the MCLs for individual VOCs, including TCE and PCE, via the cVOC Rule.

The rule was expected to be finalized sometime in 2015; however, EPA determined in January 2017 as part of its third 6-year review that it was not appropriate at the time to revise the drinking water standards for these contaminants. As of 2021, the newly proposed timetable for the potential cVOC Rule publication has been pushed to 2022, with the final rule in 2023.

2.2.2.3 Non-Regulated Disinfection Byproducts

The EPA continually considers whether additional regulation of DBPs is warranted, as illustrated by the inclusion of several unregulated DBPs on the fourth CCL, the decision to consider revisions to the Stage 1 and 2 D/DBPRs based on the Third Six Year Review cycle, and inclusion of several classes of unregulated DBPs through the UCMR. Unregulated brominated HAAs, haloacetonitriles (HAN), halonitromethanes (HNM), haloketones (HK), and nitrosamines are among the most common non-regulated DBPs. Research into these nonregulated DBPs has indicated a potential for greater toxicity than some regulated DBPs. Since more brominated DBPs can be more toxic, EPA required monitoring for HAA9 under UCRM4. Based on a review of UCMR4 data, HAA6Br and HAA9 concentrations in Tucson Water's distribution system samples are low, with a maximum measured HAA9 concentration of 15.7 µg/L.

2.2.2.4 Algal Toxins

Poor water quality in lakes, reservoirs, and rivers is a significant and growing threat for water utilities. In particular, harmful algal blooms (HAB), which produce cyanotoxins, can cause direct harm to people and animals. The "do not drink" advisories that have occurred in several places across the U.S. highlight the detrimental impacts these events can have on the communities and the water utilities charged with supplying safe drinking water to them. Currently, the majority of lakes and reservoirs in the U.S. do not have the means to quantify their risk/vulnerability to HABs. While it is well known that the growth of cyanobacteria in lakes and reservoirs is favored by high nutrient concentrations, elevated temperatures, thermal stratification, and high levels of sunlight, the dynamic seasonal and temporal combinations of these factors is not well understood in individual circumstances. This has limited our ability to create a general system for quantifying the risk of, and making predictions for, HABs. Three cyanotoxins were listed on CCL3, and in 2015, EPA issued 10-day health advisories for microcystins (0.3 ppb for infants and preschool children, 1.6 ppb for school-age children and adults) and cylindrospermopsin (0.7 ppb for infants and preschool children, 3.0 ppb for school-age children and adults).

2.2.2.5 Strontium

Strontium is not radioactive in its naturally occurring form, but radioactive strontium-90 is formed through nuclear fission and used in medicine and industry, as well as being present from nuclear testing and nuclear reactor waste. The element emits beta particles and thus falls under the umbrella of the Radionuclides Rule but could possibly be regulated on its own. The EPA made a preliminary determination to regulate in 2014.

2.2.2.6 Chlorate

Chlorate can form in water when sodium hypochlorite or chlorine dioxide are used for disinfection. As part of their Six-Year Review of the Microbial and DBP Rules, the EPA is currently considering the regulation of chlorate. Although it was also sampled as part of UCMR3, chlorate has not yet reached the regulatory determination assessment phase. As the Six-Year Review progresses, further steps towards regulation may occur, but potential MCL values or likelihood of regulation are unclear at this time.

2.2.2.7 Nitrosamines

Nitrosamines are a group of chemical compounds, a number of which are classified by the EPA as probable human carcinogens. Nitrosamines are a byproduct of manufacturing processes such as rocket fuels, foods, beverages, and can enter the treatment plant from upstream industrial and wastewater treatment plant discharges. These compounds can also be formed within the treatment plant or distribution system as a byproduct of chloramines and chlorine reacting with organic nitrogen precursors. More recently, it was found that nitrosamines can be an unintentional by-product of quaternary ammonium cationic polymer coagulants during chloramine disinfection.

A total of six nitrosamines were monitored as part of the Unregulated Contaminant Monitoring Rule (UCMR2). UCMR2 data indicated that *N*-nitrosodimethylamine (NDMA) is the predominant nitrosamine occurring in drinking water. Further, NDMA was detected three times more frequently in surface waters than ground waters and ten times more frequently in surface water plants using chloramines versus chlorine alone. NDMA was also detected at higher concentrations at maximum residence time locations in the distribution system as compared to entry points.

The EPA considered regulating the nitrosamines as a group since most of them have common treatment/control processes and considered setting the MCLG at zero since all the nitrosamines are probable carcinogens. With the publication of the draft CCL5, the EPA added six of the nitrosamines under the category of unregulated disinfection by-products, five of which were monitored under the UCMR2. The following six nitrosamines are in the draft CCL5:

- Nitrosodibutylamine (NDBA).
- N-Nitrosodiethylamine (NDEA).
- N-Nitrosodimethylamine (NDMA).
- N-Nitrosodi-n-propylamine (NDPA).
- N-Nitrosodiphenylamine (NDPhA).
- Nitrosopyrrolidine (NPYR).

2.2.2.8 Hexavalent Chromium

Chromium is a metallic ion that occurs naturally in water along with iron, though usually in significantly smaller amounts. It is also produced by steel manufacturing plants and can be discharged into surface water bodies from such plants. Chromium will quickly convert to the hexavalent form, Cr-VI, in the presence of oxygen. Cr-VI is carcinogenic and is being evaluated by the EPA for regulation.

The EPA is currently conducting an Integrated Risk Information System (IRIS) toxicological assessment of Cr-VI. The draft assessment for Cr-VI oral ingestion will be combined with the draft assessment for Cr-VI inhalation exposure. The IRIS Cr-VI assessment is still under draft development, with the most recent preliminary assessment materials having been released in March 2019.

2.2.2.9 1,4-dioxane

1,4-dioxane is a common synthetic compound utilized for chlorinated solvent stabilization that was found in 21 percent of all public water systems tested in the UCMR3 program. In addition, EPA considers this a high priority chemical and a likely carcinogenic compound. The latest Drinking Water Specific Risk Level Concentration from EPA is 0.35 ppb for the 10^{-6} cancer level (one in a million lifetime cancer risk). EPA's health advisory level for noncancer toxicity effects is 0.2 ppm, so the 0.35 ppb level for cancer effects is the more conservative level. Tucson Water's operational target for 1,4-dioxane is 0.35 ppb. The notable removal difficulty of 1,4-dioxane is one of the key concerns in addition to its ubiquity, as essentially no conventional drinking water treatment technologies can reliably remove it at drinking water levels; however, ultraviolet light-hydrogen peroxide advanced oxidation process (UV AOP) is effective at treating 1,4-dioxane to below the method reporting limit of 0.1 ppb.

2.2.2.10 Manganese

The EPA included manganese, a naturally occurring ion, in UCMR4 to help assess if a primary MCL (in addition to the existing secondary MCL) should be established. As of March 10, 2020, the EPA determined there was not enough information to proceed to the regulatory determination assessment phase.

The EPA, however, has established health advisory levels (HALs) for manganese. For all persons, EPA has a 1-day and 10-day HAL of 1 mg/L and a lifetime HAL of 0.3 mg/L. For bottle-fed infants younger than six months, the EPA also has a 10-day HAL health advisory level of 0.3 mg/L.

2.2.2.11 Perchlorate

Perchlorate is a manmade chemical that is used in the manufacture of rocket fuels and explosives. It can also occur naturally in the environment. The discovery of perchlorate in water supplies causes concern due to the potential harmful impact on the functioning of the thyroid gland. Perchlorate was included in the first three of four CCLs that EPA has published to date. Based on data collected from its UCM program and comments received from the public, the EPA made a determination to regulate perchlorate in drinking water in February 2011. In July 2020, the EPA withdrew the 2011 regulatory determination, and published a final determination to not issue a national regulation.

Despite a lack of a federal MCL, some states have developed their own MCLs for perchlorate. An MCL of 6 micrograms per liter (µg/L) became effective in California in October 2007. The state of Arizona has established an advisory level of 11 µg/L for perchlorate in drinking water.

2.2.2.12 Endocrine Disrupting Compounds, Pharmaceuticals, and Personal Care Products

Endocrine disrupting compounds (EDC) are chemicals, both naturally occurring and manmade, that interfere with the normal function of the endocrine or hormonal system in animals and humans. The EPA currently regulates certain suspected EDCs including atrazine, DDT, dioxin, lead, cadmium, and mercury. If adverse effects on the endocrine system are determined at concentrations lower than current MCLs, then revised regulations may be established for these compounds.

Pharmaceuticals and Personal Care Products (PPCPs), sometimes also EDCs, refer to all pharmaceuticals used for human health and cosmetic purposes, as well as veterinary drugs. Typical PPCPs include antifungal medication, oral contraceptive pills, over-the-counter medications, perfumes, detergents, insect repellents, steroids, and antibiotics. PPCPs can enter surface water bodies from a variety of sources including industrial and municipal effluents, agricultural runoff, and hospital residues. Currently PPCPs are not regulated by the EPA.

2.2.2.13 Microplastics

Microplastics, or small plastic particles occurring between 1 nanometer and 5 millimeters, are considered ubiquitous in drinking water, wastewater, and ambient water. Additionally, presence in groundwater is also indicated as a potential impact of landfill leachate. The tendency of microplastics to continuously break down in the treatment process to potentially size ranges that are more toxic, less detectable, and more difficult to remove, notable concerns for this microconstituent.

Current levels in drinking water range from less than 1 particle/L to more than 300 particles/L. Proposed ambient water thresholds are approximately 70 particles/L.

2.2.2.14 Fluoride

While fluoride is currently regulated in the NPDWR at an MCL and MCLG of 4.0 ppm, the natural occurrence of fluoride or addition of fluoride to drinking water at times gains public attention. In addition to the MCL and MCLG, a 2.0 ppm NSDWR adds nonregulatory guidance for this inorganic chemical. Despite the NPDWR and NSDWR, the presence of low levels of fluoride in drinking water are desirable for cavity prevention. Tucson Water does not add fluoride and all presence is naturally occurring within the distribution system.

2.2.3 Unregulated Contaminant Monitoring Rules

The UCM program requires that EPA issue a list of no more than 30 unregulated contaminants every five years, to be monitored by public water systems. Such periodic monitoring provides EPA with a basis for setting national drinking water regulations in the future.

Unregulated contaminant monitoring required as part of the UCM program is generally conducted using a tiered approach based on the level of development of analytical methods used. Assessment Monitoring (List 1) is conducted for contaminants that have analytical methods that are well established. Screening Survey (List 2) monitoring is conducted for contaminants whose analytical methods have generally been more recently developed and employ technologies that are not as widely used or for which laboratory capacity required to conduct larger-scale Assessment Monitoring may be insufficient. Pre-Screen Testing (List 3) is conducted for contaminants that have very new or specialized analytical methods.

The data collected through the UCMR program is stored in the National Drinking Water Contaminant Occurrence Database (NCOD) to facilitate analysis and review. To date, there have been four UCMR rules published by EPA. In the upcoming cycle from 2022 to 2026, the UCMR5 will be implemented which proposes twenty-nine per-and PFAS. The one additional contaminant for planned monitoring is lithium. Table 9 summarizes the five UCMR, their monitoring schedule, and the type of contaminants included in the list.

Table 9 Unregulated Contaminant Monitoring Rule History

	Monitoring Schedule	Contaminants Included
UCMR1	2001 – 2005	• 12 chemicals on List 1[(1)] • 14 chemicals on List 2[(2)]
UCMR2	2007 – 2011	• 10 chemicals on List 1[(1)] • 15 chemicals on List 2[(3)]
UCMR3	2012 – 2016	• 21 chemicals on List 1[(1)] • 7 hormones on List 2[(3)] • 2 viruses on List 3[(4)] pre-screening
UCMR4	2018 – 2020	• 10 cyanotoxins on List 1[(1)] • 20 chemicals on List 1[(1)]
UCMR5	2023 – 2025	• 30 chemicals on List[(5)]

Notes:

(1) All public water systems serving more than 10,000 people performed assessment monitoring for List 1 contaminants, along with a representative selection of 800 public water systems serving less than 10,000 people.

(2) A selection of 120 systems serving more than 10,000 people and 180 systems (a subset of the 800 List 1 systems) serving less than 10,000 people were assigned to monitor for List 2 contaminants.

(3) All public water systems serving more than 100,000 people, along with 320 public water systems serving 10,000 to 100,000 people and 480 public water systems serving less than 10,000 people, performed screening surveys for List 2 contaminants.

(4) A representative selection of 800 undisinfected groundwater serving public water systems serving 1,000 or fewer people participated in monitoring for two viruses and related pathogen indicators.

(5) All public water systems serving more than 3,3000 people, along with a representative selection of 800 public water systems serving less than 10,000 people, would perform monitoring for listed contaminants.

2.2.3.1 Contaminant Candidate Lists

Each of the UCMR lists that the EPA generates under the UCM program is largely based on the CCL (see Table 10). The CCL is a list that the EPA maintains of priority contaminants that are known to occur in public water systems but that are currently unregulated. The UCM program and CCL complement each other, and similar to the UCM program, the EPA uses the CCL to prioritize research and data collection efforts for future regulations. The EPA publishes the CCL periodically and decides whether to regulate at least five or more compounds present on the most recent list (called Regulatory Determinations/RegDet) every five years.

The SDWA specifies that contaminants on the CCL shall be regulated if the EPA Administrator determines that:

- The contaminant may have an adverse effect on the health of persons.
- The contaminant is known to occur, or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern.
- In the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems.

If the EPA makes a determination that regulation of a contaminant in the CCL is warranted, the Agency must develop and promulgate a NPDWR based on the timeline established by the 1996 SDWA Amendments. To date, four CCLs have been reviewed and prepared. EPA began the process of developing CCL 5 in 2018 by requesting nomination of chemicals, microbes, or other materials for consideration. The deadline for CCL 5 nominations was December 4, 2018.

Table 10 Contaminant Candidate List History

	Year Published	Contaminants Included	Proposed Regulations	Regulatory Determinations
CCL1	1998	• 10 microbial • 50 chemical	• 8 chemicals (including manganese) and 1 microorganism (*Acanthamoeba*)	• Not to advance regulation of 8 chemicals (including manganese) and 1 microorganism (*Acanthamoeba*)
CCL2	2005	• 9 microbial • 42 chemical	• 12 chemicals	• Not to advance regulation of 11 chemicals • More information needed on perchlorate
CCL3	2009	• 12 microbial • 104 chemicals	• 5 chemicals	• Preliminary determination to regulate strontium • Not to regulate 4 chemicals
CCL4	2016	• 12 microbial • 97 chemicals	• 8 chemicals	• Preliminary determinations to regulate PFOS & PFOA • Not to regulate 6 chemicals
CCL5	Nominations in 2018	• 12 microbial • 66 chemicals and 3 chemical groups	• TBD	• TBD

2.2.4 Monitoring and Planning for Unknowns

While compliance with existing regulations is paramount, potential new regulations are on the horizon. Also of interest are changes in source water quality that could change the concentrations of compounds currently found in water served to the public. This section details contaminants detected in monitoring of CAP water, Tucson's primary potable resource. The recharge, recovery, and blending of this water serves to lower potential water quality risks from CAP water.

2.2.4.1 Pathogens

Cryptosporidium and Giardia have both been detected at low concentrations in CAP water. When CAP water is recharged in surface basins, the soil retains pathogens and greatly reduces their concentrations. Disinfection of recovered CAP water also inactivates pathogens that may remain.

2.2.4.2 Turbidity, Organics, and Nutrients

Turbidity must be maintained at or below 0.3 NTU in 95 percent of finished water samples. While this has typically not been an issue of concern, climate change and forest fires increase the risk of turbidity and organic loading. The nutrient loading can also increase the potential for algal growth and the presence of algal toxins.

2.2.4.3 Disinfection By-products

Natural organic matter (NOM) in surface waters, including the CAP canal, results in the potential for formation of DBPs, including TTHM and HAA5. Furthermore, the free chlorine residual in the distribution system can increase the formation of DBPs. Absorption on soil during the recharge process for CAP, as well as blending with groundwater, helps to reduce the DBP formation potential of the recharged and recovered water.

2.2.4.4 Arsenic

Arsenic is naturally occurring in Colorado River water, but it is generally found at concentrations that are below the current MCL of 10 ppb. Arsenic data in the main and isolated systems are discussed in Section 2.4.2.3 and Appendix B.

2.2.4.5 Perchlorate

Perchlorate occurs in Colorado River water due to discharges from two chemical manufacturers in Henderson, Nevada. Remediation efforts by the Nevada Department of Environmental Quality have reduced the amount of perchlorate entering the river system, and there have been no detections of perchlorate in raw CAP water over the last three years. Recharge and recovery of Tucson Water's CAP allotment further reduce concentrations of perchlorate.

2.2.4.6 Uranium

Uranium is naturally occurring in the Colorado River at low concentrations, with risks coming from upstream mining near Moab, Utah, and other sites. As with other contaminants, Tucson Water's strategies for managing the recharged and recovered water serve to increase the utility's resilience against potential changes in CAP concentrations of uranium.

2.2.4.7 Summary of Monitoring and Planning for Unknowns

It is recommended that Tucson Water continue with a robust program for monitoring and planning for unknowns. By continuing the Sentry Program, the utility will maintain data throughout the distribution system. Adding CAP raw water as a sample point will increase Tucson Water's ability to monitor constituents entering their system. Additionally, the Sentry Program would give Tucson Water the ability to participate in research programs on opportunistic pathogens and better track guidance on mitigating risks associated with these pathogens. The utility may conduct public outreach and share water quality data with CAP and other municipal subcontractors. Additionally, it is recommended that Tucson Water identify action levels and a response plan for key contaminants in the CAP raw water. Such plans could help avoid any problems caused by these contaminants by not allowing them into Tucson Water's sources.

2.3 Colorado River and Central Arizona Project Water

2.3.1 Background

Tucson Water has an annual allocation of 144,191 acre-feet of Colorado River Water, conveyed to Tucson through the CAP aqueduct. As expected for a surface water that flows great distances from its originating watersheds, the Colorado River has much higher salinity levels than most of Tucson's high quality native groundwater (~260 ppm TDS per PAG 1994), and the salinity in Colorado River water increases as water evaporates along the 300-mile journey through the CAP canal. Because relatively little of the water entering the Tucson Active Management Area (TAMA) leaves via any route besides evaporation/evapotranspiration (approximately 20 percent of the salt loading leaves in groundwater and, at times, in the Santa Cruz River [United States Bureau of Reclamation (USBR), 2003]), the basin is accumulating salt. Other salt contributions, such as treated wastewater discharges and fertilizer application, increase this accumulation.

In 1984, the US Bureau of Reclamation (USBR, 1984) projected that TDS would reach 650 ppm in the potable supply by 2050 and 750 ppm by 2100. These projections were for direct use of CAP water without recharge and recovery; therefore, they are only applicable to TARP raw water (see Section 2.3.2). A decade later, the Pima Association of Governments (PAG, 1994) noted an increase in water softener use by households receiving CAP water. Water softeners sequester calcium and magnesium ions and release sodium ions. The Central Arizona Salinity Study (USBR, 2003) looked to quantify the amount of salt accumulation in the TAMA and calculated a value of 107,500 tons net salt accumulation in the year 2000. They projected that by 2015, the accumulation would nearly double, to 200,000 tons annually, due to full receipt (for use or local recharge) of the CAP allotments by area water providers.

Another study (Malcolm Pirnie, 2007) projected that Tucson Water's recharged and recovered CAP water, while initially significantly influenced by blending with the native groundwater, would eventually approach the same salinity as incoming CAP water, about 650 ppm. The study also noted that overall salt accumulation in the basin would increase even more rapidly due to increased water softener use.

2.3.2 CAP Aqueduct Water Quality Requirements

The CAP aqueduct was designed to deliver CAP (Project) water, which has a delivery standard of 747 ppm TDS (CAWCD and USBR, 2020). CAP also has guidance for the acceptance of Non-Project water (water wheeling) through the CAP canal (CAWCD and USBR, 2020), which would cap salinity levels for Non-Project water at 1,150 ppm TDS. The intent of the standards is to ensure that, if water providers in the TAMA purchase non-Project water and have it wheeled through the CAP canal, the TDS of all CAP water in the Tucson branch could increase above the existing level in delivered water (around 650 ppm) but would not exceed the delivery standard of 747 ppm.

CAP has historically monitored 143 compounds, most regulated under the SDWA. For future monitoring, they are moving to monitor a total of 300 contaminants, including contaminants of emerging concern (CECs) such as PFAS, cyanotoxins, and 1,4-dioxane. CAP conducts the monitoring program at three pumping plants, three additional sampling locations along the canal, and two locations at Lake Pleasant for the water that enters the CAP canal from the Agua Fria River. For Non-Project supplies to be introduced to the canal, according to the guidance (CAWCD and USBR, 2020), they would have to provide historic data for all monitored constituents or collect one year of data, with a priority list of constituents sampled quarterly and the other constituents sampled semi-annually. Non-Project supplies would then be monitored (similar quarterly/semi-annual testing) for a "proving period" of two years, with subsequent monitoring requirements based on classification of the water in one of three risk-of-exceedance categories.

2.3.3 CAP Recharge Water Quality Trends

The Colorado River Salinity Control Program (SCP) was instituted in 1985 through USBR (acting on behalf of the Secretary of the Interior) with the goal of reducing the salinity of the water throughout the Colorado River Basin. As seen in in Figure 4, salinity of Colorado River water below Parker Dam has not increased significantly in the past 40 years and is lower than modeling indicates it would have been without the SCP interventions. TDS in water entering the CAP canal has remained below the water quality standard limit of 747 ppm.

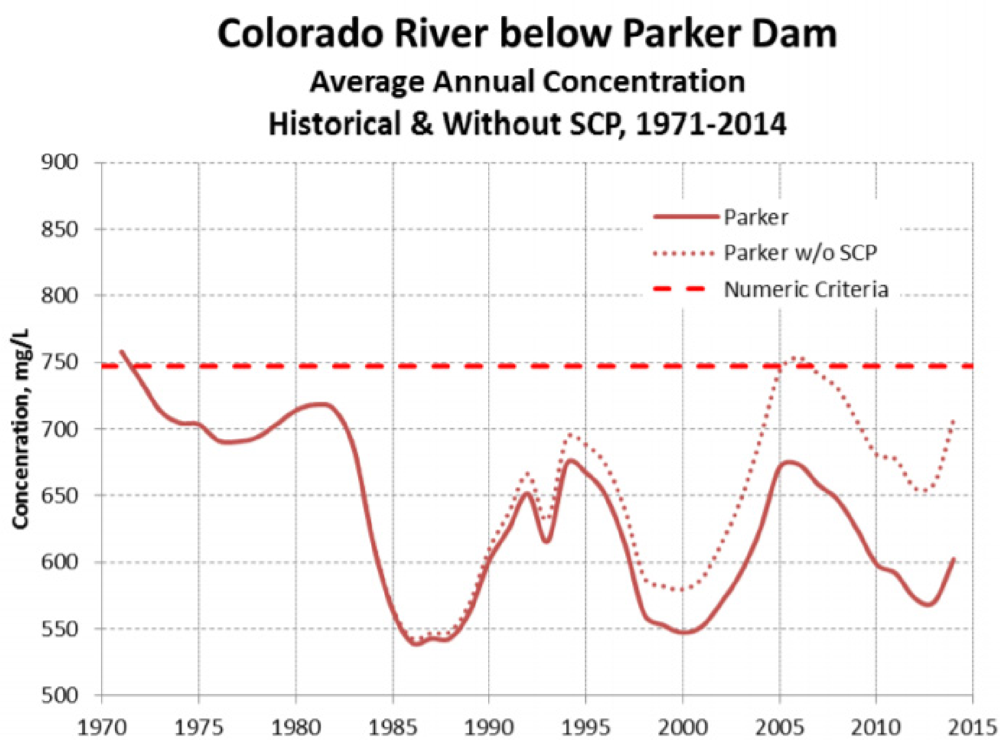

Figure 4 TDS Concentrations in Colorado River Below Parker Dam

CAP raw water reaching Tucson Water's Central Avra Valley Storage and Recovery Project (CAVSARP) facility has contained fairly steady TDS concentrations, as shown in Figure 5. In turn, the TDS in the recharged and recovered water has been fairly stable over time, rising gradually from about 480 ppm to about 540 ppm over the last decade.

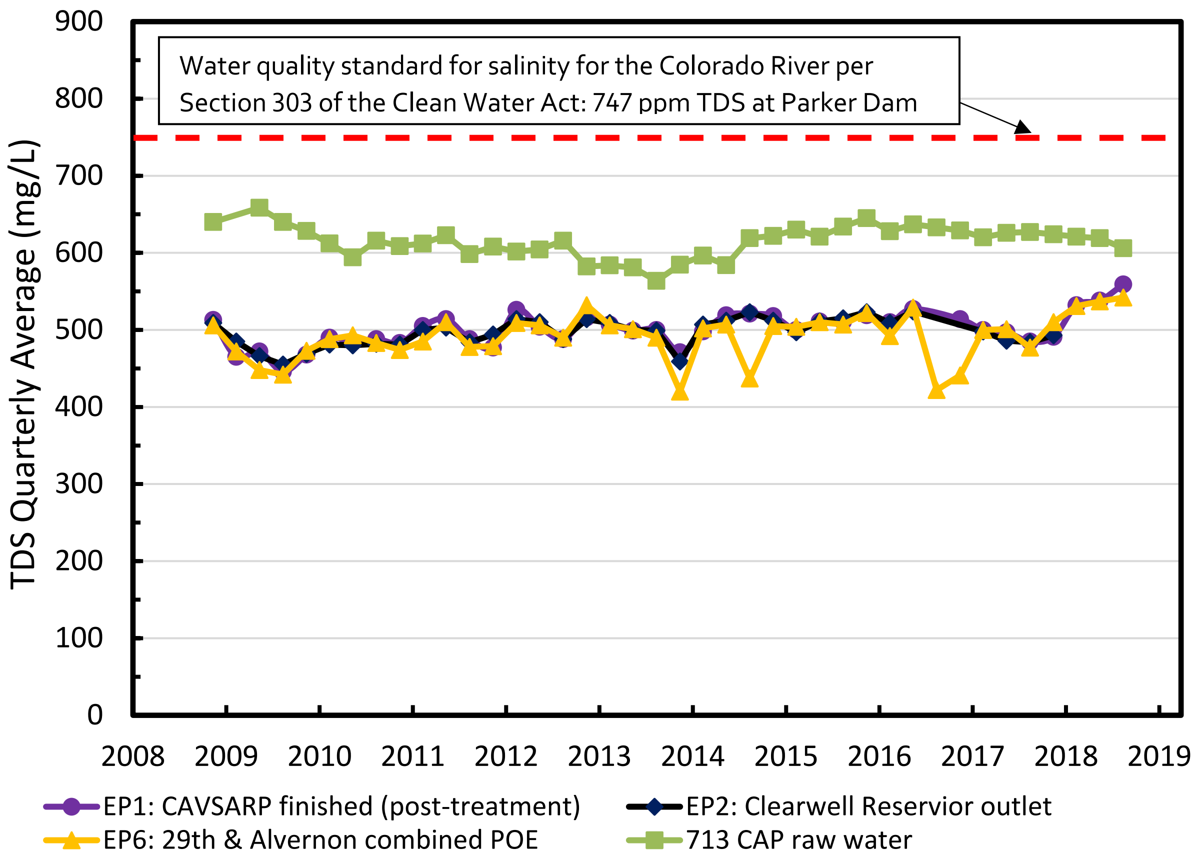

Figure 5 TDS Concentrations in Raw CAP Water and Recovered CAP Water

2.4 Potable Water System Compliance Review

2.4.1 National Primary and Secondary Drinking Water Regulations

As previously described, the NPDWRs are directly related to potential health impacts while NSDWRs are related to taste, odor, and aesthetic appeal of drinking water. During the time period of this analysis, Tucson Water met all current Federal and State regulations. This positive compliance pattern is expected to continue, including robust DBPR compliance. Opportunity to better characterize the distribution system impacts remain due to periodic source water changes due to the variety of sources in the One Water portfolio. Additionally, best management practices are always recommended to continue to be implemented to prevent aesthetic changes in the distribution system to increase customer satisfaction.

For more information on the primary and secondary water quality parameters, see Table A.1 and Table A.2, respectively. All figures for nitrate, fluoride, total dissolved solids, and alkalinity are shown in Appendix B.

2.4.1.1 Nitrate as N

The primary MCL for nitrate as nitrogen is 10 ppm. Data has historically remained within this MCL other than two data points in water quality zone (WQZ) 6 of the main system (Figure B.1). This well, D-047A, is now offline due to the elevated concentrations of nitrate. Additionally, nitrate as N remains within the appropriate range for the isolated systems, with Rancho del Sol's levels at the highest within those systems (Figure B.2).

2.4.1.2 Fluoride

The primary MCL for fluoride is 4 ppm with a secondary MCL at 2 ppm, as previously described in Section 2.2.4.2. All main system and Isolated Systems data is well below the MCL and MCLG as shown in Figures B.3 and B.4.

2.4.1.3 Total Dissolved Solids

The secondary MCL for TDS is 500 ppm due to aesthetic appeal of the water. As shown in Figure B.5, the TDS concentrations in the WQZs reflect a steady increase over the last 20 years, reflecting the contribution of recharged CAP water over time. Within the isolated systems, Silverbell West has a higher annual average TDS than any other isolated systems shown in Figure B.6. Altogether, 1,076 data points graphed were measured data points, while 65,989 of these points were estimated via conductivity for the combined main and isolated systems.

2.4.1.4 Alkalinity

There is no primary or secondary MCL for alkalinity; however, there is a secondary MCL for corrosivity indicating water must be non-corrosive. As shown in Figure B.7, WQZ 10 has the highest alkalinity outlier. Additionally, WQZ 1 has the highest maximum values typically than any other WQZ in the main system. All isolated system values remain consistent as shown in Figure B.8.

2.4.2 Chemical Contaminant Regulations

2.4.2.1 Phase II/V Rules

All Phase II/V Rule contaminants previously listed in Table 3 remain within compliance.

2.4.2.2 Lead and Copper Rule and the Lead and Copper Rule Revisions

To reduce the levels of lead and copper in the potable water system, the two most important things are to remove lead pipes from the system and to ensure finished water stability. Tucson Water has led the region in the identification, removal, and replacement of LSLs through its Get the Lead Out (GTLO) program since 1999. Tucson Water began inspecting service lines to determine the risk of LSL presence, which led to a distribution system materials inventory. With this program, more than 1,342 service lines have been assessed. Table 11 shows the numbers of known or suspected LSLs that were abandoned, inspected, replaced, are awaiting replacement, are under investigation, or were unable to be located.

Table 11 Lead Service Line Replacement Program "Get the Lead Out"

Status	Number of Service Lines
Abandoned service	118
Inspected & found copper	293
Requires inspection	26
Lead service line replaced	809
Lead service line awaiting replacement	1
Unable to locate	33
Under investigation	62
Total	**1,342**

When the recharged and recovered CAP water (see Section 2.3) was first introduced to the distribution system, Tucson Water increased the pH of the water to approximately 8.0 to help ensure chemical stability in the blend. The much higher salinity of the CAP water compared with the native groundwater created the possibility of increased corrosivity, and higher pH water helped to reduce corrosivity. Over the last 2 decades, Tucson Water was able to reduce the amount of pH adjustment and eventually stopped adjusting finished water pH as the distribution system became more acclimated to the higher salinity water.

As Table 12 shows, from 2016 through 2018, the maximum 90th percentile values for copper and lead concentrations in the distribution system were roughly an order of magnitude lower than the EPA action levels, indicating that these elements are well controlled in Tucson Water's system. In terms of historical compliance with the current LCR, Tucson Water has been in compliance with the 15 ppb action level for the entire period of time studied from 2011-2017.

Figure 6 and Figure 7 show the cumulative frequency distributions for copper and lead, respectively, for 2017, 2018, and 2019. All copper detections were well below the action level. For lead, there was one location that had samples over the action level; the lead service line to this location was replaced. Additional data about lead and copper can be found in Appendix C.

Table 12 Lead and Copper Rule Compliance

Parameter	Units	EPA Action Level	MCLG	Tucson Water Maximum 90th Percentile Value (2016-2018)
Copper	ppm	1.3	1.3	0.142
Lead	ppm	0.015	Zero	0.00107

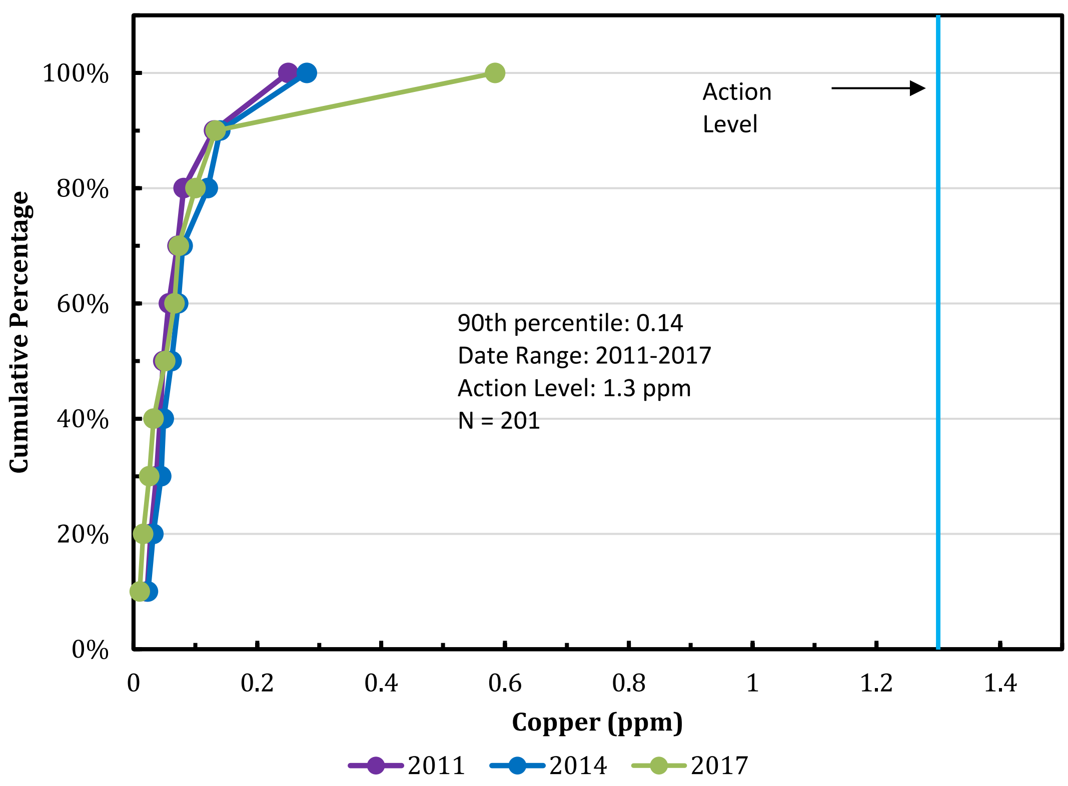

Figure 6 Main System Copper Cumulative Frequency Distribution

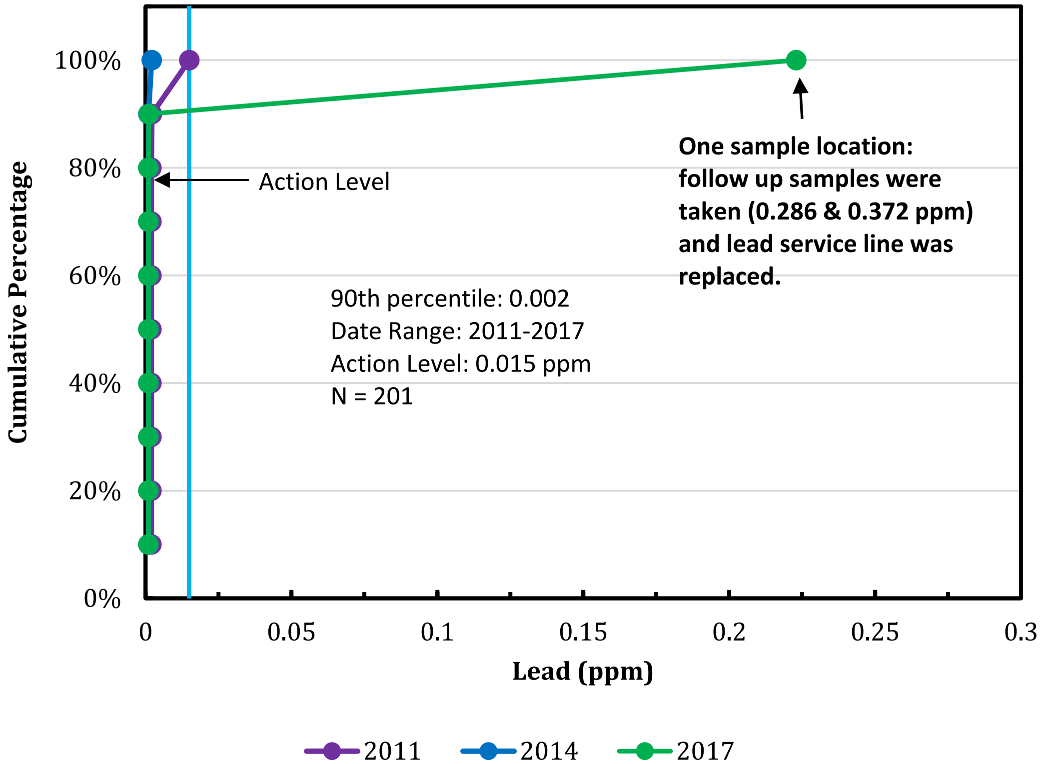

Figure 7 Main System Lead Cumulative Frequency Distribution

Tucson Water plans to carefully evaluate distribution system impacts if changing source water or treatment approaches. A flushing plan in the distribution system may help mitigate any water quality issues that arise from flow reversing direction in some pipes due to distribution system changes. A flushing standard operating procedure is given in Appendix D. Moreover, Tucson Water will calculate corrosion indices for each WQZ during times when no water is delivered through Snyder Hill Pump Station (SHPS).

Calculated values for the calcium carbonate precipitation potential (CCPP) in recharged and recovered CAP water are shown in Figure 8. EP1 samples the water recovered from the CAVSARP; EP2 samples the water from the Clearwell Reservoir, the highwater storage for recovered water; and EP6 samples the water where it enters the distribution system and blends with other system water. The CCPP calculates the quantity of calcium carbonate that will precipitate or dissolve. Positive values indicate calcium carbonate will precipitate. Negative values indicate calcium carbonate will dissolve. A stable water is considered to be one in which the CCPP is between 4 and 10 (slightly scale forming), and most of Tucson Water's samples fall into this range.

Calculated values for the Langelier Saturation Index (LSI) are shown in Figure 9. LSI calculates the pH of calcium carbonate stabilization. Positive values indicate calcium carbonate will precipitate. Negative values indicate calcium carbonate will dissolve. A balanced LSI is near zero (± 0.5), and most of Tucson Water's samples fall into this range.

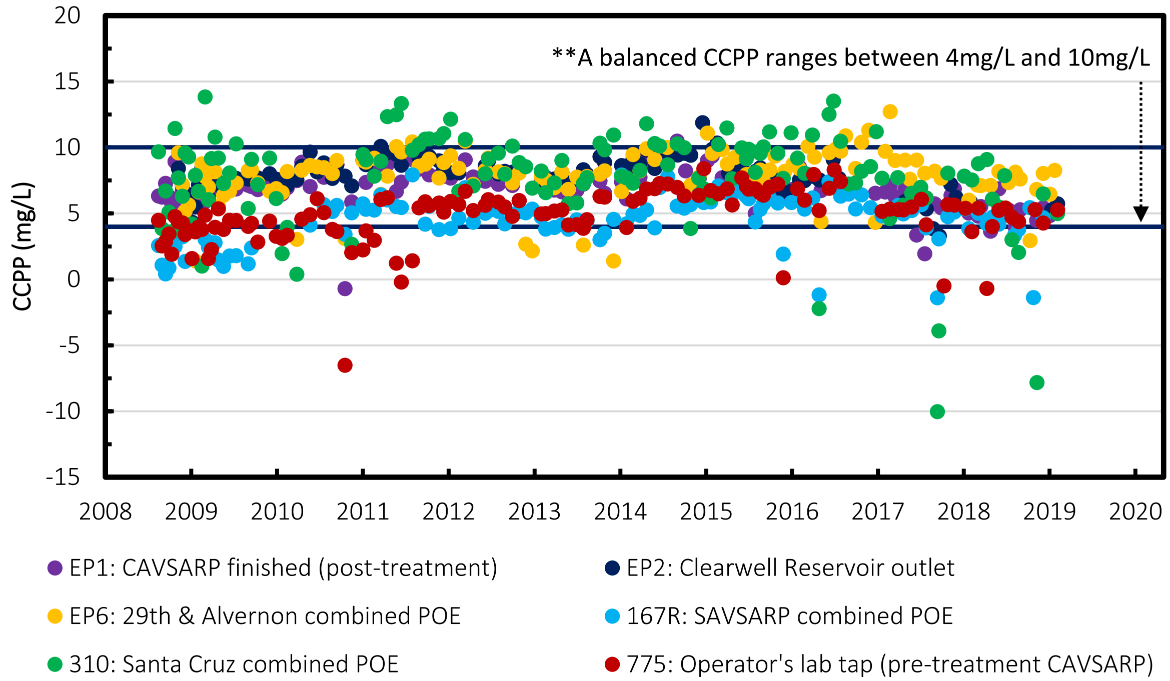

Figure 8 Calcium Carbonate Precipitation Potential (CCPP)

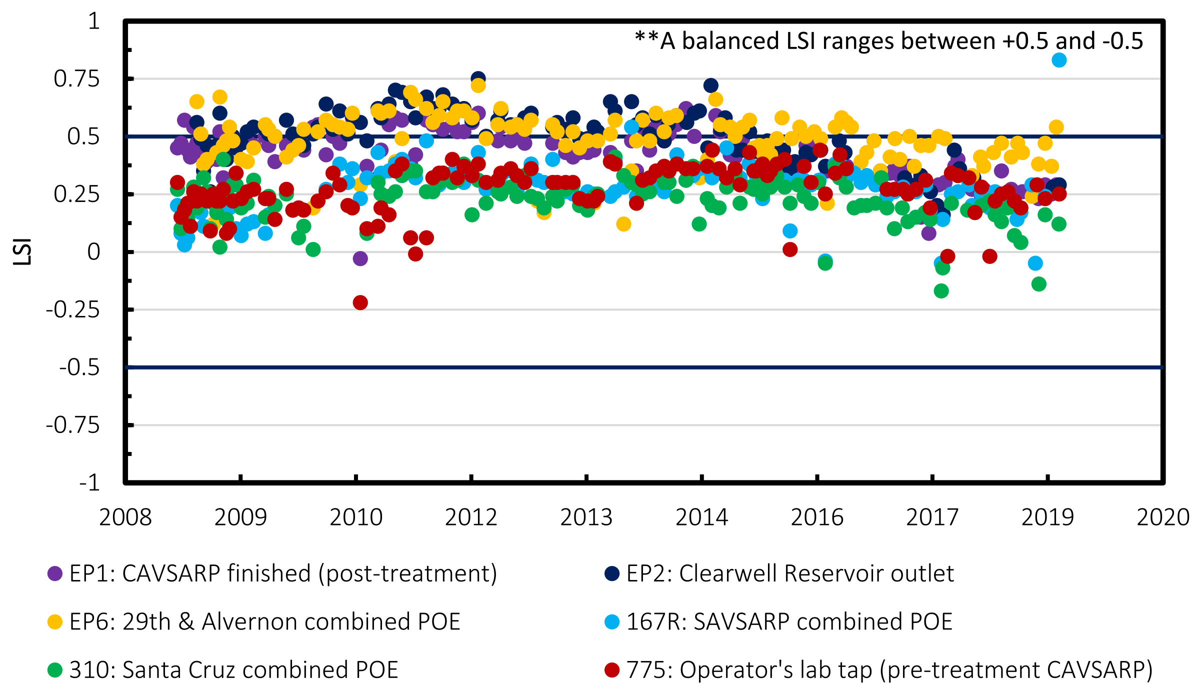

Figure 9 Langelier Saturation Index (LSI)

In addition to LCR compliance, historical data indicates that Tucson Water also has no history of the 10 ppb trigger level which begins in 2024. The data indicates that the system is well positioned for the LCRR with the current plan to continue identifying service line material as part of everyday operations and maintenance to fulfill the LSL inventory requirement by the 2024 compliance deadline. Tucson Water will begin researching machine learning to identify more service lines. Altogether, 200,000 service lines are within the service area; however, only 3,000-4,000 are considered an unknown material.

The additional requirements of the LCRR beyond those of the LCR, fall into six focus areas:

- Identifying areas most impacted.
- Strengthening treatment requirements.
- Systematically replacing lead service lines.
- Increasing sample reliability.
- Improving risk communication.
- Protecting children in schools and childcare facilities.

Complying with all the provisions of the LCRR will still require actions by Tucson Water despite the already low levels of copper and lead in the distribution system, due to the additional requirements imposed by the rule revisions. The projected effects and strategy for compliance are given in Table 13.

Table 13 Summary and Insight for Lead and Copper Rule Revisions

Focus Area	Rule Requirement	Impact to Tucson Water
Identifying areas most impacted	• Complete an LSL inventory within 3 years of rule promulgation. • Systems without LSLs must demonstrate their absence.	• Tucson Water will need to develop a LSL inventory by January 16, 2024. • The LSL inventory is in the early stages. Known LSLs have been identified and removed per the GTLO Program, but known galvanized requiring replacements (GRR) exist (<200). 3,000-4,000 service lines are lead status unknown. Reference material includes building construction records, and tap cards.
Strengthening treatment requirements	• 10 ppb trigger level (TL) for lead, in addition to the current 15 ppb action level (AL). • If the TL is exceeded based on 90th percentile lead concentrations, systems must re-optimize CCT or conduct a study if CCT is not currently in place. • Calcium hardness adjustment is no longer a lead CCT option and phosphate inhibitors must be orthophosphate. • Calcium, conductivity, and temperature analyses are no longer required as part of the water quality parameter (WQP) sampling. • If an individual tap sample exceeds 15 ppb lead, systems must collect a follow-up sample, conduct WQP monitoring at or near the site (0.5-mile radius, similar pressure zone), and perform a corrective action. This is termed a "find-and-fix" approach.	• No historical data indicates a potential for action level exceedance or trigger level exceedance.
Systematically replacing lead service lines	• Systems with lead above the TL for lead must develop a goal for LSL replacement; 3% LSL replaced per year with systems above the AL. • No partial LSLs can be conducted. • Utilities must replace their portion of an LSL within 45 days if the customer replaces their portion.	• Tucson Water is subject to public notification requirements for any lead status unknown locations. Galvanized lines on both the public and private side will also trigger notification requirements unless information is identified that confirms the pipes were never downstream of an LSL.
Increasing sample reliability	• Prioritize sample collection from sites served by LSLs. • For sites with LSLs, the 5th liter should be collected. • Collect samples in wide-mouth bottles with no cleaning, flushing, etc. prior to sample collection.	• Tucson Water may need to update its lead and copper sampling list to meet the revised tiering structure if any LSLs or GRR service lines are identified.

Focus Area	Rule Requirement	Impact to Tucson Water
Improving risk communication	• Utilities must notify individual tap sample consumers within 3 days of a 15 ppb lead sample detection. • Utilities must inform customers served by an LSL or lead status unknown service line. • Consumer Confidence Report (CCR) must provide updated health effects language and information regarding LSL replacement programs. • Utilities must notify system-wide customers of lead AL exceedance within 24 hours. • Systems must improve public access to lead information, including LSL locations, and respond to requests for LSL information, deliver educational materials to customers during water-related work that could disturb LSLs, and provide increased information to health care providers.	• Tucson Water will need to develop a plan and materials to comply with the new notification requirements for lead status unknown locations and any other materials (e.g., galvanized requiring replacement) that trigger additional communication.
Protecting children in schools and childcare facilities	• Develop a list of schools and childcare facilities by the 2024 compliance deadline. • Test 20% of licensed childcare facilities and elementary schools each year. • Provide testing to secondary schools on request. • Provide information and communicate results to users of the facility, parents, Primacy Agency, and the local or state health department.	• Tucson Water will need to sample 20% of schools and licensed childcare facilities within the city annually, or all facilities over the 5-year period. The Arizona Department of Human Services has begun screening water for lead in licensed facilities as early as 2017, which may be coordinated with LCRR requirements pending confirmation with ADEQ.

2.4.2.3 Arsenic Rule

The NPDWR MCL for arsenic is 0.01 ppm while the MCLG remains at zero. Arsenic data in the main system and isolated systems are below the MCL. However, WQZ 1 has one data point that has come close to the MCL as shown in Figure B.13. All isolated systems data, shown in Figure B.14, remains well below the MCL. When adjusting for discretionary sampling at specific wells, Figure B.15 shows the average annual arsenic concentration is well below the MCL.

2.4.2.4 Radionuclides Rule

The gross alpha particles MCL is 15 pCi/L with no MCLG. Adjusted gross alpha remains below the MCL in the main system as shown in Figure B.16. One adjusted gross alpha data point for Valley View in the Isolated Systems, shown in Figure B.17, is higher than the MCL.

2.4.3 Microbial and Disinfection Byproduct Regulations

2.4.3.1 Stage 1 and Stage 2 Disinfection Byproducts Rule

Data for the 2016-2018 study period are shown below in Table 14 which indicates Tucson Water remains below the minimum reporting limit (MRL) for bromate, chloramine, chlorine dioxide, chlorite, and total organic carbon. The remaining three parameters, free chlorine, haloacetic acids, and total trihalomethanes, remain well below the MCL and MCLG, if an MCLG is established.

Table 14 Stage 1 and Stage 2 Disinfection Byproducts Rule Compliance

Parameter	Units	EPA Primary MCL, MRDL, or TT	EPA MCLG	Maximum Detection (2016-2018)
Bromate	ppm	0.010	Zero	< MRL
Chloramine (As Free Chlorine)	ppm	4.0	4.0	< MRL
Chlorine Dioxide	ppm	0.8	0.8	< MRL
Chlorite	ppm	1.0	0.8	< MRL
Free Chlorine	ppm	4.0	4.0	0.99(1)
Haloacetic Acids (5)	ppm	0.060 LRAA	None	0.0038
Total Organic Carbon	ppm	TT	None	< MRL
Total Trihalomethanes	ppm	0.080 LRAA	None	0.021

Notes:
(1) Free chlorine is measured monthly and reported as an annual average value.

2.4.3.2 Total Trihalomethanes

The MCL for TTHM is 0.08 ppm based on a LRAA. All TTHM data for the main system and isolated system is below 0.08 ppm. Additional data on TTHMs in the main and isolated systems are shown in Figure B.9 and Figure B.10, respectively.

2.4.3.3 Haloacetic Acids (5)

The MCL for HAA5 is 0.06 ppm based on a LRAA. All HAA5s are well below the MCL for the main system and isolated systems. Additional data on HAA5s in the main and isolated systems are shown in Figure B.11 and Figure B.12, respectively.

2.4.4 Potential Future Regulatory Requirements and Contaminants of Emerging Concern

2.4.4.1 Potential Future Regulatory Requirements

As discussed in Section 2.2.3, contaminants on the UCMR lists may be regulated in the future. Table 15 and Table 16 show contaminants from UCMR3 and UCMR4, respectively, that have been detected in Tucson Water's wells or distribution system sampling points. In cases where the compound has a health advisory level, a relative health risk was also calculated, which is the maximum detection divided by the health advisory, such that a value of one would reflect a contaminant occurring at the health advisory level. For the UCMR3 and UCMR4 contaminants detected, none were measured at levels higher than the existing health advisory, so no exceedances would be expected if the contaminants were to be regulated at the existing health advisory level. As toxicology data is gathered, however, it is possible that maximum contaminant levels could be issued that are lower than the existing health advisory.

The highest relative health risk was found for 1,4-dioxane, at 0.629. In the case of this contaminant, Tucson Water has managed and treated its supplies, such as by shutting down some wells with detection and by treating TARP groundwater to remove 1,4-dioxane (see Section 3.3.1.2) to mitigate 1,4-dioxane levels in the distribution system.

UCMR Programs

Table 15 UCMR3 Compounds Detected

Parameter	Units	Maximum Detection	Minimum Reporting Level	Health Advisory	Relative Health Risk(1)	Percent of Locations with Detections(2)	Sample Point with Highest Detection
1,4-dioxane	ppb	0.22	0.07	0.35(3)	0.629	10%	SP-830
Chlorate	ppb	1,100	20	-	-	100%	C-016B
Chromium (total)	ppb	2.2	0.2	100(4)	0.022	80%	310
Chromium-6	ppb	2.3	0.03	-	-	100%	310
HCFC-22	ppb	0.09	0.08	-	-	10%	C-112A
Molybdenum	ppb	13	1	40	0.325	80%	SP-830
Strontium	ppb	1,200	0.3	4,000	0.3	100%	AV-021A
Vanadium	ppb	9.8	0.2			100%	EP1

Notes:
(1) Relative health risk calculated as the maximum detection divided by the health advisory.
(2) Sample size is ten well locations; two samples were collected from each well.
(3) This is the lowest HAL for 1,4-dioxane, representing a 10^{-6} excess lifetime cancer risk.
(4) Value is a maximum contaminant level.

UCMR4

Table 16 UCMR4 Compounds Detected

Parameter	Units	Maximum Detection	Minimum Reporting Level	MCL	Relative Health Risk(1)	Percent of Locations with Detections(2)	Sample Point with Highest Detection
Haloacetic acids (5)	ppb	7.7	-	60	0.128	100%	SP-860
Haloacetic acids (6)	ppb	9.1	-	-	-	100%	SP-860
Haloacetic acids (9)	ppb	15.7	-	-	-	100%	SP-860

Notes:
(1) Relative health risk calculated as the maximum detection divided by the maximum contaminant level.
(2) Sample size is eight well locations; one sample was collected from each well.

Together, the UCMR and Sentry Program offer a comprehensive summary of emerging contaminants in Tucson Water's supplies. Refer to Appendix E for the 2020 report and results from the Sentry Program. An increased number of contaminants detected through UCMR and other monitoring does not equate to increased risk and in many cases is due to increasingly sensitive analytical methods. It is recommended that Tucson Water continue its monitoring programs and compare results to health-based guidance.

2.4.4.2 Impaired Groundwater

The CECs causing the most risk to Tucson Water's potable supply wells are 1,4-dioxane and PFAS, but other contaminants are also present in Tucson area groundwater, as shown in Figure 10. An approximate delineation of PFAS groundwater contamination in Pima County is also given in Figure 10. Contamination plumes appear to originate from two areas, the Morris Air National Guard facility near Tucson International Airport and the Davis Monthan Air Force Base (DMAFB). The AFFFs used in fighting aircraft fires (and training to fight such fires) are currently thought to be the major sources of PFAS contamination in these areas. PFAS is also present in treated wastewater, so additional PFAS is thought to be released to the environment at the outfalls of the Agua Nueva and Tres Rios water reclamation facilities near Prince Road and Ina Road, respectively, along Interstate 10. Additionally, PFAS contamination occurs in groundwater at locations along the Santa Cruz River and other surface water features, with no clear point source. There are also high concentrations of 1,4-dioxane in the TARP plume and in groundwater near the Santa Cruz River and Cañada del Oro wash north of Tucson. As seen in Figure 10, Tucson Water has numerous potable water production wells within or near the areas of groundwater contamination shown. To help meet Tucson Water's operating targets for 1,4-dioxane and PFAS, if any well has contaminant concentrations above the utility's operational water quality target, the well is taken out of service. See Appendix F for a summary table of out-of-service wells.

Detail about the wells affected by PFAS near TARP and DMAFB can be seen in Figure 11. In 2021, ADEQ began construction of the Central Tucson PFAS Project Demonstration Facility (Carollo Engineers, Inc. [Carollo] 2021) at Well C-007, on the east side of Figure 11. The project is a demonstration-scale installation consisting of sediment removal and ion exchange (IX) for the adsorption of PFAS compounds. Because it is a demonstration program, the treated water is being discharged to a storm sewer, but the demonstration could pave the way toward wellhead IX treatment in areas of groundwater impaired by high levels of PFAS.

In the northwest portion of the PFAS and 1,4-dioxane plumes, Tucson Water conducted the Northwest Area Wells Alternatives Evaluation (Carollo 2020), identifying nine wells for potential centralized treatment in three clusters. Treatment proposed for the sites would be UV AOP and GAC.

PFAS and 1,4-dioxane have already restricted use of Tucson Water's groundwater supplies. It is recommended that the utility continue its monitoring programs and compare the results to health-based guidance while continuing to prioritize and implement strategic groundwater treatment efforts.

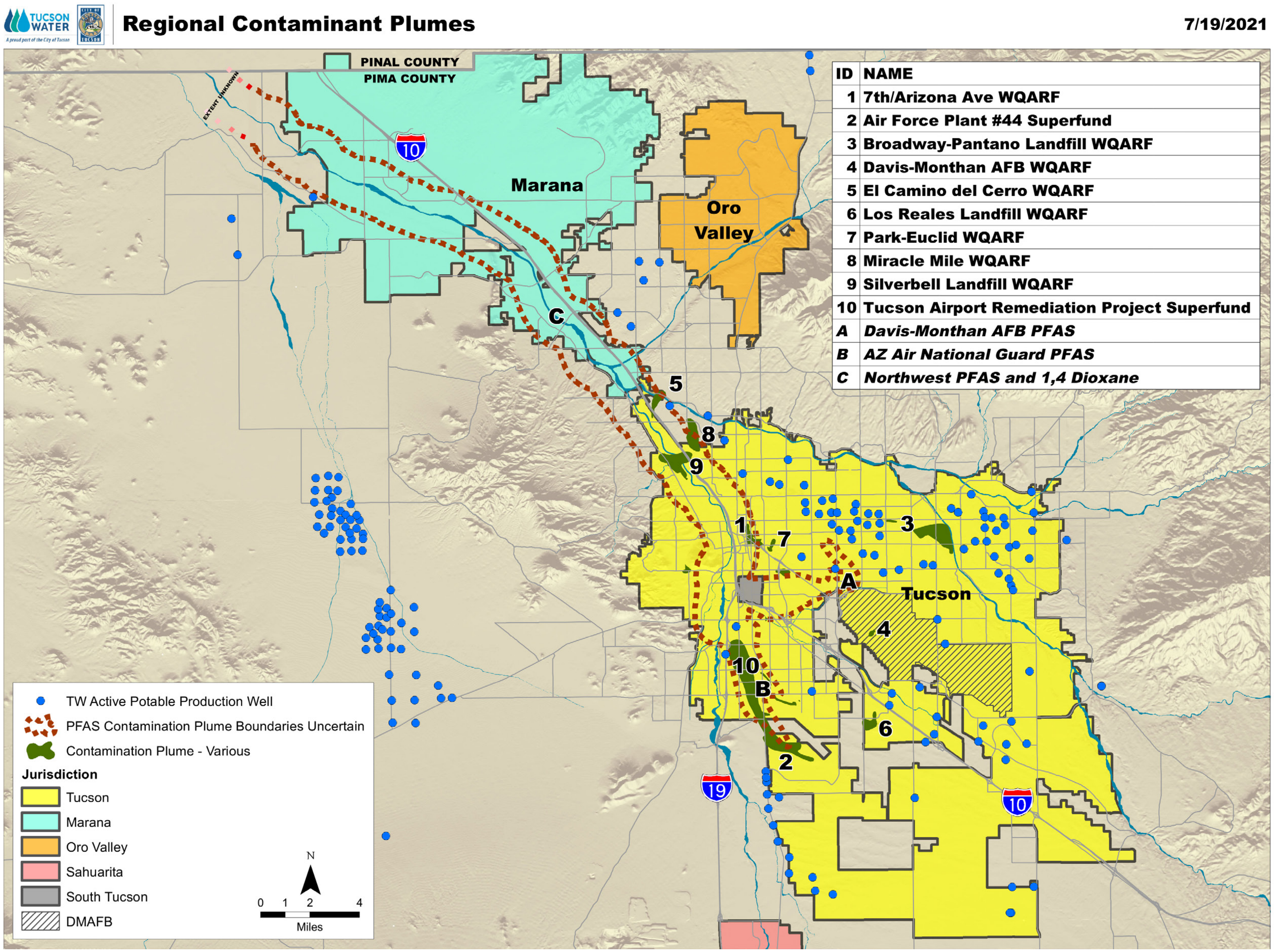

Figure 10 Regional Contaminant Plumes, Including Superfund and Water Quality Assurance Revolving Fund Sites

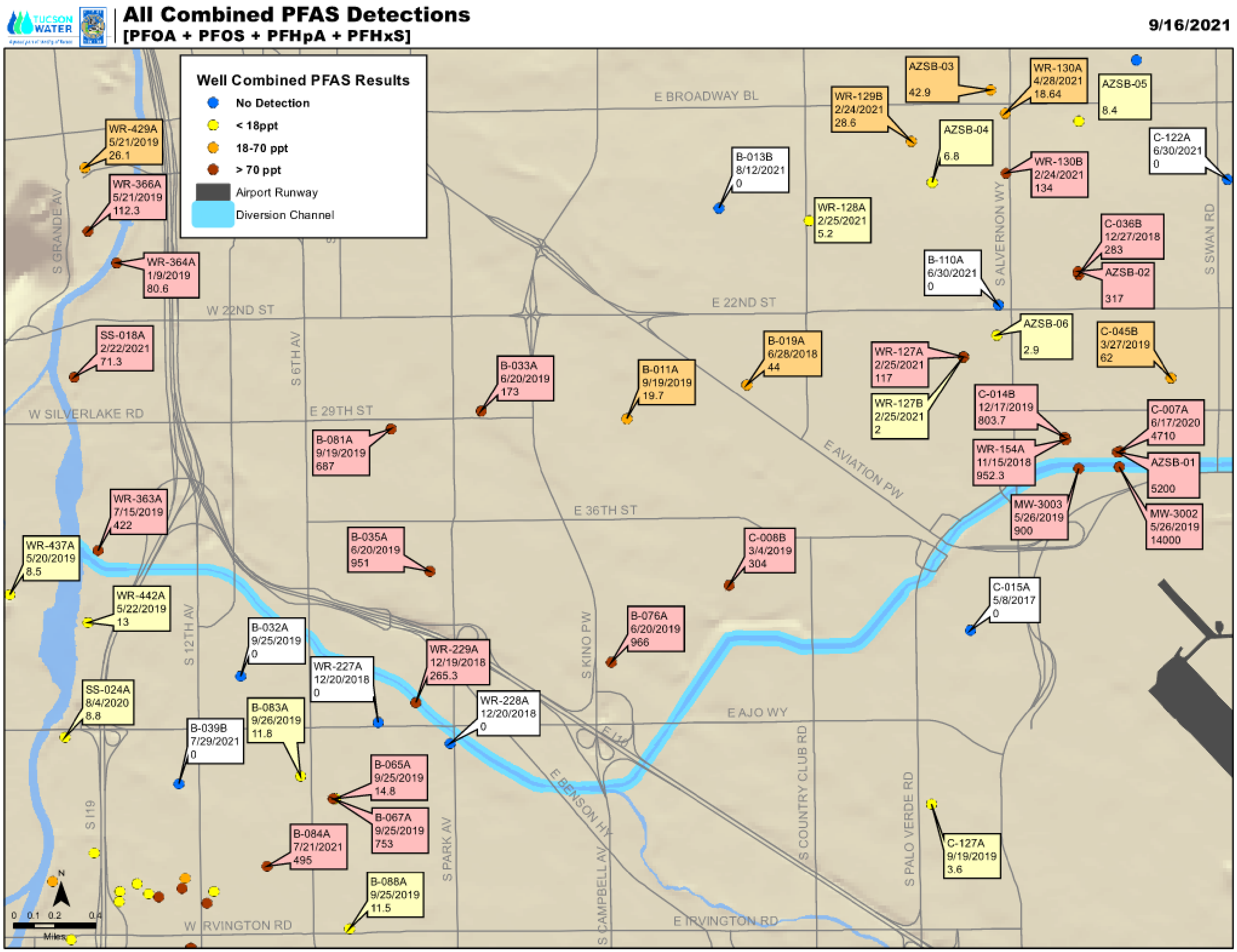

Figure 11 PFAS Detections in Wells Near TARP and DMAFB

3.0 Recycled Water Quality

Tucson Water owns and operates a municipal recycled water system (RWS) comprised of treatment facilities, aquifer storage and recovery wells, storage tanks, booster pumping stations, and distribution system piping located throughout a 390 square-mile service area. The system serves major irrigation customers, other non-potable uses, and underground storage. The supplies for the recycled water system are final effluent from Pima County Regional Wastewater Reclamation Department's Agua Nueva Wastewater Reclamation Facility (WRF), located on the east bank of the Santa Cruz River in northern Tucson, and remediated groundwater from the Silverbell Landfill Water Quality Assurance Revolving Fund (WQARF) site, located on the west bank of the Santa Cruz River south of Agua Nueva WRF. Tucson Water also maintains a series of infiltration basins at the Sweetwater Wetlands for aquifer storage and recovery of the recycled water. This section discusses water quality considerations in the recycled water system.

3.1 Recycled Water Regulations

Recycled water in the State of Arizona must meet water quality standards outlined in state statutes. Additionally, water released to surface watercourses or groundwater recharge facilities must have the appropriate discharge permits.

3.1.1 Water Quality Standards

3.1.1.1 Recycled Water Quality Standards

Tucson Water supplies Class A+ reclaimed (recycled) water, as defined by the Arizona Administrative Code (A.A.C.), Section R18-11-303. Key treatment processes required for the A+ designation are secondary treatment, filtration, nitrogen removal, and disinfection. Additionally, the state requires that the water meet the standards shown in Table 17.

Table 17 ADEQ Class A+ Reclaimed Water Quality Requirements

Parameter	Units	Value
24- hour average turbidity prior to disinfection	NTU	≤2
Turbidity of treated water (single sample maximum)	NTU	≤5
Fecal coliform	-	No fecal coliforms in 4 of 7 daily samples each week Maximum single sample 23 / 100 ml
Total nitrogen	ppm	< 10 (5-sample geometric mean)

As the highest class of recycled water, Class A+ water can be used for any approved type of direct reuse listed in Table A of A.A.C. Section R18-11-303.

3.1.2 Water Pollution Control

3.1.2.1 Use of Recycled Water

Recycled water in Tucson is primarily used for landscape irrigation and groundwater recharge. The RWS supplies 17 golf courses, 37 parks, and 62 schools, including the University of Arizona and Pima Community College. The system also serves over 700 single family homes in a few neighborhoods that are connected to branches of the recycled water distribution system. Tucson Water also conducts groundwater recharge at the Sweetwater Wetlands aquifer storage and recovery facility and at South Houghton Area Recharge Project (SHARP), as well as sending recycled water to the Santa Cruz River Heritage Project, which has restored perennial flow to a section of the Santa Cruz River near downtown Tucson.

3.1.2.2 Aquifer Protection Permits

Aquifer Protection Permits (APP) are required for surface discharges and groundwater recharge of recycled water. These permits are administered by ADEQ and set volumetric and water quality limits for each facility involved in such discharge or recharge.

Sweetwater Wetlands

Tucson Water constructed the Sweetwater Wetlands facility just south of the now-decommissioned Roger Road Wastewater Treatment Plant, which was replaced by the Agua Nueva WRF. The utility produces recycled water from the Sweetwater Reclamation Facility, which treats effluent from Agua Nueva WRF with tertiary filtration and disinfection via chloramination. When demand in the RWS is low, water produced by the plant is recharged in surface basins, and when demand in the RWS is high, water from the plant is sent directly into the RWS and can be supplemented with water recovered via a series of extraction wells near the basins.

The APP (issued 2003, revised 2014) for the facility prescribes a sampling point for discharge monitoring after the recycled water booster pumps and before the metering vaults. Tucson Water maintains a separate APP for discharge of the filter backwash water to the wetlands. Key water quality requirements of the APP are shown in Table 18. Additionally, the facility is required to conduct semi-annual monitoring of a list of 13 metals and 24 VOCs and semi-volatile organic compounds (SVOCs).

Table 18 Sweetwater Wetlands APP Water Quality Requirements

Parameter	Units	Value	Sampling Frequency	Reporting Frequency
Daily Flow (as calculated at flowmeters in filtration building)	mgd	No limit specified	Daily	Quarterly
Monthly Average Flow	mgd	9.5	Monthly (calculated)	Quarterly
E. coli	CFU or MPN	Non-detect in 4 of 7 daily samples each week Maximum single sample 15 / 100 mL	Daily	Quarterly
Turbidity of Treated Water (single sample maximum)	NTU	≤5	Daily	Quarterly
Enteric Virus (4 of 7 samples)	PFU	None detected per 40 liter sample	Monthly	Quarterly
Total Nitrogen (5-sample geometric mean)	ppm	No limit specified	Quarterly	Quarterly
Nitrate/Nitrite	ppm	No limit specified	Quarterly	Quarterly
Total Kjeldahl Nitrogen (TKN)	ppm	No limit specified	Quarterly	Quarterly

Abbreviations:
mgd = million gallons per day; CFU = colony forming units; MPN = most probable number; PFU = plague-forming unit; ppm = parts per million

Santa Cruz River Heritage Project

The Santa Cruz River Heritage Project discharges recycled water produced by the Sweetwater Reclamation Facility to the Santa Cruz River. The project restores perennial flow to a section of the river that used to flow year-round but has been ephemeral for nearly a century due to the decline of local groundwater levels. Key provisions of the APP are summarized in Table 19. Additionally, the facility is required to conduct quarterly monitoring of a list of 13 metals and semi-annual monitoring of 24 VOCs and SVOCs, both at the point of discharge and in the groundwater at the point of compliance, a monitoring well near the eastern bank of the Santa Cruz River, near Verdugo Park, approximately one quarter mile downstream of the outfall.

Table 19 Santa Cruz River Heritage Project APP Water Quality Requirements

Parameter	Units	Value	Sampling Frequency	Reporting Frequency
Daily Flow (as calculated at flowmeters in filtration building)	mgd	No limit specified	Daily	Quarterly
Annual Average Flow	ac-ft	4,000	Annually (calculated)	Annually
E. coli	MPN	Non-detect in 4 of 7 daily samples each week Maximum single sample 15 / 100 mL	Daily	Quarterly
Total Nitrogen (5-sample geometric mean)	ppm	No limit specified	Monthly (calculated)	Quarterly
Nitrate-Nitrite as N	ppm	≤10	Monthly	Quarterly
Nitrate as N	ppm	≤10	Monthly	Quarterly
Nitrite as N	ppm	≤1	Monthly	Quarterly
Total Kjeldahl Nitrogen (TKN)	ppm	No limit specified	Monthly	Quarterly

Abbreviations:
mgd = million gallons per day; MPN = most probable number; PFU = plague-forming unit

SHARP

SHARP was developed to recharge groundwater supplies in the southeast part of Tucson. Recycled water from the Sweetwater Reclamation Facility is conveyed to SHARP for recharge during low demand times. The APP requirements for the point of discharge and points of compliance (two monitoring wells) are summarized in Table 20. Additionally, the facility is required to conduct quarterly monitoring of a list of 13 metals and annual monitoring 24 VOCs and SVOCs, both at the point of discharge (semi-annual for VOCs and SVOCs) and in the groundwater at the points of compliance.

Table 20 SHARP APP Water Quality Requirements

Parameter	Units	Value	Sampling Frequency	Reporting Frequency
Daily Flow (as calculated at flowmeters in filtration building)	mgd	No limit specified	Daily	Quarterly
Annual Average Flow	ac-ft	4,000	Annually (calculated)	Annually
E. coli	MPN	Non-detect in 4 of 7 daily samples each week Maximum single sample 15 / 100 mL	Daily	Quarterly
Total Nitrogen (5-sample geometric mean)	ppm	No limit specified	Monthly (calculated)	Quarterly
Nitrate-Nitrite as N	ppm	≤10	Monthly	Quarterly
Nitrate as N	ppm	≤10	Monthly	Quarterly
Nitrite as N	ppm	≤1	Monthly	Quarterly
Total Kjeldahl Nitrogen (TKN)	ppm	No limit specified	Monthly	Quarterly

3.1.2.3 Arizona Pollutant Discharge Elimination System (AZPDES)

AZPDES is the Arizona implementation of the National Pollutant Discharge Elimination System (NPDES), which, under the Clean Water Act, regulates water quality of discharges to waters of the United States.

Santa Cruz River Heritage Project

The Santa Cruz River Heritage Project, because it discharges to a water of the US, must maintain an AZPDES permit in addition to an APP. Water quality requirements at the outfall for the Heritage Project are summarized in Table 21.

Table 21 Santa Cruz River Heritage Project AZPDES Water Quality Requirements

Parameter	Units	Monthly Average Value(1)	Daily Maximum Value(1)	Monitoring Frequency
Discharge Flow	mgd	No limit specified	No limit specified	Continuous
E. coli	CFU/100mL	126	575	4x monthly
Total Residual Chlorine	ppb	9.0	18	Weekly
Ammonia	ppm	No limit specified	No limit specified	Semi-Monthly
Ammonia Impact Ratio	-	1	2	Semi-Monthly
Cyanide	ppb	7.9	16	Quarterly
Iron	ppb	819	1640	Quarterly
Lead	ppb	5	11	Quarterly
Hardness	ppm	No limit specified	No limit specified	Quarterly
Selenium	ppb	2	3	Quarterly
pH	S.U.	6.5 – 9.0	6.5 – 9.0	Weekly
Temperature	Deg. C	No limit specified	No limit specified	Semi-Monthly
Total Chromium	ppb	No limit specified	No limit specified	Quarterly
Chromium VI	ppb	8	16	Quarterly
Copper	ppb	15	31	Quarterly
Mercury	ppb	0.01	0.02	Quarterly
Silver	ppb	7.3	15	Quarterly
Whole Effluent Toxicity (WET) – green algae	TUc	1.6	1.0	Annually
WET – fathead minnow	TUc	1.6	1.0	Annually
WET – water flea	TUc	1.6	1.0	Annually

Notes:
(1) Limits given as concentration values. A mass limit also applies; it is equivalent to the concentration limit in ppm times the flow rate (mgd) times 3.785 conversion factor.
Abbreviations:
ppm = parts per million; S.U. = standard units; TUc = chronic toxic unit

TARP (Heritage Project Irvington Outfall)

The TARP outfall to the Santa Cruz River, also known as the Heritage Project Irvington Outfall, likewise discharges to a water of the US and must maintain an AZPDES permit. Water quality requirements at the outfall for the Heritage Project Irvington Outfall are summarized in Table 22.

Table 22 TARP Heritage Project Irvington Outfall AZPDES Water Quality Requirements

Parameter	Units	Monthly Average Value(1)	Daily Maximum Value(1)	Monitoring Frequency
Discharge Flow	mgd	No limit specified	No limit specified	Continuous
1,4-dioxane	ppb	0.35	0.35	Monthly
Antimony	ppb	986	986	Quarterly
Beryllium	ppb	8.7	8.7	Quarterly
Cadmium	ppb	6.18	6.18	Quarterly
Cyanide	ppb	16	16	Quarterly
Iron	ppb	1,642	1,642	Quarterly
Lead	ppb	8.81	8.81	Quarterly
Hardness	ppm	No limit specified	No limit specified	Quarterly
Selenium	ppb	3	3	Quarterly
PFOA	ppt	No limit specified	No limit specified	Monthly
PFOS	ppt	No limit specified	No limit specified	Monthly
PFOA + PFOS	ppt	70	70(2)	Monthly
pH	S.U.	6.5 – 9.0	6.5 – 9.0	Weekly
Temperature	Deg. C	No limit specified	No limit specified	Semi-Monthly
Total Chromium	ppb	No limit specified	No limit specified(2)	Quarterly
Trichloroethene (TCE)	ppb	5.0	5.0	
Chromium VI	ppb	No limit specified	No limit specified	Quarterly(3)
Silver	ppb	10.8	10.8	Quarterly
Thallium	ppb	109	109	Quarterly
Sulfides	ppb	No limit specified	No limit specified(4)	Quarterly
Hydrogen Sulfide	ppb	3	3	Monthly(4)
Whole Effluent Toxicity (WET) – green algae	TUc	1.6	1.0	Annually
WET – fathead minnow	TUc	1.6	1.0	Annually
WET – water flea	TUc	1.6	1.0	Annually

Notes:
(1) Limits given as concentration values. A mass limit also applies; it is equivalent to the concentration limit in ppm times the flow rate (mgd) times 3.785 conversion factor.
(2) If PFOA + PFOS exceeds 18 ppt, ADEQ must be notified.
(3) If total chromium exceeds 8 ppb, chromium VI must be monitored for the rest of the permit. Otherwise, chromium VI sampling is not required.
(4) Any detection of sulfides (detection limit must be no higher than 100 ppb) will trigger monthly monitoring of hydrogen sulfide. Otherwise, hydrogen sulfide monitoring is not required.
Abbreviations:
ppm = parts per million; S.U. = standard units; TUc = chronic toxic unit

3.2 Source Water Changes and Anticipated Water Quality Effects

Tucson Water also owns and operates the Tucson Airport Remediation Project (TARP) Water Treatment Plant (WTP). Groundwater contaminated with trichloroethene (TCE), as well as the unregulated compounds 1,4-dioxane and PFAS, is treated at the plant and was introduced into Tucson Water's potable water system until June 21, 2021. Due to rising PFAS levels in the raw water for TARP, Tucson Water is constructing infrastructure to redirect TARP treated water to both the recycled water distribution system and the Santa Cruz River. Discharge of some TARP treated water to the Santa Cruz River commenced on November 2, 2021.

According to the EPA Superfund Consent Decree for TARP, TCE must be removed to below 1.5 ppb based on a 90-day weighted average of sample analysis results, and TARP has consistently produced water with TCE below the method reporting limit of 0.5 ppb since the plant was brought online in 1994. TARP's existing treatment process is an UV AOP followed by granular activated carbon (GAC).

Treated water produced by TARP has met and will continue to meet existing drinking water quality regulations, which are more stringent than the recycled water standards detailed in Section 3.1.1.1. Therefore, introduction of the TARP treated water to the RWS will generally improve the quality of water supplied through the system. It is anticipated that TARP treated water will supply most RWS demands in the winter (with excess flow going to SHARP) and a portion of the demand in other seasons.

3.3 Contaminants of Emerging Concern

While contaminants of emerging concern are not regulated in recycled water, they can nevertheless affect aquifer water quality when used for irrigation or underground storage. This section discusses these implications.

3.3.1 Occurrence of Emerging Contaminants in Reclaimed Water

Two primary CEC are present in the recycled water, PFAS and 1,4-dioxane. Both contaminants are also present in the raw water for TARP, but 1,4-dioxane is removed nearly completely by the UV AOP, and concentrations of PFAS are reduced significantly by the GAC system, as discussed below.

3.3.1.1 Per and Polyfluoroalkyl Substances

According to analysis performed by Tucson Water in 2018 and 2019, PFAS has been detected in the recycled water recovery wells at the Sweetwater Wetlands, due to PFAS present in the recycled water itself. Combined totals of PFOS and PFOA ranged from 80 to 265 ppt, as shown in Figure 12. Therefore, all recycled water recovered from Sweetwater has PFOS + PFOA concentrations that exceed the water quality operational target of 70 ppt. Because the water is nonpotable, Tucson Water can serve recycled water with any level of PFAS without needing to notify any customers, but PFAS in recycled water affects groundwater supplies in areas receiving recycled water, particularly groundwater recharge facilities, so Tucson Water would like to minimize, to the extent practical, the concentrations of PFAS in the RWS.

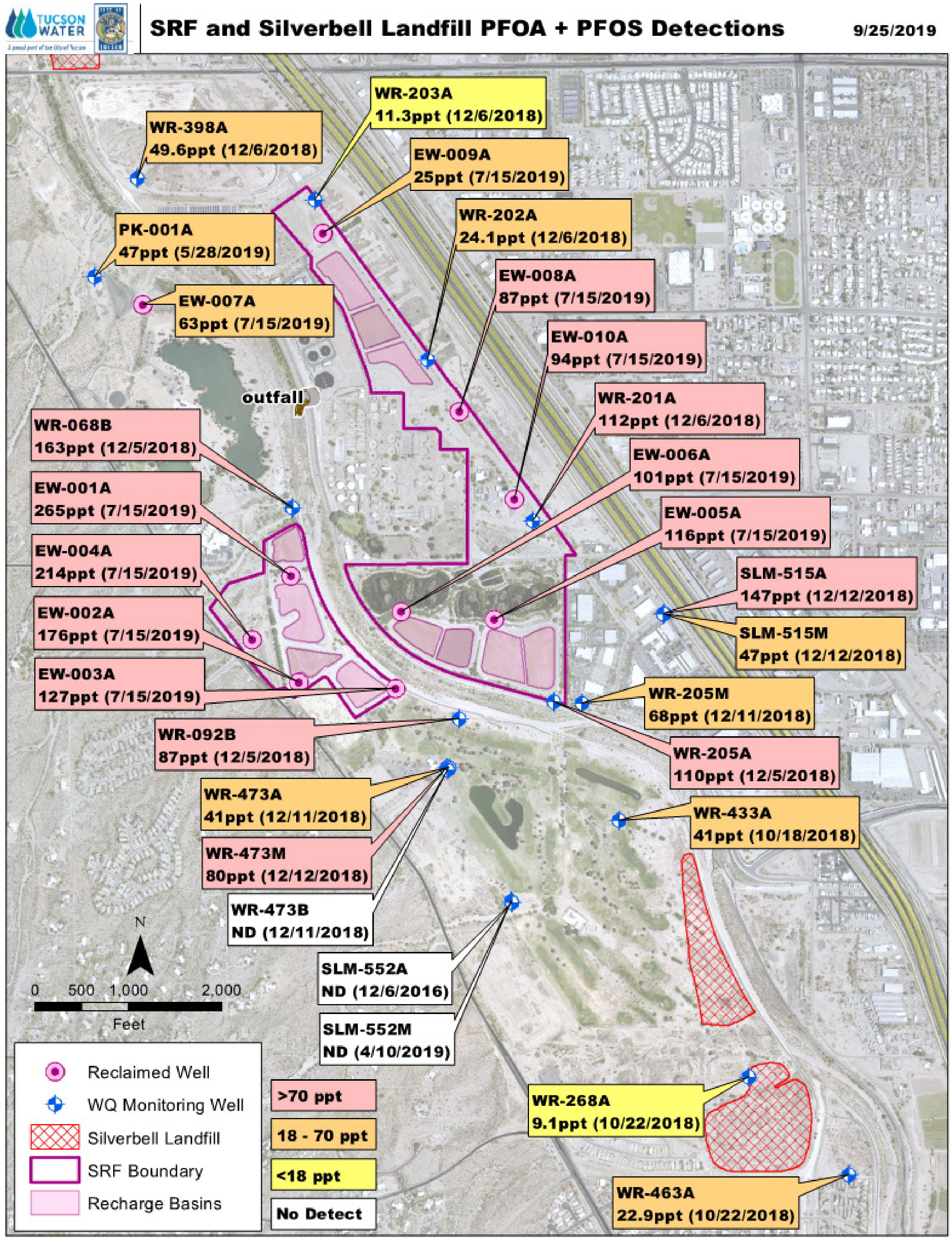

Figure 12 PFAS Detections in Recycled Water Recovery Wells and Nearby Monitoring Wells

Tucson Water is required by the AZPDES permit (see Table 22) to maintain a PFOS + PFOA concentration of no more than 70 ppt in TARP treated water and will notify ADEQ and other parties (PAG, Pima County, and the Town of Marana) if PFOS + PFOA exceeds 18 ppt. The GAC at the TARP WTP was originally installed to quench residual hydrogen peroxide from the UV AOP but also functions for adsorption of PFAS. It works particularly well for longer-chain PFAS such as PFOS and PFOA. As the GAC adsorbs PFAS, the adsorption sites gradually fill up, and eventually when few sites remain, the compounds break through into the treated water. When concentrations in the treated water approach the operational target, the GAC will be changed out to restore the adsorptive capacity of the beds. Using TARP treated water in the RWS will substantially reduce the concentrations of PFAS served through the system.

3.3.1.2 1,4-dioxane

The contaminant 1,4-dioxane is also found at low levels in Tucson Water's recycled water; Figure 13 displays the concentrations measured in 2018 and 2019 in recovery and monitoring wells near the Sweetwater Wetlands. The concentrations range from approximately 0.5 to 1.0 ppm, greater than the HAL of 0.35 ppb.

The UV AOP at TARP was constructed specifically for the purpose of destroying 1,4-dioxane and as such, removes the compound to below the MRL of 0.1 ppb. Therefore, introducing TARP treated water to the RWS will decrease the concentrations of 1,4-dioxane and should reduce the compound to non-detectable levels during the winter when the TARP water is anticipated to be the dominant supply.

3.3.1.3 Potential Treatment for the Recycled Water System

Tucson Water considered treating recycled water (from extraction wells, Agua Nueva effluent, and the Silverbell Landfill pump and treat system) with ion exchange and UV AOP to remove PFAS and 1,4-dioxane, respectively. At this time, the primary method of reducing the concentrations of CECs in the RWS will be the introduction of TARP treated water. It is worth noting that because the TARP raw water is not under the same wastewater influence as the other RWS source waters, introduction of TARP treated water to the RWS is also anticipated to reduce the concentrations of all other CECs that have been detected in the RWS.

3.3.2 Tucson Water Sentry Program Monitoring

Tucson Water's Sentry Program conducts semi-annual monitoring of CECs throughout the distribution system. This voluntary program was started in 2008 to track and proactively manage CECs. See Appendix E for the 2020 report and results from this program.

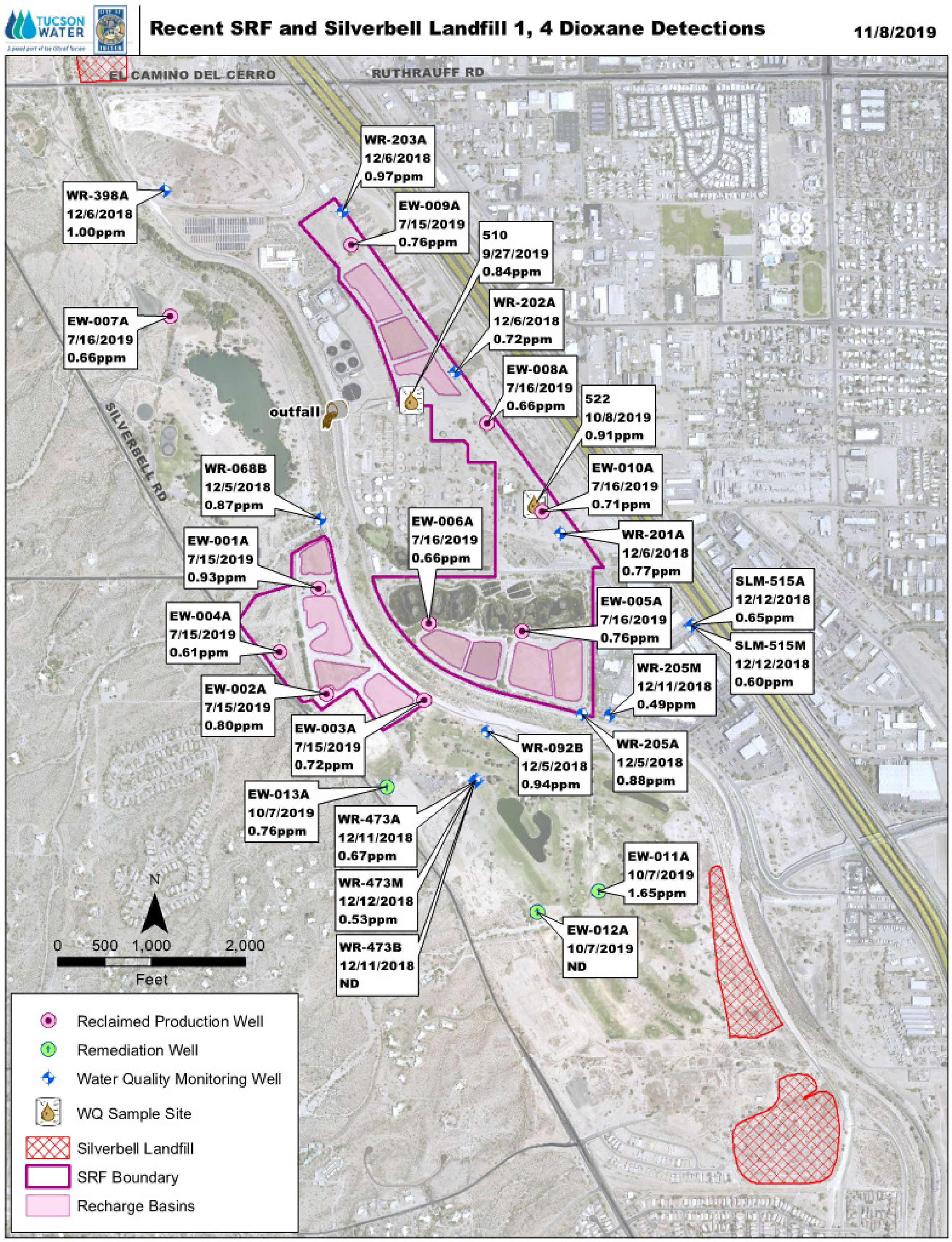

Figure 13 1,4-Dioxane Detections in Recycled Water Recovery Wells and Nearby Monitoring Wells

4.0 Conclusions

4.1 Primary Drinking Water Regulations

Tucson Water is meeting all current Federal and State regulations, and this current compliance pattern is expected to continue. Water quality information is available to customers at https://www.tucsonaz.gov/water/about-your-water-quality.

Tucson Water has an opportunity to anticipate future regulations and ensure the utility is ready to mitigate challenges to drinking water quality, whether from new or updated regulations or changes in raw water quality.

4.2 Emerging Contaminants

CECs have been detected in many locations in Tucson Water's distribution system. While the number of contaminants detected has increased in recent years, this does not necessarily equate to increased risk when contaminants remain at concentrations below health advisory levels. PFAS and 1,4-dioxane have already restricted use of Tucson Water's groundwater supplies, particularly in the vicinity of TARP, near DMAFB, and in the Northwest area.

Continued monitoring of CECs is recommended. Detected concentrations should be compared with health-based guidance to prioritize which water sources and contaminants need to be addressed and implement strategic groundwater treatment efforts.

4.3 Lead and Copper Rule and Lead and Copper Rule Revisions

Tucson Water is complying with the current LCR and is well positioned to comply with the new LCRR through continued implementation of the "Get the Lead Out" program. Any changes to source water or treatment technologies should be carefully evaluated to assess any possible effects on the distribution system.

4.4 Salinity and Basin-wide Salt Loading

While the Tucson basin experiences a net influx of salt every year, TDS management on the Colorado River through the SCP and in Tucson through recharge and recovery has ensured that TDS concentrations in CAP water and the recharged and recovered water are relatively stable. CAP has introduced draft standards for monitoring and delivery of Non-Project water, which are intended to maintain CAP aqueduct water quality but do allow Non-Project water entering the canal to have higher salinity levels than those present in Project water. If a Tucson-area provider begins ordering and receiving Non-Project water, the salt content of Tucson Water's CAP supply could increase, though not above the CAP delivery standard of 747 ppm TDS.

4.5 Planning for Known and Unknown Guidance

In addition to those covered by existing regulations and guidance, more contaminants are likely to be regulated in the future. Recharge, recovery, and blending mitigates CAP water quality risks by reducing contaminant concentrations. Tucson Water has a robust monitoring program and is well positioned to manage contaminants with known and unknown regulations and guidance. It is recommended for Tucson Water to stay engaged with the broader water industry, share water quality data with CAP and other users, and expand the Sentry Program to include raw CAP water.

4.6 Recycled Water

Tucson Water has investigated management options to address the presence of emerging contaminants in recycled water. Introduction of TARP treated water to the RWS will help to blend down the concentrations of emerging contaminants and curtail the use of Sweetwater extraction wells. Tucson Water may also implement treatment of CECs in recycled water at the Sweetwater Reclamation Facility; this decision may be influenced by future regulation of one or more CECs.

State regulations and EPA's Action Plan support a One Water approach to water reuse, recognizing that potable water, recycled water, groundwater, and stormwater contribute to the region's water portfolio and as such, represent important resources for the future. By understanding existing water quality data and planning for future potential regulations, Tucson Water is well positioned to use One Water resources wisely and continue to serve the high-quality water that customers have come to expect.

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Appendix A

WATER QUALITY REGULATIONS

Table A.1 Primary Drinking Water Regulations, Goals, and Tucson Water Maximum Detection (2016-2018)

Contaminant	MCL[1] or TT[2] (ppm)[3]	MCLG[4] (ppm)[3]	Arizona Primary MCL (ppm)[3]	Tucson Water Maximum Detection (2016-2018) (ppm)[3, 5]
Organic Chemicals				
Acrylamide	TT[6]	Zero	NA	-
Alachlor	0.002	Zero	0.002	-
Atrazine	0.003	0.003	0.003	0.00008
Benzene	0.005	Zero	0.005	-
Benzo(a)pyrene (PAHs)	0.0002	Zero	0.0002	-
Carbofuran	0.04	0.04	0.04	-
Carbon tetrachloride	0.005	Zero	0.005	-
Chlordane	0.002	Zero	0.002	-
Chlorobenzene	0.1	0.1	0.1	-
2,4-D	0.07	0.07	0.07	-
Dalapon	0.2	0.2	0.2	-
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Zero	0.0002	-
o-Dichlorobenzene	0.6	0.6	0.6	-
p-Dichlorobenzene	0.075	0.075	0.075	-
1,2-Dichloroethane	0.005	Zero	0.005	-
1,1-Dichloroethylene	0.007	0.007	0.007	-
cis-1,2-Dichloroethylene	0.07	0.07	0.07	-
trans-1,2-Dichloroethylene	0.1	0.1	0.1	-
Dichloromethane	0.005	Zero	0.005	-
1,2-Dichloropropane	0.005	Zero	0.005	-
Di(2-ethylhexyl) adipate	0.4	0.4	0.4	-
Di(2-ethylhexyl) phthalate	0.006	Zero	0.006	-
Dinoseb	0.007	0.007	0.007	-
Dioxin (2,3,7,8-TCDD)	0.00000003	Zero	0.00000003	-
Diquat	0.02	0.02	0.02	-
Endothall	0.1	0.1	0.1	-
Endrin	0.002	0.002	0.002	-
Epichlorohydrin	TT[6]	Zero	NA	-
Ethylbenzene	0.7	0.7	0.7	-
Ethylene dibromide	0.00005	Zero	0.00005	-
Glyphosate	0.7	0.7	0.7	-
Heptachlor	0.0004	Zero	0.0004	-
Heptachlor epoxide	0.0002	Zero	0.0002	-
Hexachlorobenzene	0.001	Zero	0.001	-
Hexachlorocyclopentadiene	0.05	0.05	0.05	-
Lindane	0.0002	0.0002	0.0002	-
Methoxychlor	0.04	0.04	0.04	-
Oxamyl (Vydate)	0.2	0.2	0.2	-
Pentachlorophenol	0.001	Zero	0.001	-
Picloram	0.5	0.5	0.5	-
Polychlorinated Biphenyls (PCBs)	0.0005	Zero	0.0005	-
Simazine	0.004	0.004	0.004	0.00011

Contaminant	MCL[1] or TT[2] (ppm)[3]	MCLG[4] (ppm)[3]	Arizona Primary MCL (ppm)[3]	Tucson Water Maximum Detection (2016-2018) (ppm)[3, 5]
Styrene	0.1	0.1	0.1	-
Tetrachloroethylene	0.005	Zero	0.005	-
Toluene	1	1	1	-
Toxaphene	0.003	Zero	0.003	-
2,4,5-TP (Silvex)	0.05	0.05	0.05	-
1,2,4-Trichlorobenzene	0.07	0.07	0.07	-
1,1,1-Trichloroethane	0.2	0.2	0.2	-
1,1,2-Trichloroethane	0.005	0.003	0.005	-
Trichloroethylene	0.005	Zero	0.005	0.0007
Vinyl Chloride	0.002	Zero	0.002	-
Xylenes (total)	10	10	10	-
Inorganic Substances				
Antimony	0.006	0.006	0.006	-
Arsenic	0.010	Zero	0.050	0.0075
Asbestos (fibers/L > 10 µm)	7 million fibers/L	7 million fibers/L	7 million fibers/L	-
Barium	2	2	2	0.16
Beryllium	0.004	0.004	0.004	-
Cadmium	0.005	0.005	0.005	-
Chromium (total)	0.1	0.1	0.1	-
Copper[7]	TT AL=1.3	1.3	NA	0.142
Cyanide	0.2 (as free cyanide)	0.2	0.2	-
Fluoride	4.0	4	4	1.17
Lead[7]	TT AL=0.015	Zero	NA	0.00107[8]
Mercury (inorganic)	0.002	0.002	0.002	-
Nitrate (as N)	10	10	10	6.58
Nitrite (as N)	1	1	1	-
Selenium	0.05	0.05	0.05	0.0062
Thallium	0.002	0.0005	0.002	-
Radionuclides				
Gross Alpha	15 pCi/L	NA	15 pCi/L	6 pCi/L
Beta and photon radioactivity	4 mrem/yr	Zero	4 mrem/yr	-
Radium-226 + Radium-228	5 pCi/L	Zero	5 pCi/L	1.3 pCi/L
Uranium	0.030	Zero	NA	0.019
Microorganisms				
Cryptosporidium[9]	TT oocyst/100L	Zero	NA	-
Fecal coliform and *E. coli*	MCL[10]	Zero[10]	MCL[10]	-
Giardia lamblia[9]	TT cyst/100L	Zero	NA	-
Heterotrophic plate count (HPC)[9]	TT CFU/mL	NA	NA	-
Legionella[9]	TT #/mL	Zero	NA	-
Total Coliform[11]	5.0 percent #/mL	Zero	5 percent #/mL	0.8 percent[12]
Turbidity[9, 13]	0.3 NTU	NA	NA	-
Viruses[9]	TT #/mL	Zero	NA	-

Contaminant	MCL(1) or TT(2) (ppm)(3)	MCLG(4) (ppm)(3)	Arizona Primary MCL (ppm)(3)	Tucson Water Maximum Detection (2016-2018) (ppm)(3, 5)
Disinfectant Byproducts				
Bromate	0.010	Zero	NA	-
Chlorite	1	0.8	1.0	-
Haloacetic Acids (HAA5(14))	0.060(15)	NA(16)	NA	0.0038
Trihalomethanes (total)	0.080(15)	NA(16)	NA	0.021
Bromodichloromethane	-	Zero	NA	-
Bromoform	-	Zero	NA	-
Chloroform	-	0.07	NA	-
Dibromochloromethane	-	0.06	NA	-
Dichloroacetic acid	-	Zero	NA	-
Monochloroacetic acid	-	0.07	NA	-
Trichloroacetic acid	-	0.02	NA	-
Disinfectant Residuals				
Chloramines (as Cl_2)	4(17)	4(18)	NA	-
Chlorine (as Cl_2)	4(17)	4(18)	NA	0.99(19)
Chlorine Dioxide (as ClO_2)	0.8(17)	0.8(18)	NA	-

Notes:

(1) Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

(2) Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

(3) ppm unless otherwise noted

(4) Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected health risk. MCLGs allow for a margin of safety and are non-enforceable public health goals.

(5) A dash indicates that sampling was conducted for the contaminant, but it was not detected above the method reporting limit.

(6) Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 ppm (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 ppm (or equivalent).

(7) Lead and copper are regulated by a treatment technique to control corrosion in potable water systems. If 10% of tap water samples exceed the action level (AL), additional steps must be taken.

(8) Lead is reported as a 90th percentile value.

(9) The EPA's surface water treatment rule requires systems using surface water or ground water under the direct influence of surface water to disinfect and filter/meet the criteria to avoid filtration so that microbial contaminants are controlled.

(10) Routine samples containing fecal coliform or *E. coli* triggers a repeat sampling event. If the repeat sample is fecal coliform-positive, an acute MCL violation occurs. If the repeat sample is negative, and other repeat sampling is triggered. If the repeat sample is fecal coliform-positive, an acute MCL violation occurs.

(11) No more than 5.0 % samples total coliform positive in a month. Every sample that is coliform-positive must be analyzed for fecal coliforms and *E. coli*. If two consecutive samples are total coliform-positive and one is fecal coliform-positive, an acute MCL violation occurs.

(12) Follow up samples collected were negative.

(13) Performance standard: no more than 5 percent of monthly samples may exceed 0.3 NTU.

(14) Sum of concentrations of five haloacetic acid species (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, dibromoacetic acid).

(15) Measured as locational running annual average at each monitoring site.

(16) The group itself does not have an MCLG, but some individual contaminants have an MCLG as shown in the table (bromodichloromethane, bromoform, chloroform, dibromochloromethane, dichloroacetic acid, monochloroacetic acid, trichloroacetic acid).

(17) Maximum Residual Disinfectant Level.

(18) Maximum Residual Disinfectant Level Goal.

(19) Free chlorine is measured monthly and reported as an annual average value.

Abbreviations:

ppm = parts per million; pCi/L = picocuries per liter; NTU = Nephelometric Turbidity Unit; cfu/mL = colony forming units per milliliter; #/mL = number of microbes per milliliter

Table A.2 Secondary Drinking Water Regulations and Goals

Contaminant	Units	EPA Secondary MCL(1)	Noticeable Effects above Secondary MCL	Tucson Water Maximum Detection (2016-2018)
Aluminum	ppm	0.05-0.2	colored water	
Chloride	ppm	250	salty taste	85(2)
Color	color units	15	visible tint	
Copper	ppm	1	metallic tasting; blue-green staining	
Corrosivity	-	non-corrosive	metallic taste; corroded pipes/fixture staining	
Fluoride	ppm	2	tooth discoloration	
Foaming Agents	ppm	0.5	frothy, cloudy; bitter taste; odor	
Iron	ppm	0.3	rusty color; sediment; metallic taste; orange staining	
Manganese	ppm	0.05	black color; black staining; bitter metallic taste	
Odor	TON2	3	"rotten egg", musty or chemical smell	
pH	-	6.5-8.5	low pH: bitter taste; corrosion high pH: slippery feel, deposits	7.7-7.9(2)
Silver	ppm	0.1	skin discoloration, graying of white part of the eye	
Sulfate	ppm	250	salty taste	187(2)
Total Dissolved Solids (TDS)	ppm	500	hardness, deposits, colored water, staining, salty taste	542(2)
Zinc	ppm	5	metallic taste	

Notes:
(1) Secondary Maximum Contaminant Level (MCL): The highest level of a contaminant that is recommended in drinking water based on aesthetic and corrosion considerations. Secondary MCLs are not enforceable standards.
(2) Measured at EP6 as the Clearwater Blend enters the distribution system.
Abbreviations:
ppm = parts per million; TON = Threshold Odor Number

Table A.3 Lead and Copper Rule

Parameter	Units	EPA Action Level	MCLG	Tucson Water Maximum 90th Percentile Value (2016-2018)
Copper	ppm	1.3	1.3	0.142
Lead	ppm	0.015	Zero	0.00107(1)

Notes:
(1) Lead is reported as a 90th percentile value.

Table A.4 Radionuclides Rule

Parameter	Units	EPA Primary MCL	MCLG	Tucson Water Maximum Detection (2016-2018)
Gross Alpha Particles	pCi/L	15	Zero	6
Beta and photon radioactivity(1)	mrem/yr	4	Zero	-
Radium-226 + Radium-228	pCi/L	5	Zero	1.3
Uranium	ppm	0.030	Zero	0.019

Notes:
(1) A total of 168 beta particles and photon emitters may be used to calculate compliance with the MCL.
Abbreviations:
ppm = parts per million; pCi/L = picocuries per liter

Table A.5 Stage 2 Disinfectants and Disinfection Byproducts Rule (DBPR) Compliance

Parameter	Units	EPA Primary MCL, MRDL, or TT	EPA MCLG	Tucson Water Maximum Detection (2016-2018)
Bromate	ppm	0.010	Zero	< MRL
Chlorite	ppm	1.0	0.8	< MRL
Haloacetic Acids (HAA5(1))	ppm	0.060(2)	NA(3)	0.0038
Trihalomethanes (total)	ppm	0.080(2)	NA(3)	0.021
Chloramine (as Cl_2)	ppm	4(4)	4(5)	NA
Chlorine (as Cl_2)	ppm	4(4)	4(5)	0.99(6)
Chlorine Dioxide	ppm	0.8	0.8	NA
Total Organic Carbon	ppm	TT	NA	< MRL

Notes:
(1) Sum of concentrations of five haloacetic acid species (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, dibromoacetic acid).
(2) Measured as locational running annual average at each monitoring site.
(3) The group itself does not have an MCLG, but some individual contaminants have an MCLG as shown in the table (bromodichloromethane, bromoform, chloroform, dibromochloromethane, dichloroacetic acid, monochloroacetic acid, trichloroacetic acid).
(4) Maximum Residual Disinfectant Level.
(5) Maximum Residual Disinfectant Level Goal.
(6) Free chlorine is measured monthly and reported as an annual average value.

The following sections describe federal drinking water regulations that do not apply to Tucson Water due to the fact the utility doesn't use surface water directly. (CAP water becomes groundwater when it is recharged and recovered.)

A.1 Surface Water Treatment & Interim Enhanced Surface Water Treatment Rules

On June 29, 1989, the EPA published the final SWTR for drinking water systems using surface water sources. Tucson Water infiltrates CAP water to the ground before recovering the water through recovery wells; the water is considered groundwater at that point, so the SWTR does not apply. The SWTR requires that treatment be provided to reduce turbidity, *Giardia*, *Legionella*, viruses, and HPC bacteria, or the system must meet requirements for avoiding filtration, i.e. already low concentrations of these contaminants. The SWTR established treatment and performance standards to provide a minimum reduction of 99.9 percent (3-log) for *Giardia* cysts and 99.99 percent (4-log) for viruses. The overall reduction of *Giardia* and viruses is to be achieved through a combination of physical removal by pretreatment and filtration and inactivation by disinfection.

Treatment effectiveness under this rule is determined through turbidity measurements:

- The turbidity of representative samples of a system's combined filtered water must be less than or equal to 0.5 NTU in at least 95 percent of the measurements taken each month (subsequently reduced to 0.3 NTU by IESWTR).
- The turbidity level of representative samples of a system's combined filtered water must at no time exceed 5 NTU (subsequently reduced to 1 NTU by IESWTR).

Well-operated conventional treatment plants that meet or exceed the 0.5 NTU effluent turbidity standard are credited with a 2.5-log removal of *Giardia* cysts and a 2-log removal of viruses. The remainder of the overall 3-log *Giardia* cyst and 4-log virus treatment is to be provided by inactivation using disinfection.

The rule requires utilities to demonstrate compliance with primary disinfection requirements by meeting minimum "CT" requirements, where C is the residual disinfectant concentration in ppm, and T is the effective contact time with the disinfectant in minutes. The ability to meet minimum "CT" requirements is a function of the actual detention time downstream of disinfection, water temperature, pH, required log removal (*Giardia*, *Cryptosporidium*, or virus), disinfection type (i.e., chlorine), and disinfectant residual concentration.

In addition to primary disinfection requirements, the SWTR also requires protection against microbial contamination in the distribution system. Specifically, the SWTR outlines secondary disinfection or distribution system disinfection requirements to inactivate microbiological pathogens including *Legionella* and HPC bacteria. Secondary disinfection refers to application of a disinfectant to meet regulatory requirements for distribution system bacteriological quality as set forth in the TCR.

The IESWTR was promulgated by the EPA in 1998 and was the first regulation to specifically address chlorine resistant pathogens such as *Cryptosporidium*. In addition to the requirements of the SWTR, the rule establishes an MCLG of zero for *Cryptosporidium*. It also lowered the combined filter effluent turbidity standard to less than or equal to 0.3 NTU in 95 percent of all measurements. At no time can any turbidity measurement exceed 1 NTU. Systems that meet the turbidity standard are assumed to provide at least 2-log *Cryptosporidium* removal through filtration.

The rule also establishes criteria for systems that must establish a disinfection profile by collecting additional data related to the disinfection process and DBP formation.

A.2 Filter Backwash Recycling Rule

The FBRR was promulgated by the EPA in June 2001 and establishes regulations governing the way that certain recycle streams (spent filter backwash water, thickener supernatant, and liquids from dewatering processes) are handled within the treatment processes of conventional and direct filtration systems. Because Tucson Water does not use these processes in the potable water system, this rule does not apply. The purpose of the rule is to minimize *Cryptosporidium* concentrations in the treated water as a result of recycling sludge supernatant and filter backwash wastewater to the head of the treatment plant. The main requirement of the rule is that systems that recycle backwash waste must do so prior to the point of application of primary coagulant. The rule also requires utilities to submit a Recycle Notification Form to the State that includes a plant schematic showing the origin of all recycle flows and the typical recycle flows observed.

A.3 Long Term 1 & 2 Enhanced Surface Water Treatment Rules

The LT1ESWTR builds on the requirements of the SWTR and specifies treatment requirements to address *Cryptosporidium* and other microbial contaminants in public water systems serving less than 10,000 persons (therefore not applicable to Tucson Water). The rule balances the need for treatment with potential increases in disinfection by-products.

The LT2ESWTR was promulgated by the EPA in 2006 and requires proportional or watershed-based treatment levels based on *Cryptosporidium* levels in the source water. The rule assigns utilities to one of four 'bins', and each bin has associated requirements for additional *Cryptosporidium* treatment, as indicated in Table 5.

Table A.6 Cryptosporidium Inactivation Requirements Per LT2ESWTR

Bin No.	Average *Cryptosporidium* Concentration (oocysts/L)	Additional *Cryptosporidium* Treatment Required		
		Conventional Filtration, Diatomaceous Earth Filtration, or Slow Sand Filtration	Direct Filtration	Alternative Filtration Technologies
1	< 0.075	No additional treatment	No additional treatment	No additional treatment
2	0.075 to < 1.0	1 log(1)	1.5 log(1)	Note(3)
3	1.0 to < 3.0	2 log(2)	2.5 log(2)	Note(4)
4	≥ 3.0	2.5 log(2)	3 log(2)	Note(5)

Notes:
(1) Systems may use any technology or combination of technologies from toolbox.
(2) Systems must achieve at least 1 log of the required treatment using ozone, chlorine dioxide, UV, membranes, bag/cartridge filters, or in-bank filtration.
(3) Total *Cryptosporidium* removal and inactivation should be at least 4 log.
(4) Total *Cryptosporidium* removal and inactivation should be at least 5 log.
(5) Total *Cryptosporidium* removal and inactivation should be at least 5.5 log.

Appendix B

ADDITIONAL CONTAMINANT ANALYSIS

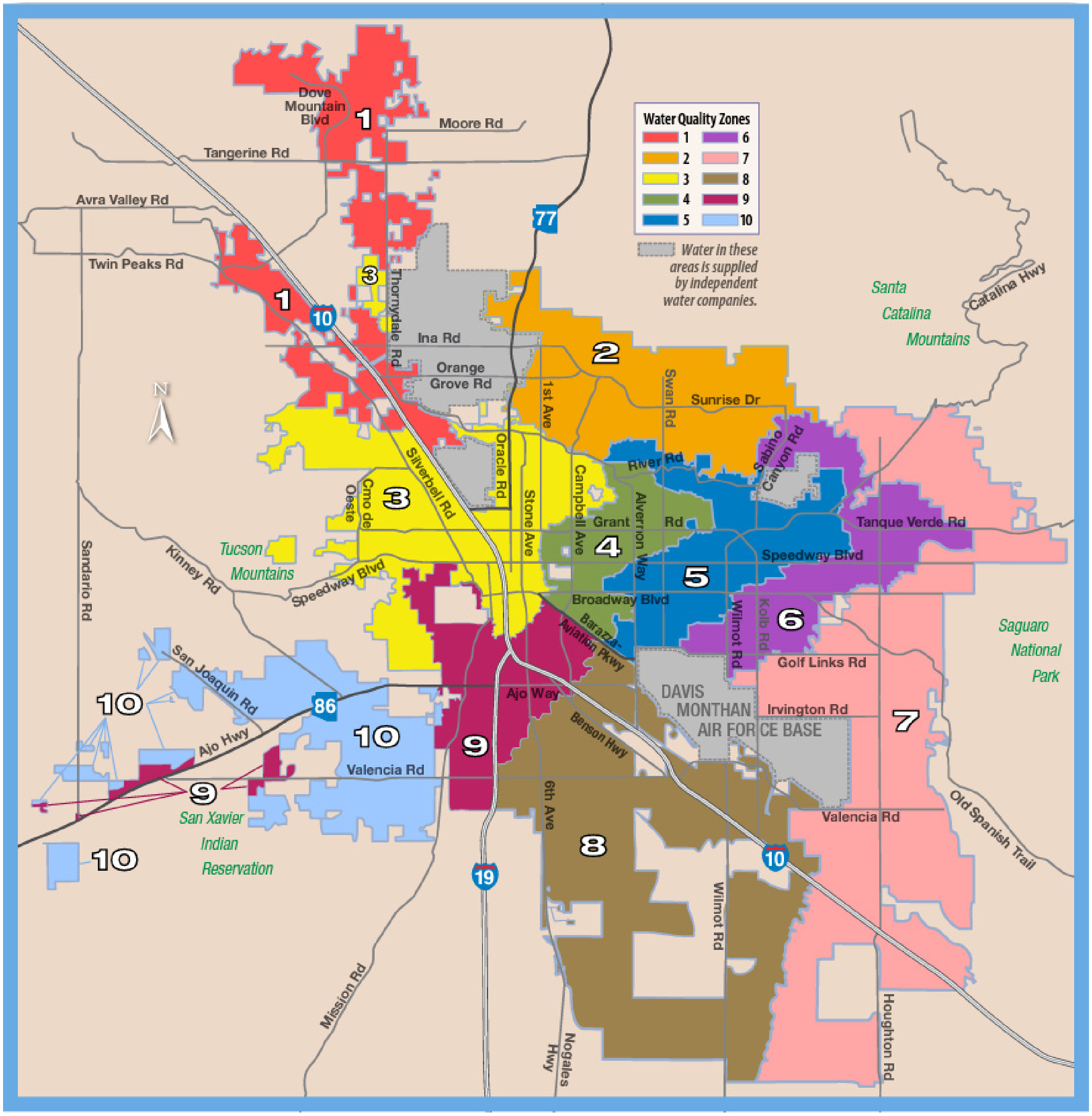


Figure B.1 Water Quality Zone Map

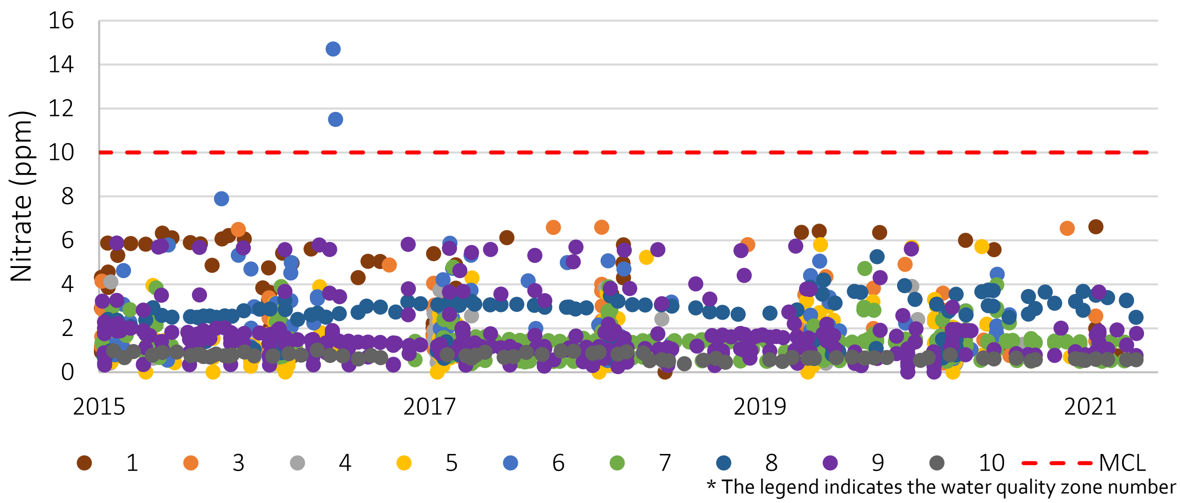


Figure B.2 All Data for Nitrate as N in the Main System

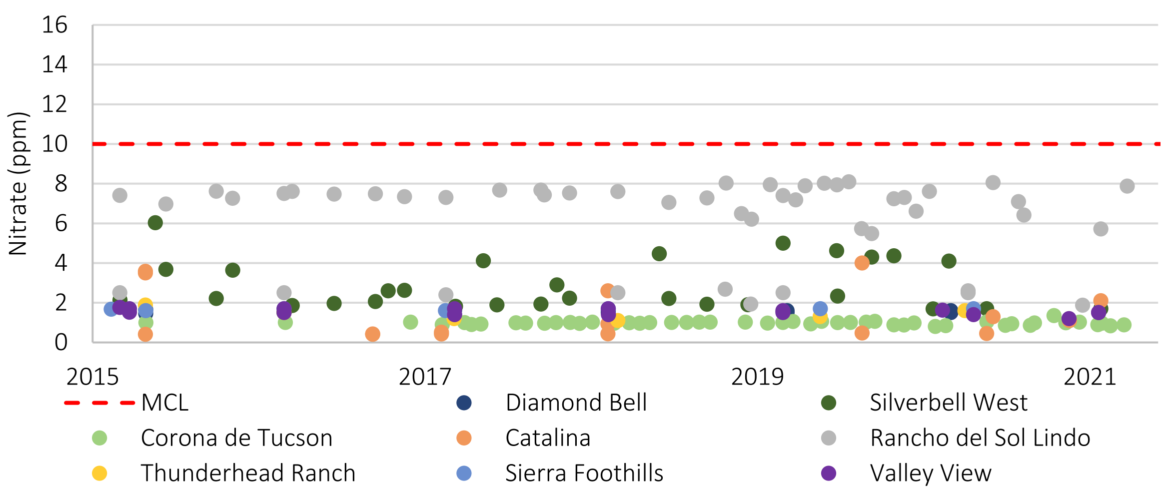


Figure B.3 All Data for Nitrate as N in Isolated Systems

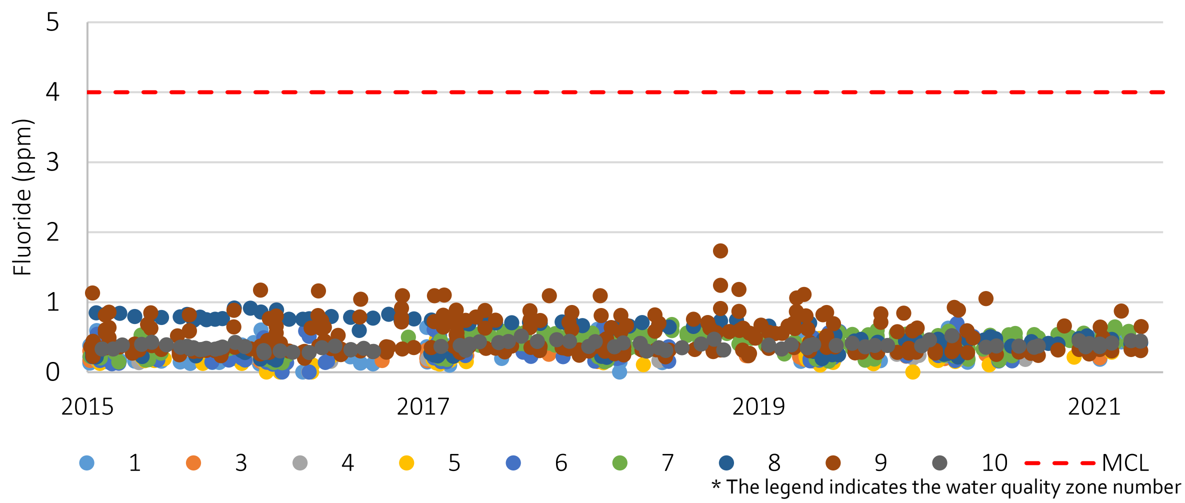


Figure B.4 All Data for Fluoride in the Main System

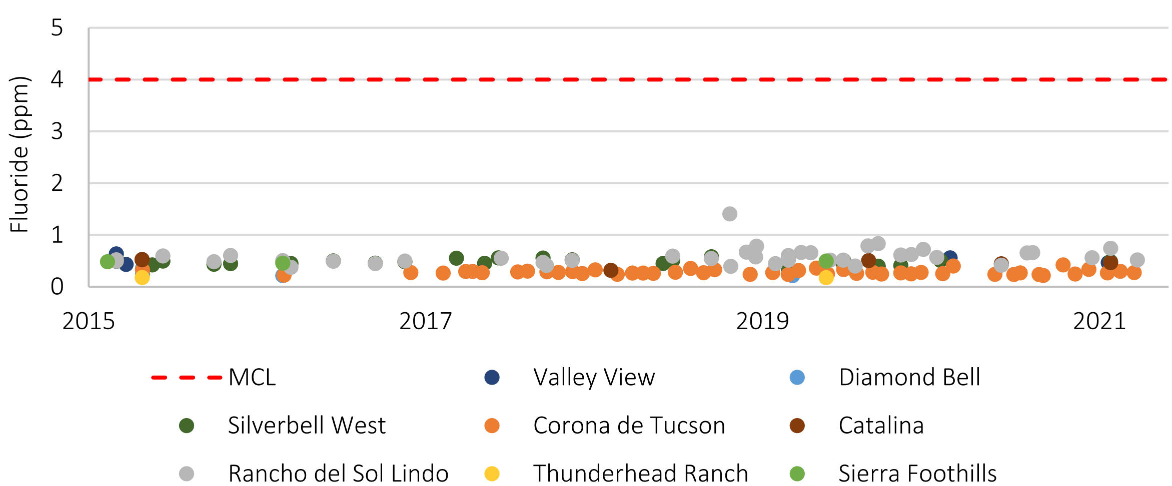


Figure B.5 All Data for Fluoride in Isolated Systems

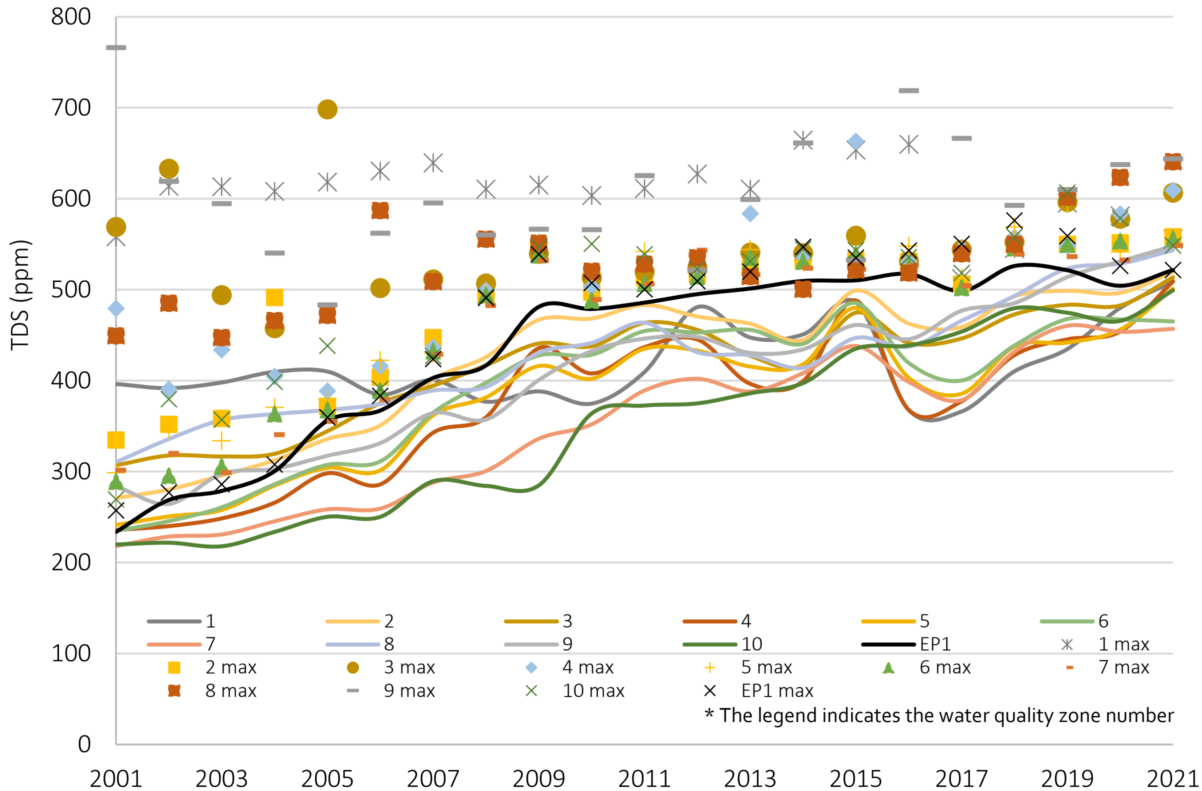


Figure B.6 Average Annual and Annual Max Total Dissolved Solids in the Main System

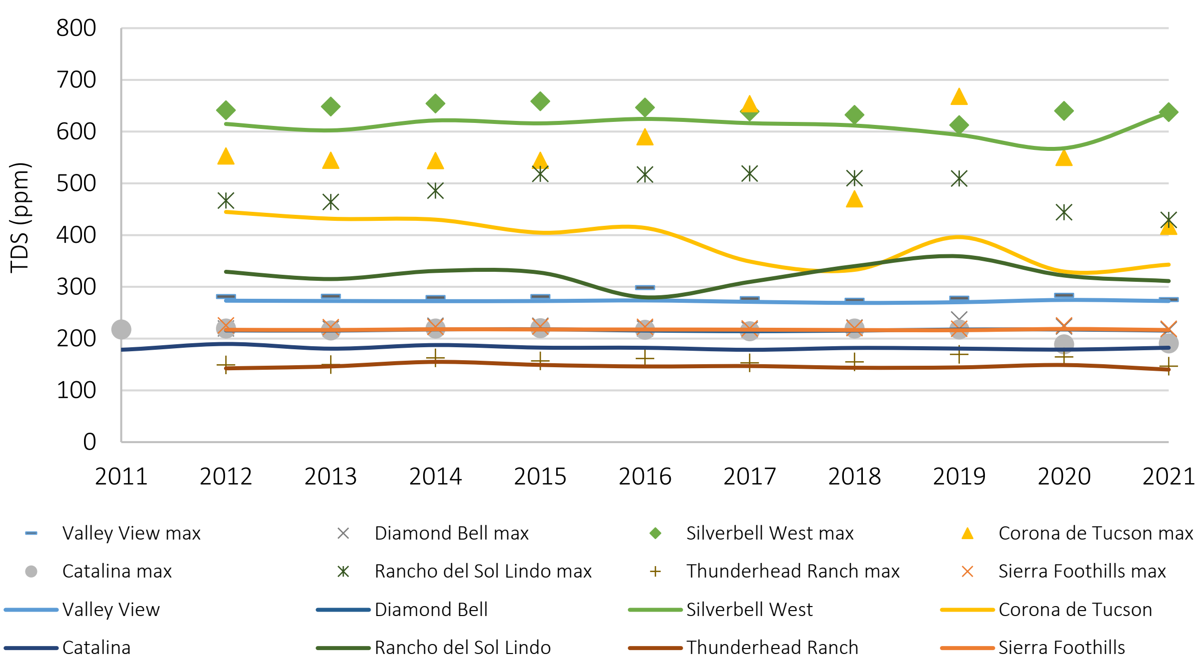


Figure B.7 Average Annual and Annual Max Total Dissolved Solids in Isolated Systems

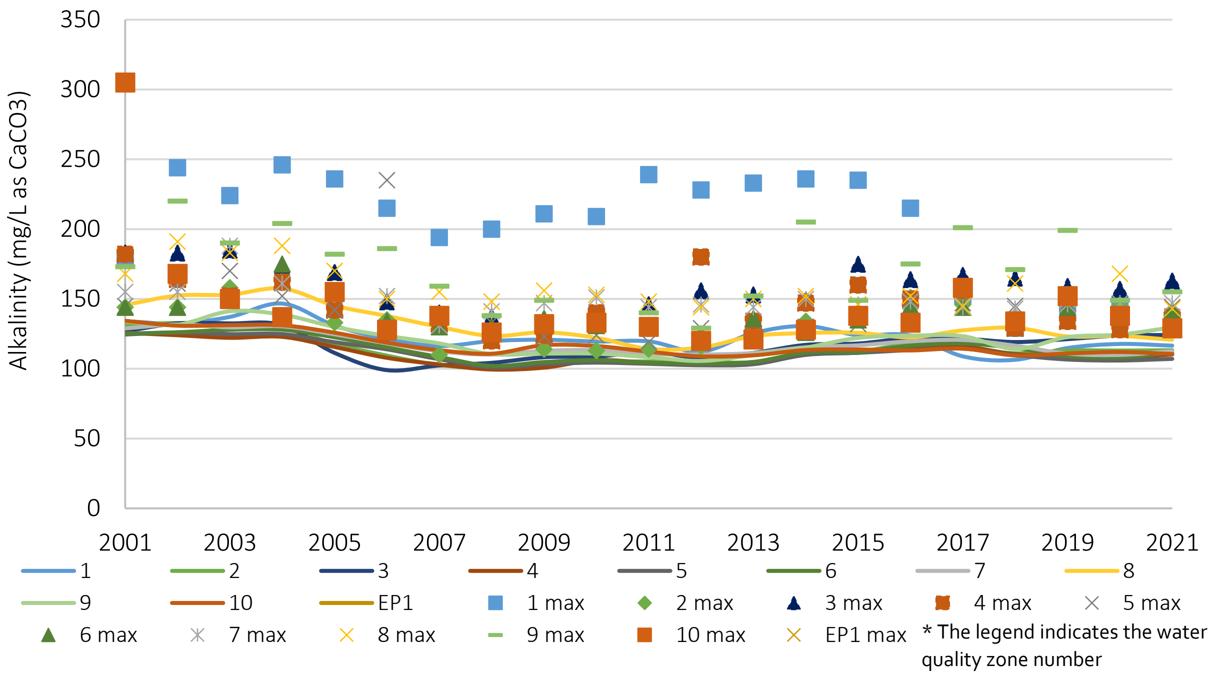


Figure B.8 Average Annual and Annual Max Alkalinity in the Main System

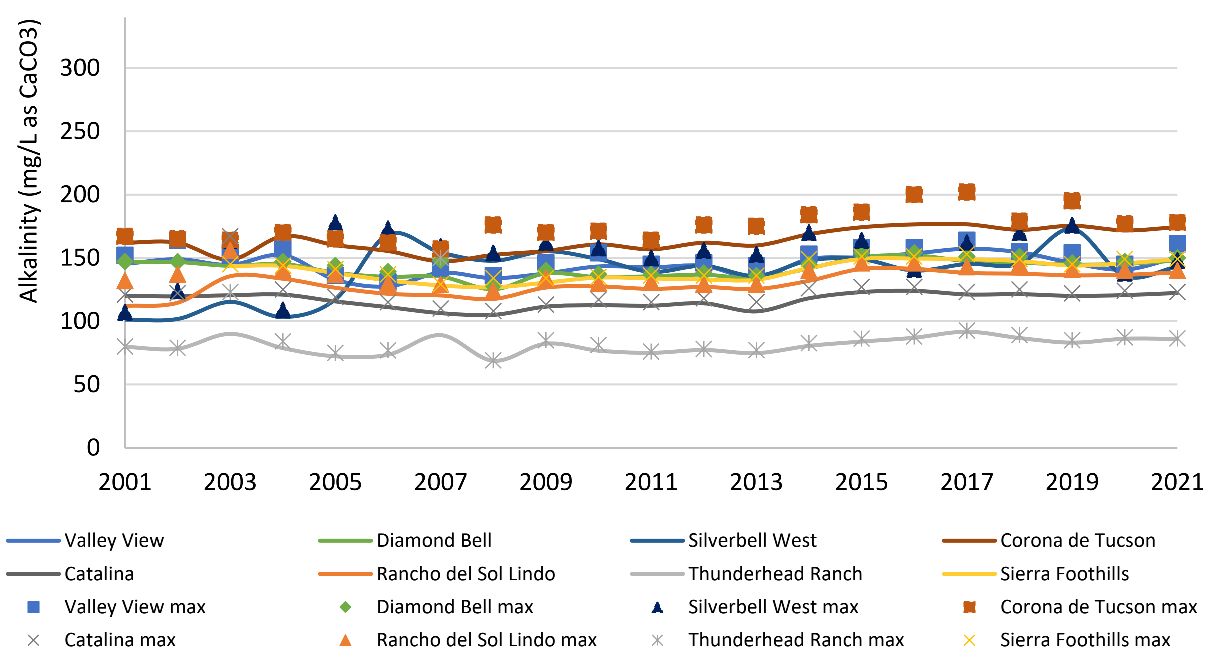


Figure B.9 Average Annual and Annual Max Alkalinity in Isolated Systems

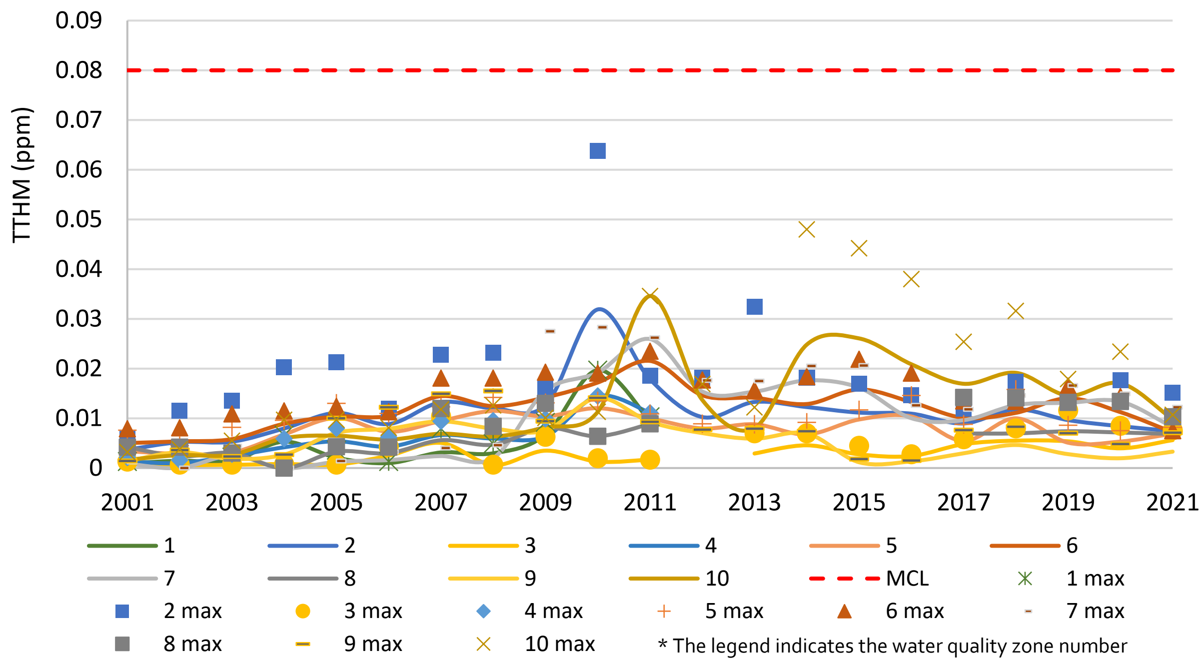


Figure B.10 Annual Average and Annual Max Total Trihalomethane in the Main System

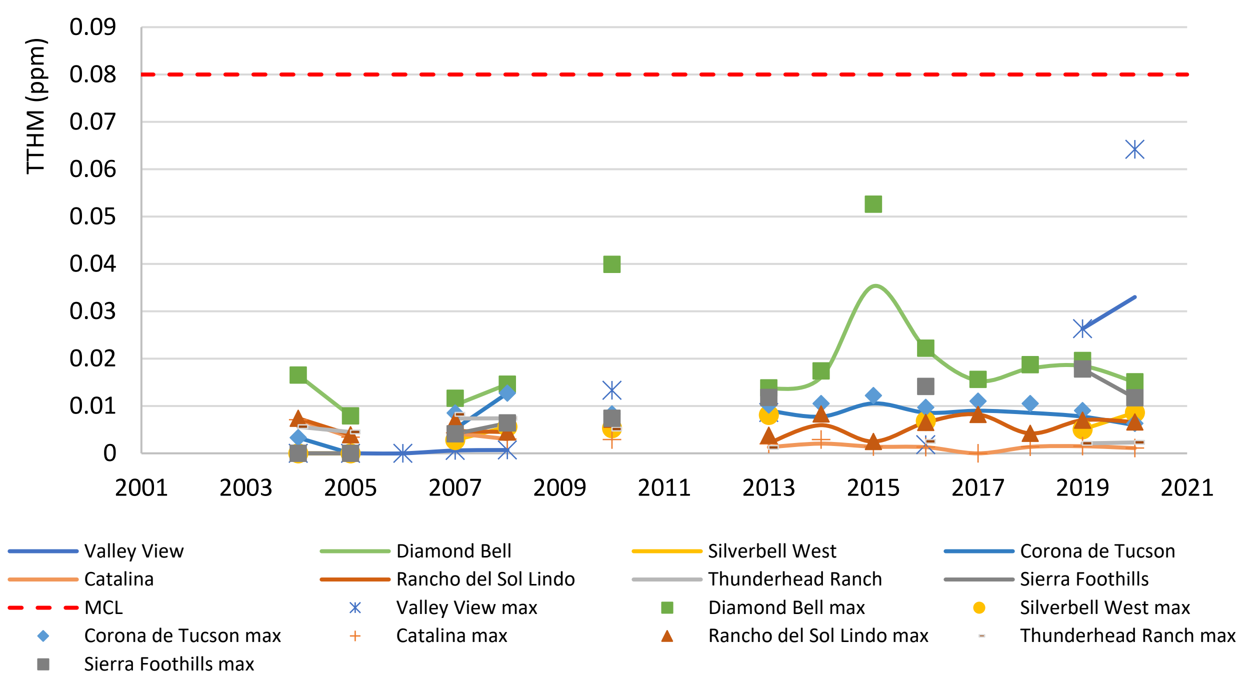


Figure B.11 Average Annual and Annual Max Total Trihalomethane in Isolated Systems

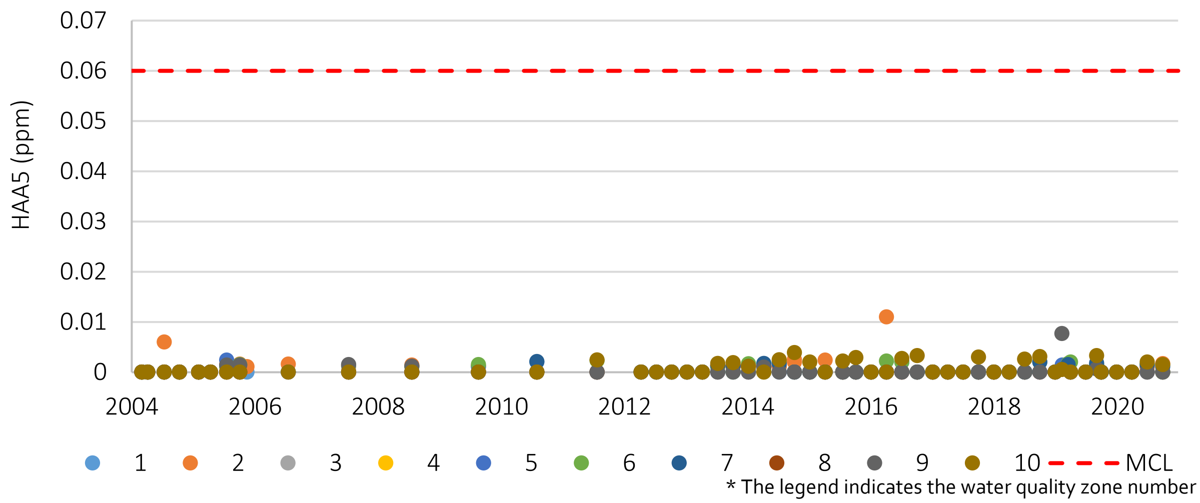


Figure B.12 Haloacetic Acids in the Main System

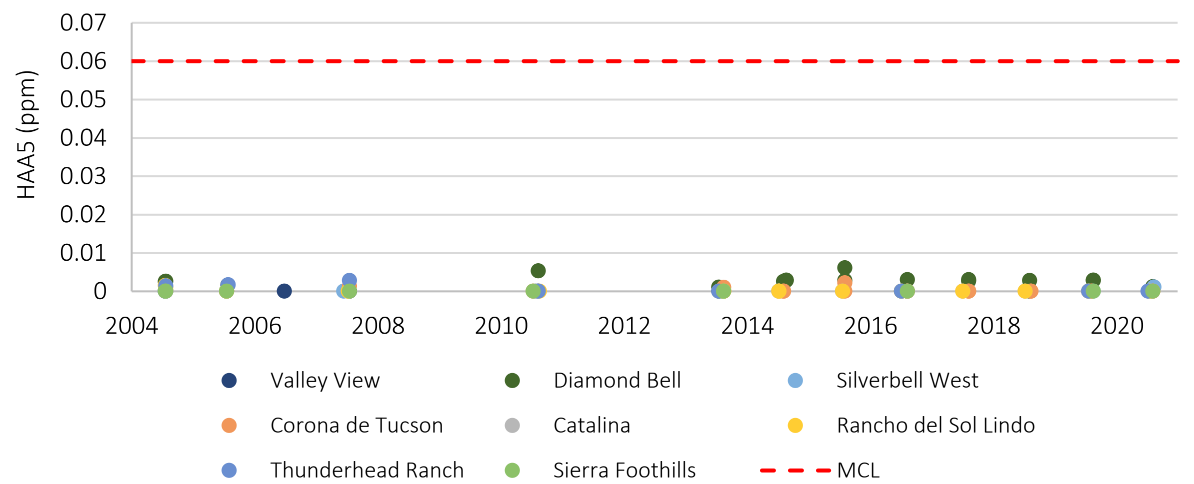


Figure B.13 Haloacetic Acids in Isolated Systems

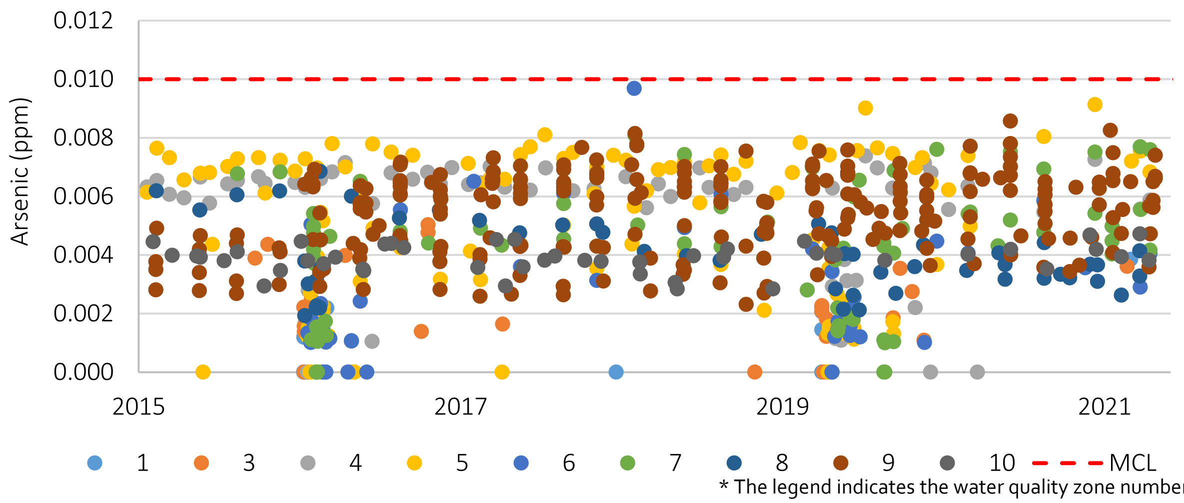


Figure B.14 All Data for Arsenic in the Main System

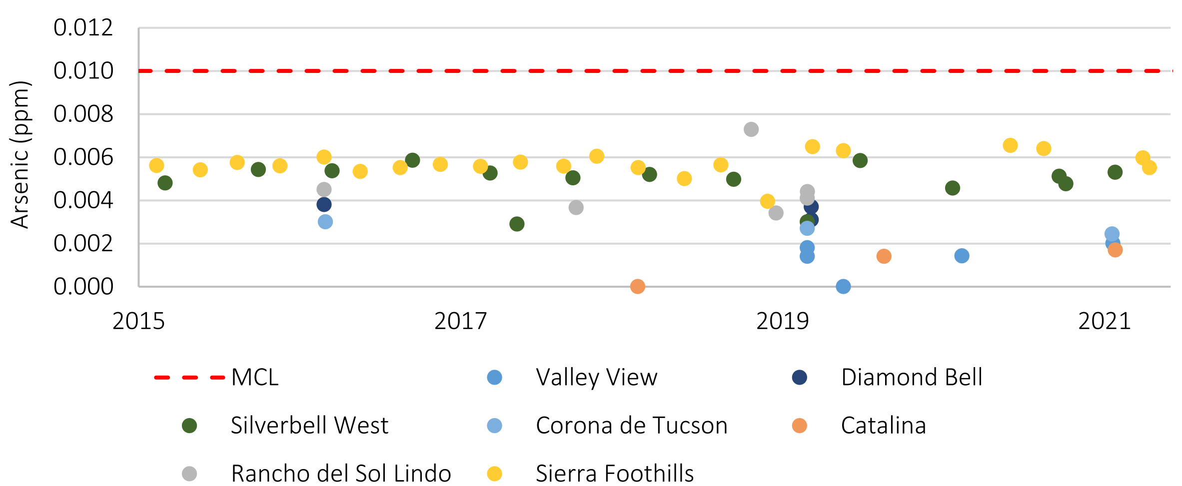


Figure B.15 All Data for Arsenic in Isolated Systems

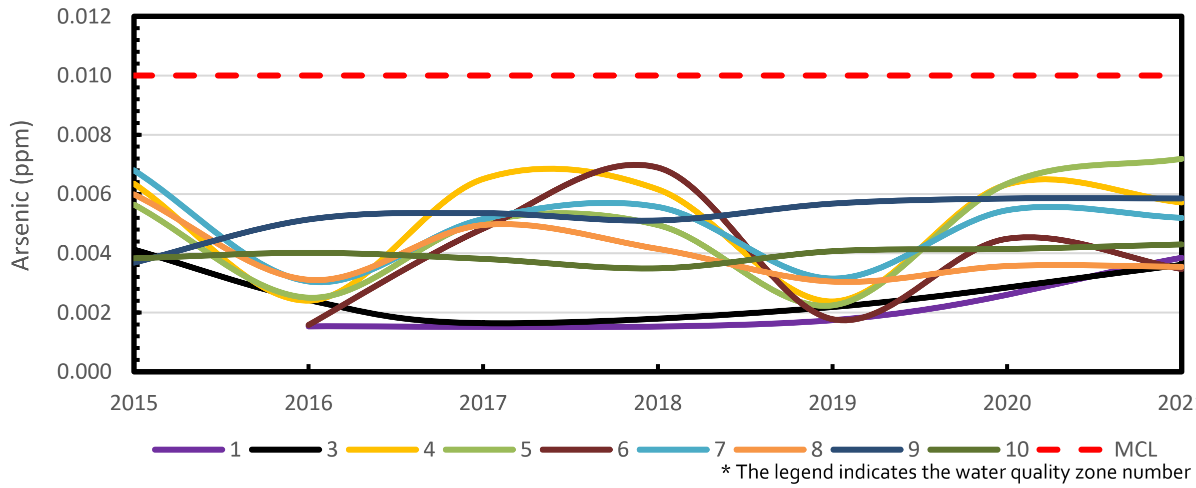


Figure B.16 Average Annual Arsenic of Wells by WQZ

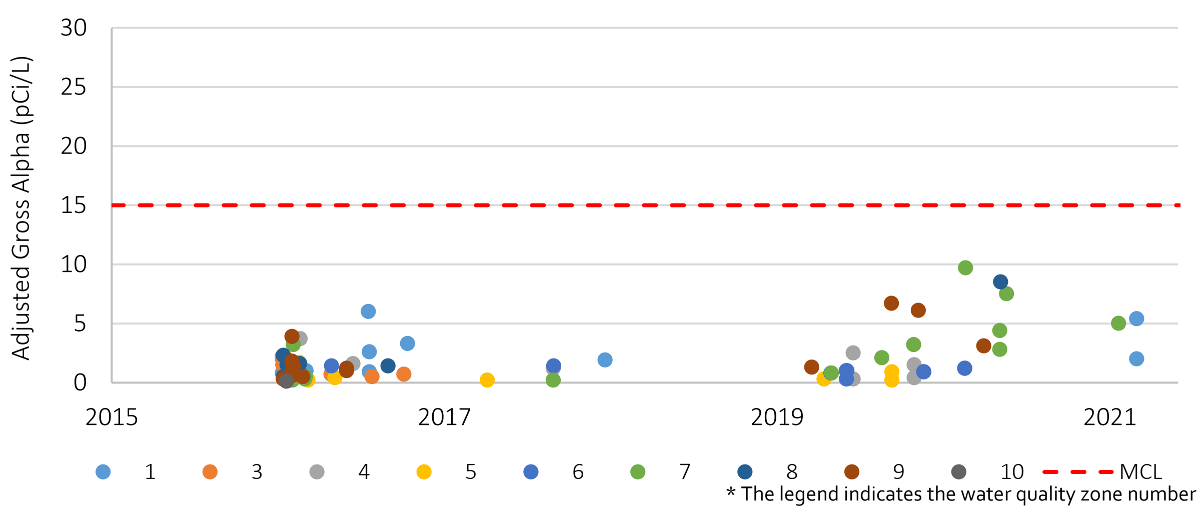


Figure B.17 Adjusted Gross Alpha in the Main System

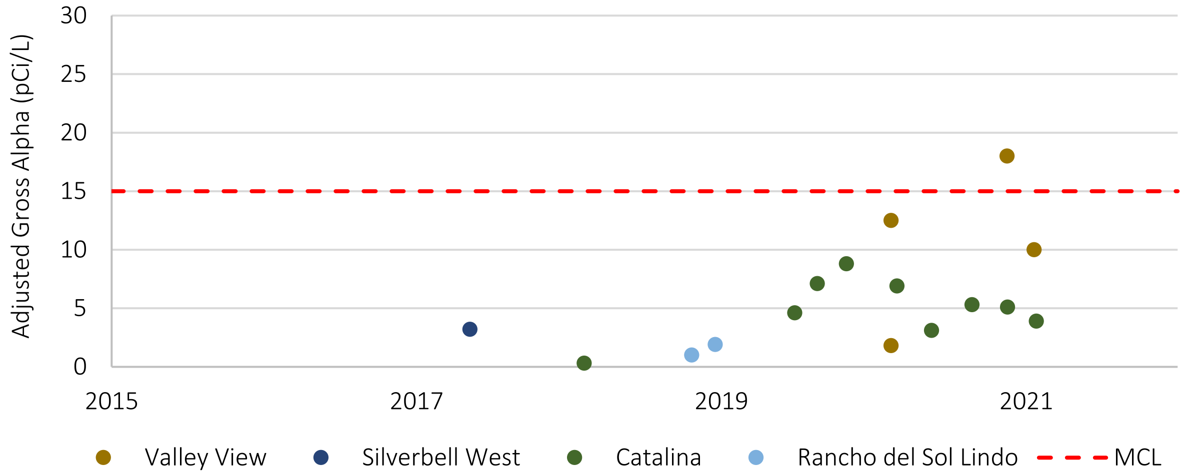


Figure B.18 Adjusted Gross Alpha in Isolated Systems

Appendix C

LEAD AND COPPER ANALYSIS

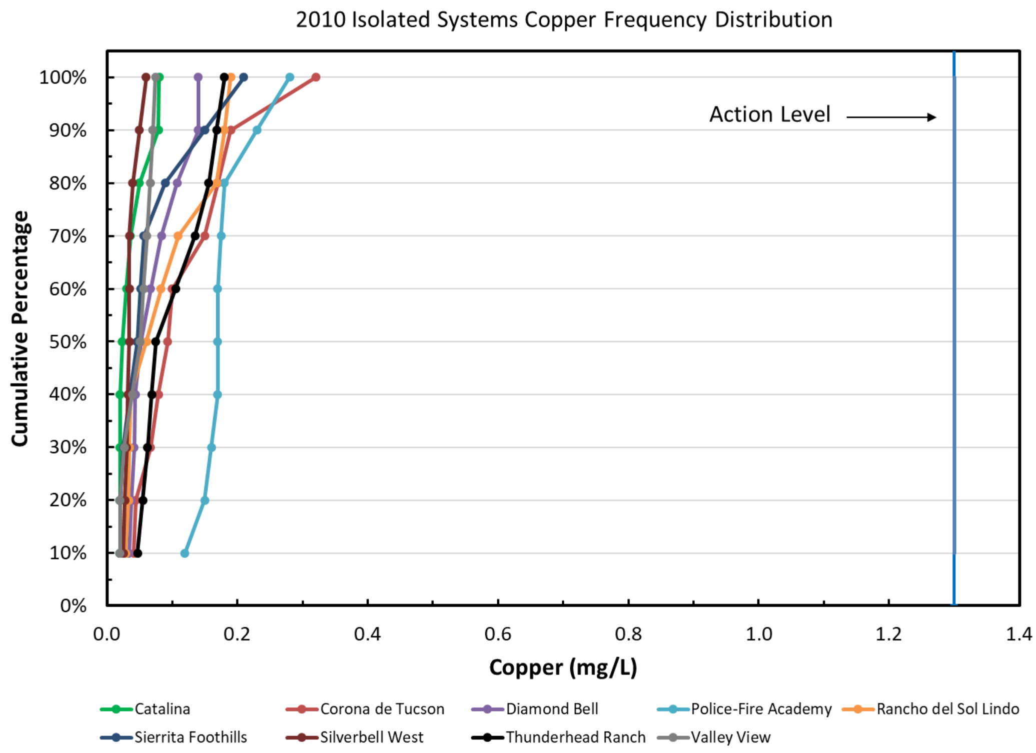


Figure C.1 2010 Isolated Systems Copper Frequency Distribution

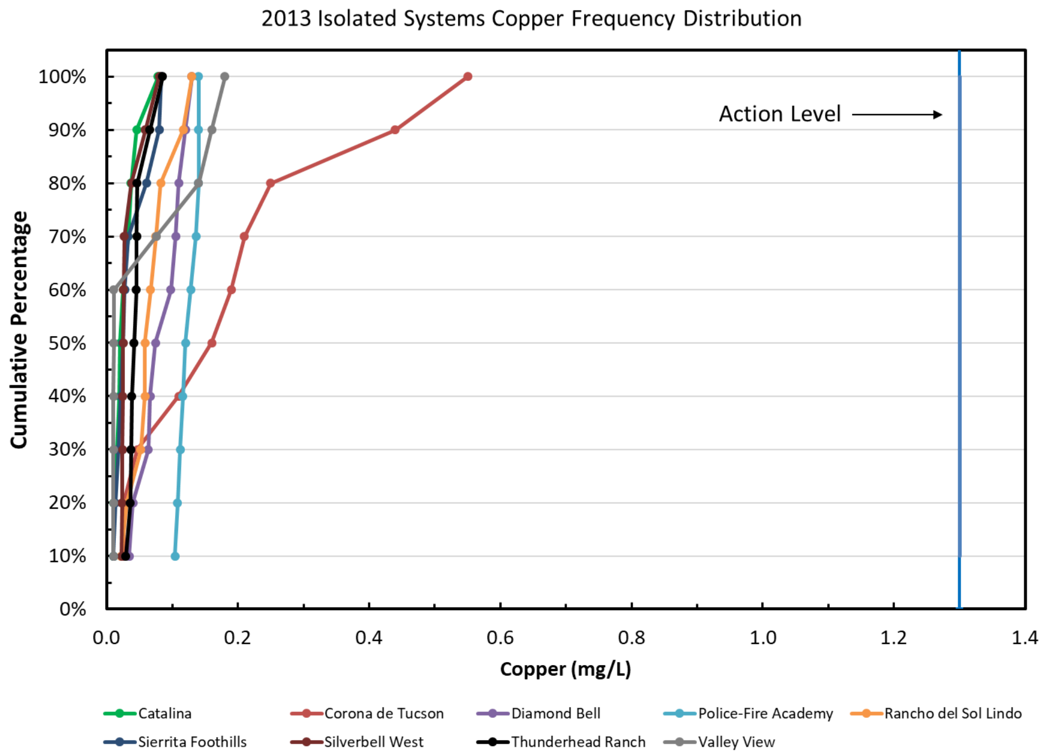


Figure C.2 2013 Isolated Systems Copper Frequency Distribution

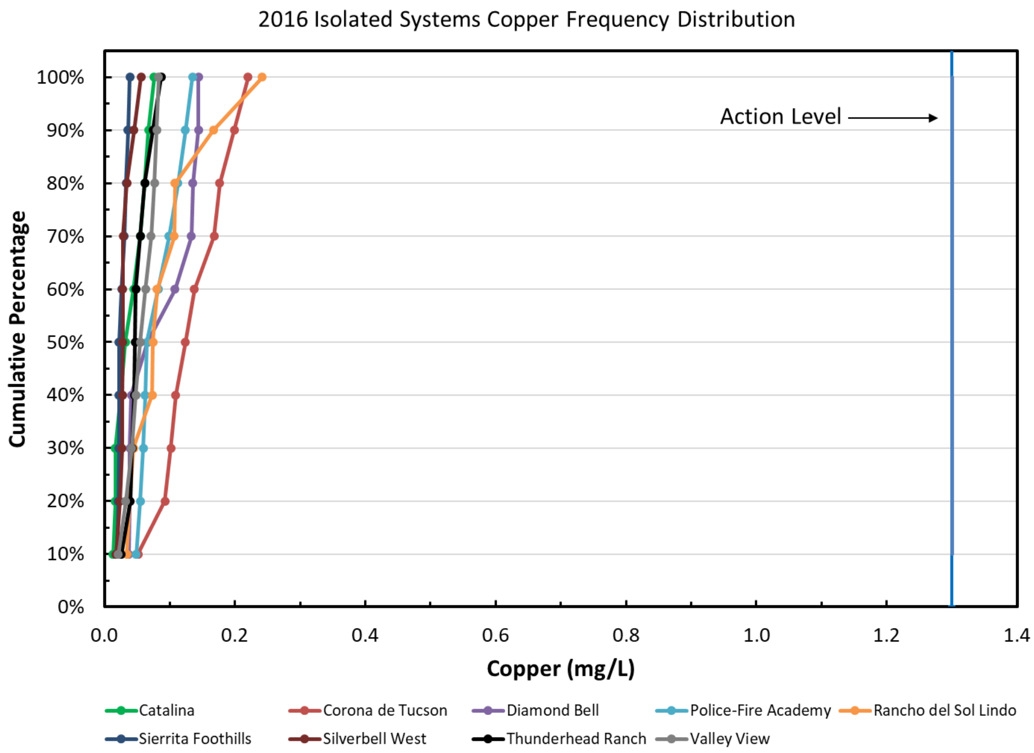


Figure C.3 2016 Isolated Systems Copper Frequency Distribution

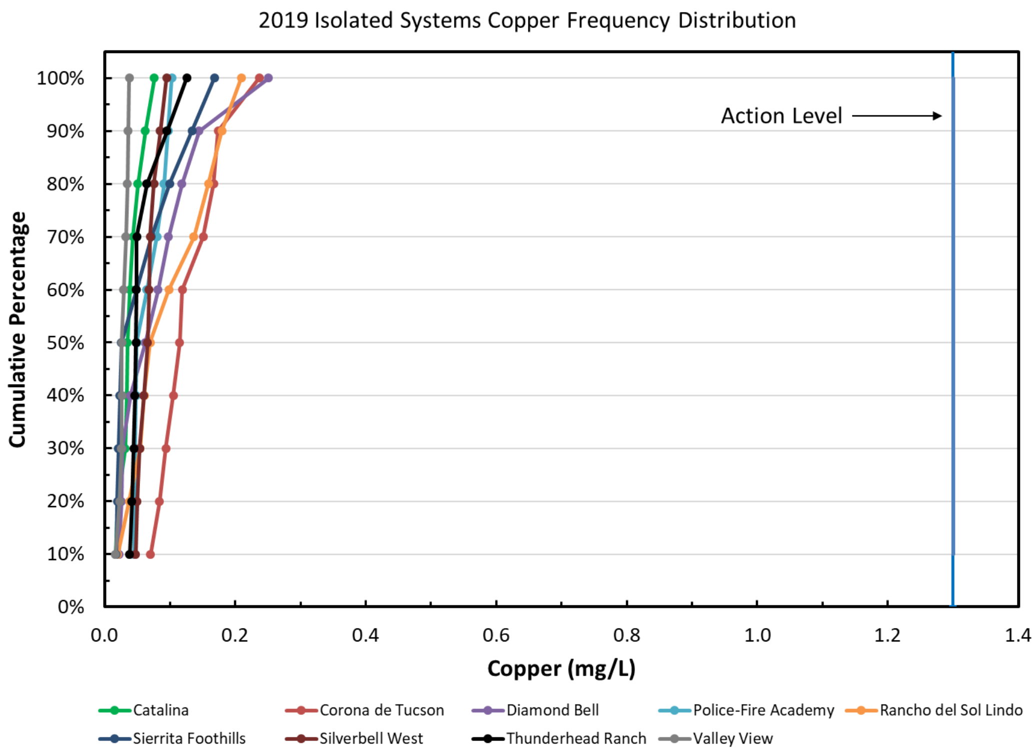


Figure C.4 2019 Isolated Systems Copper Frequency Distribution

Table C.1 90th Percentile Copper Data for Isolated Systems

System	90th Percentile (mg/L)	Number of Samples
Catalina	0.075	42
Corona de Tucson	0.220	86
Diamond Bell	0.137	46
Police-Fire Academy	0.170	21
Rancho del Sol Lindo	0.178	45
Sierrita Foothills	0.083	23
Silverbell West	0.072	20
Thunderhead Ranch	0.122	22
Valley View	0.083	21

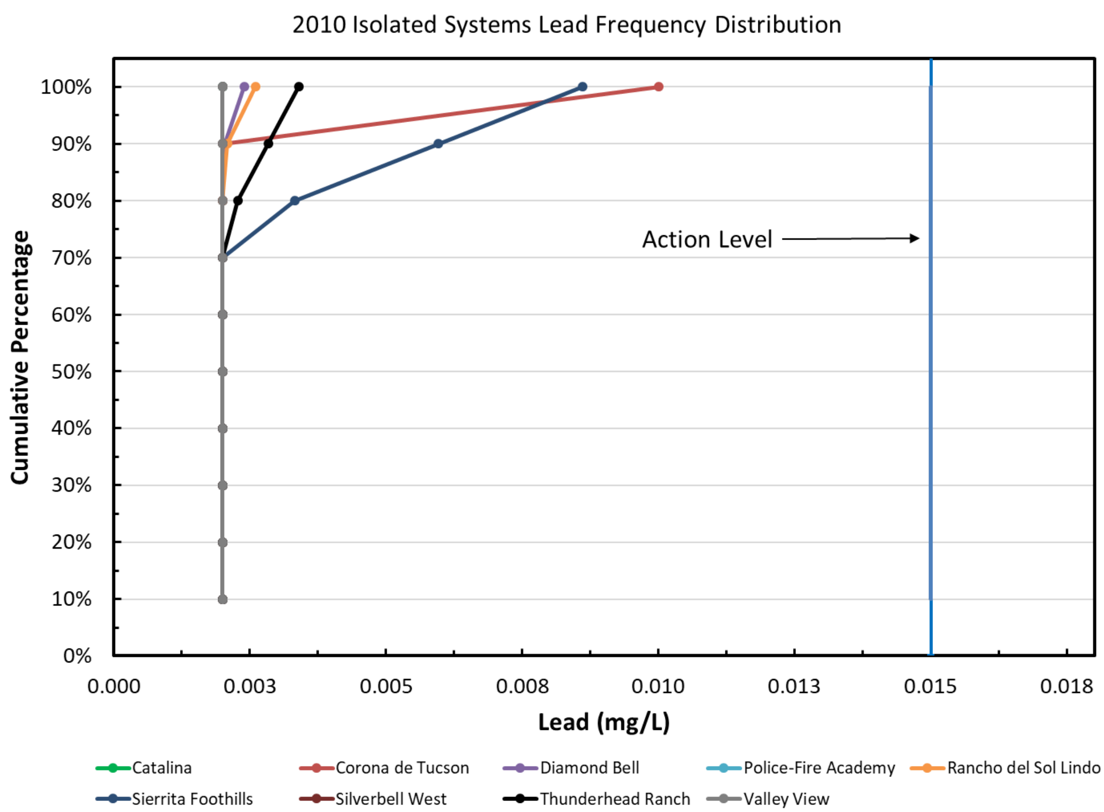


Figure C.5 2010 Isolated Systems Lead Frequency Distribution

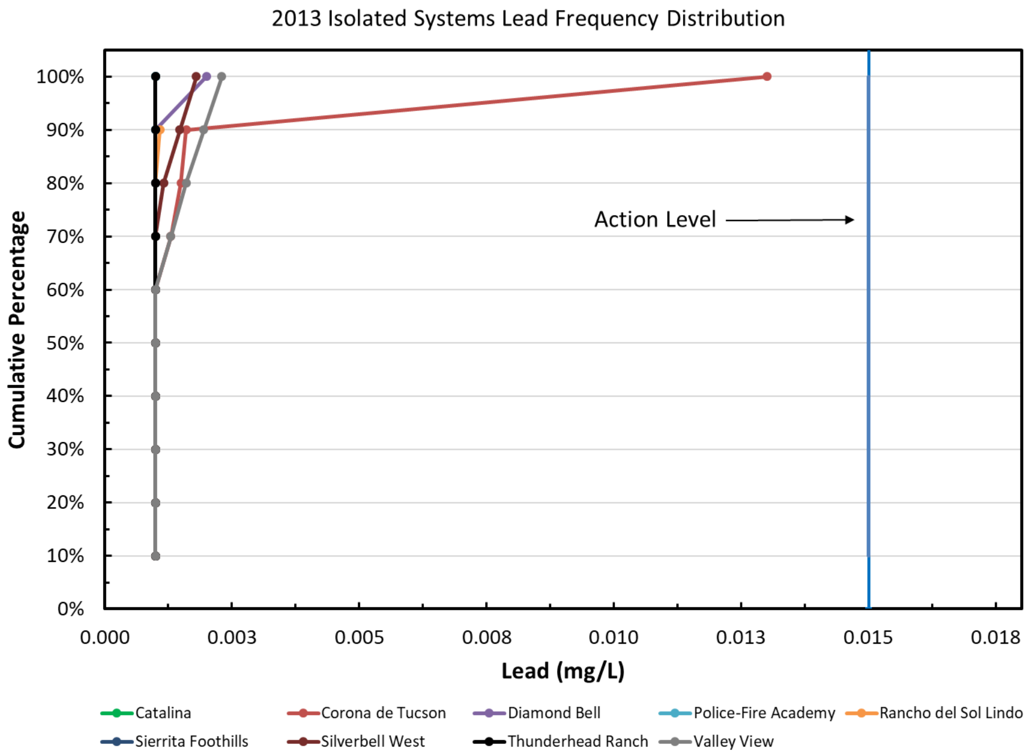


Figure C.6 2013 Isolated Systems Lead Frequency Distribution

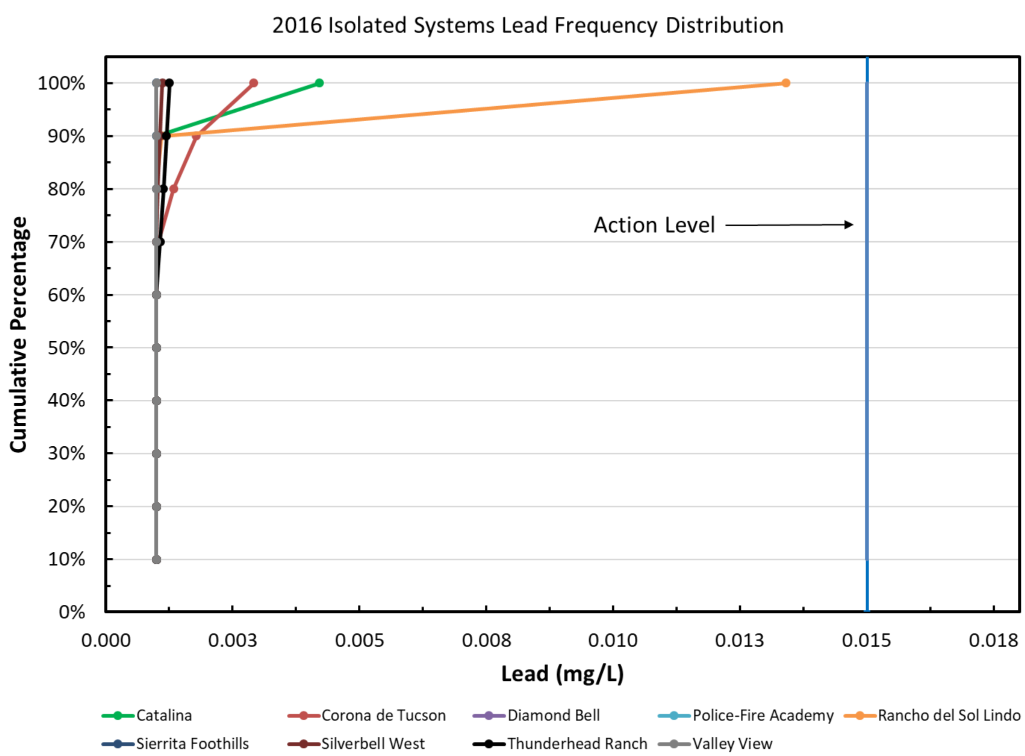


Figure C.7 2016 Isolated Systems Lead Frequency Distribution

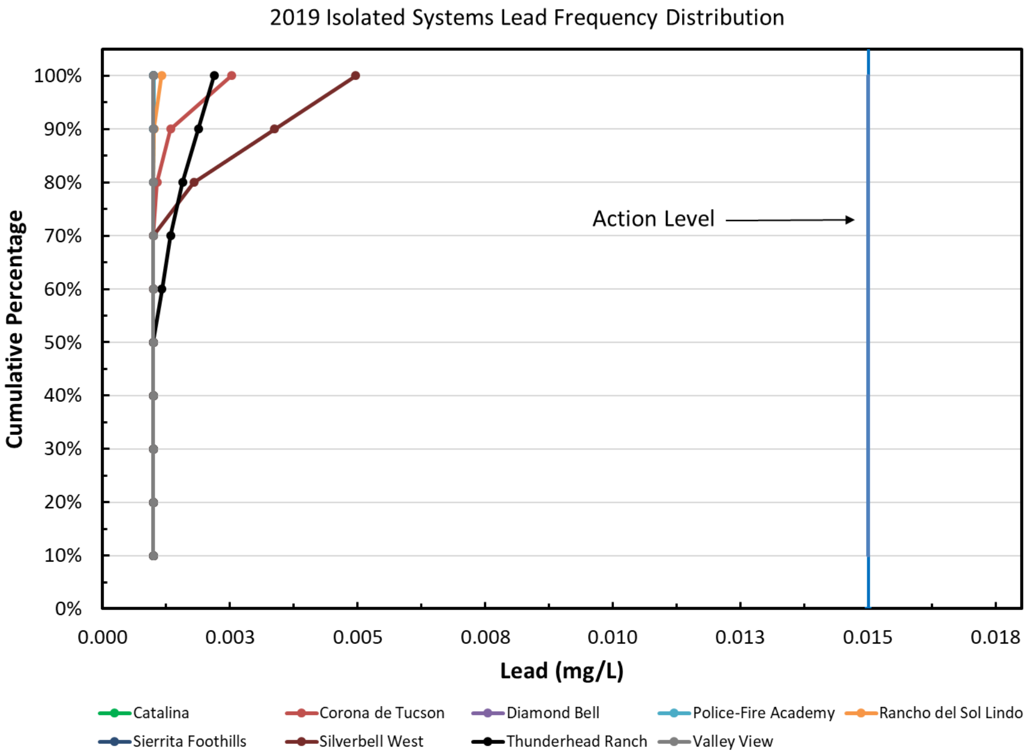


Figure C.8 2019 Isolated Systems Lead Frequency Distribution

Table C.2 90th Percentile Lead Data for Isolated Systems

System	90th Percentile (mg/L)	Number of Samples
Catalina	0.002	42
Corona de Tucson	0.002	86
Diamond Bell	0.002	46
Police-Fire Academy	0.002	21
Rancho del Sol Lindo	0.002	45
Sierrita Foothills	0.002	23
Silverbell West	0.002	20
Thunderhead Ranch	0.002	22
Valley View	0.002	21

Appendix D

FLUSHING SOP

PROJECT MEMORANDUM

ONE WATER 2100 MASTER PLAN

Tucson Water

Date:	12/22/2021
Project No.:	11442A00

Prepared By:	Aurelie Nabonnand, P.E. and Natalie Reilly, P.E.
Reviewed By:	Corin Marron, P.E.
Subject:	Conventional Flushing Standard Operating Procedure

Scope/Purpose

The purpose of this standard operating procedure (SOP) is to define the procedure for conventional flushing of a distribution area. This SOP includes a description of situations when conventional flushing is recommended, a summary of pre-flushing planning steps, and the flushing procedures.

Situations for Conventional Flushing

The conventional flushing method is performed by opening hydrants in targeted areas and discharging water until any accumulations are flushed and the water runs clear. Unidirectional flushing (UDF) is performed by isolating each pipeline, using the set sequences from the flushing program, to create flow in a single direction to clean pipe mains.

Conventional flushing is performed under different circumstances than main cleaning using UDF. Before performing conventional flushing, determine if UDF may be more applicable to the situation.

Conventional flushing is recommended under the following planned circumstances:

- After a customer complaint about water quality.
- Before bringing groundwater wells online after a period of downtime to avoid water quality concerns.
- During routine valve/fire hydrant maintenance.

Conventional flushing is recommended under the following unplanned circumstances:

- After a potential or real contamination, including super-chlorination/de-chlorination, in order to flush and restore service.
- After a main break.

Flushing Planning

This section summarizes the steps to be taken prior to performing the actual flushing, including the following:

1. Public outreach.
2. Governing agency coordination.
3. Tracking water discharges.
4. Personnel and safety measures.
5. System review and route selection (if flushing multiple hydrants is required).
6. Site safety considerations.

7. Sensitive area considerations.
8. Equipment.

1. Public Outreach

Public outreach should be performed before planned flushing and during the flushing event and includes the following:

- Mailers for planned flushing explaining water quality side-effects and reasons for flushing for planned flushing (two weeks prior to start of planned flushing event).
- Update to Tucson Water's Water Outages & Advisories online map (two weeks prior to start of planned flushing event).
- Social media notification (one week prior to start of planned flushing event and day of planned flushing event).
- Email notification to affected customers (one week prior to start of planned flushing event).
- Residential and/or commercial property notifications (one week prior to start of planned flushing event).
- Posted placards and signs at the flushing site (day of flushing event).

Public outreach should be performed during unplanned flushing events, such as a main break, and includes the following:

- Social media notification.
- Email notification to affected customers.
- Notify Ward office electronically.
- Update to Tucson Water's Water Outages & Advisories online map.
- Posted placards and signs at the flushing site.

Note, any media inquiries should be directed to the Tucson Water Public Information Office (PIO).

2. Governing Agency Coordination

Outreach to appropriate governing agencies should be performed before planned flushing or during the flushing event, if possible. If purging a well or flushing large quantities of water is expected, coordination with other governing agencies is required. Governing agencies could include one or more of the following:

- City of Tucson Department of Transportation (TDOT).
- City of Tucson Ward Offices.
- Pima County Transportation Department.
- Pima County Regional Wastewater Reclamation Department (PCRWRD).
- Municipalities including Marana, South Tucson, Oro Valley, Catalina, and Sahuarita.

Communication to governing agencies can occur through the dispatch center or directly to the agency's PIO and is recommended to be in both written correspondence and verbal communication. Ward offices should be notified in writing and/or via email depending on the size of the flushing event. Communication with an external agency PIO should come from Tucson Water PIO. Agencies can be directed to Tucson Water's Water Outages & Advisories online maps, which includes planned flushing events.

If discharge to the sanitary sewer is planned for a flushing event, coordination with Water Quality is required. Water Quality & Operations will report the flushing event to PCRWRD.

Note, Tucson Water's flushing procedures should comply with requirements of adjacent utilities and governing agencies.

3. Tracking Water Discharges

All water discharges must be tracked to meet two regulatory programs: Arizona Pollutant Discharge Elimination System Permit Program (AZPDES) and Tucson Water's Non-Revenue Water (NRW) tracking.

Tucson Water's AZPDES De Minimis permit, through the Arizona Department of Environmental Quality (ADEQ), allows discharges under the following circumstances that are related to conventional flushing:

- Discharges related to installation, maintenance, and repair of potable water supply systems (pipelines, tanks, wells, reservoirs, fire hydrants, etc.).
- Well development and maintenance, and aquifer testing. Discharges of water associated with drilling, rehabilitation and maintenance of non-potable water wells, wells being developed for potable use, and piezometers; and discharges from water supply and water quality evaluations.

All discharges must comply with the AZPDES De Minimis permit. Monitoring requirements for the AZPDES permit including the following:

- For potable water system discharge activities, monitoring flow rate, duration of flow, total residual chlorine, and constituents of concerns is required.
- For well test pumping and purging, monitoring flow rate, duration of flow, total residual chlorine, oil and grease, and constituents of concern is required.

Due to the new Environmental Protection Agency's (EPA) Navigable Waters Protection Rule (published September 3, 2021), Tucson Water is working with ADEQ on the dechlorination requirements for the AZPDES De Minimis permit. Further clarification is needed at the time of publishing this Flushing SOP. Water Quality should be contacted to determine if dechlorination is required based on the receiving water body.

Documentation of discharge quantity is also required for Tucson Water's NRW tracking to meet Arizona Department of Water Resources (ADWR) annual water loss regulation, which requires water loss totals not to exceed 10 percent annually.

Water Quality should be contacted prior to water discharge under the following circumstances:

- If discharge is greater than 500,000 gallons or longer than four hours (including non-potable water).
- If discharge leaves the property or impedes traffic requiring signate and/or a right of way (ROW) permit.
- If discharge is within a quarter mile or directly into a major wash

4. Personnel and Safety Measures

The Tucson Water personnel required to plan and perform the flushing and their roles and responsibilities are as follows:

- Water Operations Supervisor:
  - Work with Water Quality for scheduling and planning flushing events.
  - Post flushing event on Water Outages & Advisories online map.
  - Notify Tucson Water PIO before flushing event.
  - Assign field personnel for flushing event.

  - Review and approve discharge permits.
- Field Personnel – Utility Technician(s) or Well Maintenance Technician(s):
  - Notify dispatch office and include information such as location of flush, direction of flush, expected duration, and purpose for flush.
  - Review safety and sensitive area considerations before flushing.
  - Perform flushing activity.
  - Prepare records from flushing activities, including any maintenance concerns.
- Water Quality Technicians:
  - Collect samples.
- Water Quality Environmental Scientist:
  - Maintain flushing records.
  - Notify MS4 permittee holders.
- Dispatch Center:
  - Coordinate between on-site lead or supervisor and various contractors for traffic control as needed.
- Planner Scheduler (Liaison with Water Quality):
  - Develop flushing schedule.
  - Develop plans for flushing.
- Tucson Water PIO:
  - Public notifications to ward offices, social media, and other public domains, as required.
  - Communication with media.

Wachs Water will be assisting Tucson Water is valve and fire hydrant maintenance as well as UDF implementation.

The following personnel safety measures should be implemented before and during flushing events:

- Traffic control during the flushing event, including contact information for Tucson Water PIO, ROW permit, traffic cones, temporary signs, and additional equipment as needed for busy streets.
  - Signage warning of standing water for traffic and pedestrians should be used when needed.
- Personal protective equipment (PPE), including hard hat, high visibility clothing, safety glasses, work gloves, steel-toed boots, and knee pads as needed.
- Employees shall perform a pre-trip inspection in their vehicles prior to driving the vehicle. The inspection shall include but not be limited to all safety equipment, gear, lights, and personal protective equipment necessary to perform their job safely and in accordance with the applicable policies and procedures. In addition, the vehicle shall be inspected for fluid levels, damage, leaks etc. See Administrative Directive 6.01-1 for additional details. Vehicles shall be fueled before leaving the yard or at the end of the shift.

5. System Review and Route Selection

System review and route selection is a case-by-case process and will vary based on location and flushing purpose.

System maps, including geographic information system (GIS), as-builts, and asset history, should be reviewed before any flushing events. This review can help identify hydrants that are in busy intersections, near sensitive customers, or may result in hydraulic impacts to the system. Also, pipe diameters, valve locations, and other useful facility data can be identified during the system review. The flushing crew will select the hydrants to use based on operability and location from the system review. Tucson Water staff is asked to collect operational data every time a valve or hydrant is used, which can be helpful for determining the valves and hydrants to be used for flushing.

If multiple hydrants will be used for flushing, the best route for flushing, including the start hydrant, end hydrant, and sequence in between, should be identified before the flushing event. For planned flushing events, flushing is usually performed in one direction, targeting each hydrant in the line of sight.

For planned flushing events, the location for flushing water discharge should be determined. Contact Water Quality to determine if dechlorination is required based on the receiving water body. If water must be discharged to the sanitary sewer system, coordination with the PCRWRD through Water Quality is required. PCRWRD has specifications for large quantities of discharged flushing water that must be followed.

Note, that in emergencies, a detailed system review and route selection may not be possible.

6. Site Safety Considerations

Before beginning the hydrant flushing, it is important to inspect the site for safety. The following issues should be addressed:

- Water flow path to a nearby drain inlet should be unencumbered.
- Drain inlets should be free of debris.
- Potential flooding/damage to neighboring property should be strictly avoided.
- The flow trajectory of the water should not endanger passing vehicles or pedestrian traffic.
- Water should not cause slick or unsafe conditions in traveled areas.
- If flushing hydrants in a sensitive area (as outlined below), dechlorination is required.

Do not flush a hydrant if the above or any other conditions create an unsafe situation.

7. Sensitive Area Considerations

Sensitive areas are those that could be adversely impacted by a large influx of drinking water. Such areas might include creeks, ponds, or other water bodies. The Tucson Water Best Management Practices AZPDES Area-Wide General Permit AZG-57466 document should be reviewed before any flushing event. The 2018 AZPDES BMPs are included in Attachment A (pdf page 11 of 37).

Tucson Water chlorinates all water wells to kill existing microorganisms and protect against contamination. Chlorine present in flush water is toxic to fish and other small freshwater biota and must be removed before the water reaches any natural water bodies. In addition, extremely silty water can potentially suffocate animals living in natural ponds and streams. The following questions should be addressed before flushing a hydrant in any area suspected as sensitive:

- Where will the discharge go?
- Are the road surfaces free of significant debris that could flow into the drain inlets?
- Are curbs or ditches sufficient to handle hydrant flow without creating a buildup of silt?
- Are the surfaces over which water will flow free of possible contaminants such as oil, soil, etc.?
- Will water discharged during the flow test erode unpaved areas, etc.?

If any of the above conditions exist, steps should be taken to mitigate the situation.

As mentioned in the Tracking Water Discharges section, due to the new EPA Navigable Waters Protection Rule, Tucson Water is working with ADEQ on the dechlorination requirements for the AZPDES De Minimis permit. Further clarification is needed, and as sensitive areas are identified, they will be added to the SOP. Contact Water Quality to determine if dechlorination is required based on the receiving water body.

Dechlorination should also be done when flushing involves super-chlorinated water or if large volumes of water will be discharged to the sanitary sewer. When flushing large transmission mains, sometimes water will need to be discharged to the sanitary sewer. Clearance for discharging to the sanitary sewer must be provided by PCRWRD though coordination with Water Quality. Past requirements have included an air gap between the discharged water and the sewer and dechlorination for water over a specific quantity.

8. Equipment

This section summarizes the equipment required for flushing, including detailed descriptions of the diffuser and dechlorination equipment. A summary of the recommended equipment for flushing is as follows:

- Hydrant diffuser with hose (as needed for directing flow).
- Dechlorination equipment as needed depending on location and outfall.
- Hydrant aprons.
- Adjustable combination hydrant and spanner wrench.
- 18-inch pipe wrench.
- Adjustable 12-inch crescent wrench.
- 12-inch channellock pliers.
- 6-inch screwdriver.
- 24-foot engineers tape measure.
- Roll of 1/2-inch x 520-inch PTFE tape for thread sealing.
- Map for locating hydrants.
- Repair forms for identifying valves and hydrants that need repair.
- Cloth rags.

Flow diffuser equipment should be used during flushing if available. This equipment reduces the energy of the water as the flow from the hydrant is released to the discharge point. Even though the flushing flow rate may be high, the energy diffuser will minimize damage from erosion and allow the water to flow towards the discharge point instead of spraying across the street.

If dechlorination is required, such as discharging large amounts of water to the sanitary sewer or as determined by Water Quality based on the receiving water body, dechlorination equipment should be used. The possible two methods for dechlorination of potable water are injecting chlorine neutralizer such as sodium bisulfite or allowing the water to flow past a solid form of dechlorination chemical such as sodium bisulfite or ascorbic acid. A metering pump may inject liquid or the dechlorination equipment may have an eductor and a flow control valve that will suck in the required amount of chemical. Dry chemical tablets may be placed in the flow diffuser, or in porous bags in the gutter. The equipment selected for use by Tucson Water will have directions for the proper application of chemical. Always sample water before it flows into a storm drain inlet to ensure it is fully dechlorinated and remove all equipment, including any porous bags in the gutter.

Flushing Procedures

This section presents a general protocol for performing flushing for a well purge and a general protocol for performing hydrant flushing in other situations (e.g., a customer complaint, or a main break). The section also includes contingencies to consider during flushing and recommended data collection.

The following procedures should be used for each flush. Safety is a key issue when implementing a flushing program. As previously mentioned, while performing a flush, it is important to avoid damage to private property, to allow adequate drainage, and to use traffic control where necessary. In addition, it is important to be aware of creating erosion from the high flow rates and transporting sediment and other debris beyond Tucson Water property boundary and into MS4 permitted areas. It is important to dechlorinate the water, where required, and to ensure that excessive sediment is not discharged into a sensitive area.

Detailed Flushing Procedure for Well Purge

The following procedure should be used for each flush for a well purge:

- Assess the well to be flushed and the area surrounding the tee that will be used to discharge water to determine the safety and sensitivity of the site.
- Locate the tee to be used for discharging from the well purge. Remove the tee cap and install any necessary adaptors. Attach combination flow tester/discharge diffuser on the tee. Also, set up dechlorination, if required.
  - ***Note***: It is important to dechlorinate the discharge before it reaches any sensitive areas, as determined by Water Quality. If flushing discharge flows to a sewer, dechlorination may be required based on quantity, as determined by PCRWRD.
- Flush the well at a low flow rate (about 10 gpm) by slightly opening the valve at the discharge tee. Take total chlorine and turbidity measurements.
  - ***Note***: Verify the direction of the water flow away from the test area. Ensure that water is not causing any damage to neighboring property. Water should also discharge properly into a drain inlet, or other discharge location as previously determined. Check the path of the water and visually inspect the drain inlet for plugging or other obstructions. If water drainage is problematic, do not conduct any further testing. Shut the tee, remove all equipment, and choose another location. If the discharge caused or created movement of soil or debris, request clean-up of the area.
- Follow the flow path all the way to discharge point to make sure there are no issues downstream of the flushing site.
- Once water quality data is recorded, increase the flow rate using the following guide:
  - Approximately 200 gpm for all flushing with adjacent pipe size 6-inch diameter or larger, regardless of pipe type.
  - Approximately 100 gpm for all flushing with adjacent pipe smaller than 6-inch diameter.
  - For transmission lines larger than 12-inch diameter, the flow rate can be increased above 200 gpm, but the flushing velocity should always be kept below 2 fps.
  - ***Note***: flow meter at well should be used to measure flow.
- Purge well until approximately five times the well capacity has been flushed.
- Periodically check the chlorine and turbidity during the flush. Well Maintenance Mechanics should collect and analyze samples at least once every ten minutes. In sensitive areas, increased monitoring may be needed. The optimal frequency will depend on distance to the clean water source, pipe diameter, and the extent to which valving is used to improve process control.
- Continue the flush until the established water quality goals have been met.
- Once the flush is completed, slowly close the valve at the discharge tee. If the valve is closed too quickly, a water hammer (pressure surge) may occur.
- After discharge tee is closed, remove equipment from tee.
- If multiple wells need to be purged, continue to next designated well.

Detailed Procedure for Other Circumstances

The following procedure should be used for each hydrant flush for other situations, such as a main break, customer complaint, or after a known contamination event:

- Assess the hydrant to be flushed and the area surrounding the hydrant to determine the safety and sensitivity of the site. Verify the following information in the field:
  - Hydrant ID number.
  - Street/Address.
  - Other location notes.
  - Hydrant source main size.
  - Map discrepancies (if applicable).
- Locate the hose outlet on the flush hydrant. Remove the outlet cap and install any necessary adaptors. Attach combination flow tester/discharge diffuser on the hydrant. Also, set up dechlorination, if required.
  - ***Note***: It is important to dechlorinate the discharge before it reaches any sensitive areas, as determined by Water Quality. If flushing discharge flows to a sewer, dechlorination may be required based on quantity, as determined by PCRWRD.
- Open hydrant slightly to allow low flow from the hydrant. Take total chlorine measurement.
  - ***Note***: Verify the direction of the water flow away from the test area. Ensure that water is not causing any damage to neighboring property. Water should also discharge properly into a drain inlet, or other discharge location as previously determined. Check the path of the water and visually inspect the drain inlet for plugging or other obstructions. If water drainage is problematic, do not conduct any further testing. Shut off the hydrant, remove all equipment, and choose another hydrant.
- Follow the flow path all the way to discharge point to make sure there are no issues downstream of the flushing site.
- Increase the flow rate by opening hydrant until a reasonable flow for flushing is achieved.
- Periodically check the chlorine during the flush. Utility Technicians should collect and analyze samples at least once every ten minutes. In sensitive areas, increased monitoring may be needed. The optimal frequency will depend on distance to the clean water source, pipe diameter, and the extent to which valving is used to improve process control.
- Flush hydrant until white bucket test indicates water has cleared and chlorine goals have been met. If after 30 minutes, the water quality criteria are still not met, closing valves to isolate pipe and/or using multiple hydrants could be implemented.
- Once the flush is completed, slowly turn off the hydrant. If the hydrant is closed too quickly, a water hammer (pressure surge) may occur.
  - ***Note***: Pressure regulated areas require an even slower shutdown of the hydrant. In pressure regulated areas, shut the hydrant down halfway while monitoring the pressure gauge and let the water flow for 30 to 45 seconds. This allows the distribution system to recover and permits water pressures to level off. Then, partially close the hydrant and again allow the system to recover. After the short wait, shut down the hydrant slowly until fully closed.
- After hydrant is closed, remove equipment from hydrant, and close all nozzle caps.
- If multiple hydrants need to be flushed, continue to next designated hydrant. Continue through each area from the clean water source, moving out by decreasing pipe size

Contingencies

It is important to be prepared for unplanned events prior to commencing the hydrant flushing. Some of the following issues may arise during hydrant flushing:

- Loss of system pressure or water supply to a specific area.

- The hydrant may continue to leak after shut down.
- Customer complaints may arise after flushing a particularly sensitive area.
- Complaints from other government agencies.
- Erosion (review of BMP for water discharge should be done before performing any flushing event).
- Damage to roadways.

If there is a significant loss of pressure during the hydrant flushing, it could be an indication that there are valves in the system that are closed but should not be. Review the system maps to find valves that may be causing the low-pressure issue. Verify that they are open and repeat the flushing procedure.

Once a flush is complete, the operations staff will close the flowing hydrant. If any of these facilities are not functioning properly, i.e. the hydrant continues to leak, a report should be made to repair the equipment.

Customer complaints that could arise during the hydrant flushing include low water pressure, discolored water, odor, damaged laundry, etc. Both the crew working in the field, as well as staff answering the phones at the utility office should be sensitive to these issues and be prepared to answer any questions. Low water pressure will be corrected when the flow tests are complete. Customer water that is discolored or has an odor should be flushed from the plumbing by allowing the water to run until it is clear. A similar process can be used for complaints from other governing agencies.

Using the BMPs for water discharges should help avoid erosion during flushing events. The procedures and recommended equipment outlined in the BMP should be used to avoid erosion during the flushing event, including the use of diffusers and hydrant aprons, but if erosion does occur, repairs may be necessary. If erosion occurs on private property, the property owner should be notified. If erosion occurs in the public right-of-way, the appropriate governing agency should be notified.

If damage to roadway occurs, the appropriate department of transportation should be notified. Traffic control devices and signage should remain in place and a ROW permit should be obtained, as needed.

Note, Tucson Water PIO will manage public notifications for contingencies.

Data Collection

Notes from the flushing activity should be recorded and kept in the system records. Currently, data from the flushing event is documented in a discharge permit in Work Asset Management (WAM). Attachment B (pdf page 31 of 37) includes documentation of the WAM entry process and instructions for filling out the discharge permit form.

The discharge permit requires the date and time of flushing, the flow rates, and the flushing duration be recorded. In addition, the hydrants and valves used, water quality results, and who performed the flushing should be noted.

The NRW/AZPDES Dual Discharge Paper Form, which can be found in Attachment C, must also be completed after a flushing event.

Additional important data should be noted if applicable, including the following:

- Inoperable hydrants.
- Broken valves.
- Low flows.
- Customer complaints.
- Water quality issues.
- Inaccurate GIS data.

Note, all follow-up work from the flushing activity should have a work request created.

References

AWWA Standard G200-09 Distribution Systems Operations and Management.

https://www.michigan.gov/documents/flintwater/SOP431_Conventional_Flushing_for_Water_Turnover_FINAL_613074_7.pdf

TUCSON WATER

BEST MANAGEMENT PRACTICES
AZPDES AREA-WIDE GENERAL PERMIT
AZG-57466

CITY OF TUCSON

TUCSON WATER

2018

Signatory Requirements

In accordance with the ADEQ De Minimus permit guidelines, AZG-57466, Part V., K.2, this Best Management Plan is certified.

"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. In addition, I certify that the operator will comply with all terms and conditions stipulated in General Permit No. AZG2010-001 issued by the Director."

Albert Avila

Printed Name of Contact

Albert Avila 10/8/2018

Signature Date

Tucson Water, Water Quality Administrator

Business/Agency

Table of Contents

Introduction:

Tucson Water Department of the City of Tucson is the largest municipal and industrial water provider in southeast Arizona, serving over 710,000 people. The Tucson Water Service area encompasses about 325 square miles within a 30 mile radius from downtown Tucson. This document contains a variety of potential Best Management Practices (BMPs) Tucson Water will use for water discharges associated with the operation of a water utility.

Climate:

The Tucson Water service area climate is characterized by hot summers and mild winters. The majority of precipitation occurs from winter rains and during the "monsoon season". The Monsoon season usually begins in July and lasts through early September. The winter storms usually occur between late November through early March. The average rainfall between 1986 and 2015 was about 11.3 inches (NOAA, 2015).

Topography:

The Tucson Water service area lies in the southern Basin and Range geologic province of western North America. It is characterized by elongate and generally northwest-trending narrow mountain ranges separated by broad alluvial valleys. Regional topography is dominated by basin-margin mountains and alluvial fans which have developed along their flanks. These mountains grade into flatland toward the middle of the basins. Tucson Water's service area is within two distinct valleys known as the Tucson Valley and adjacent Avra Valley. Surface runoff from the Tucson Water service area will drain into one of two major watercourses; the Santa Cruz River or the Brawley Wash. Major tributaries of the Santa Cruz River are the Canada del Oro Wash and Rillito Creek. Major tributaries of the Rillito Creek are the Tanque Verde Creek and the Pantano Wash. The Black Wash is the only major tributary of the Brawley Wash within the service area of Tucson Water. All the major tributaries of the Santa Cruz River and Brawley Wash are for the most part ephemeral. The Brawley Wash is also ephemeral. A segment of the Santa Cruz River is considered effluent dependent down gradient from the Pima County Agua Nueva Treatment Facility as defined by A.A.C. R-18-11-113.

Adjacent Land Uses and Downstream Uses

The adjacent land uses and downstream uses are primarily municipal and agricultural. Most De Minimus discharges by Tucson Water will never reach a major tributary, waterway or effluent dependent waterway. In addition most of the discharges are either potable or groundwater and should have minimal impact or potential impact to adjacent land uses or downstream uses.

Potential Flow Paths

Most De Minimus discharges evaporate or percolate on the ground immediately adjacent to the discharge location and may never reach a designated drainage. Other De Minimus discharges are directed to streets or small local drainage channels. In these cases discharges are conveyed to a major tributary via a storm sewer or drainage channel. Discharges in the Tucson Valley usually drain into the Santa Cruz River directly or from one of its tributaries. Discharges in Avra Valley typically drain into the Brawley Wash which eventually drains into the Santa Cruz River. The Santa Cruz River eventually drains into the Gila River which is the nearest downstream perennial/intermittent waterbody located over 75 miles from the nearest upstream De Minimus discharge from Tucson Water.

Best Management Plan

Purpose

The purpose of Best Management Practices (BMPs) for discharges is to minimize pollutants, sediment erosion and/or deposition of sediments resulting from discharge activities. Well purging, pump testing, reservoir and storage tank maintenance, hydrant flushing, water main flushing, and water quality sampling are the most common source activities resulting in discharges by Tucson Water. The following contains a variety of potential BMPs to be used by Tucson Water during AZPDES De Minimis discharge activities. The BMPs that may be employed include but are not limited to: the installation of straw wattles, wetland filter bags, tarpoline covers, geotextile sediment traps, sand bags, de-chlorination equipment, air strippers, and carbon filtration systems. The area supervisors, or other defined on-site supervisors, will have the option of selecting the sediment or contaminant control protocols for the BMP that is appropriate for the project. If the BMPs fail to perform as expected, replacement BMPs or modifications of those installed may be required. The area supervisors, or other defined on-site supervisors, will be responsible for the following:

- Selecting the appropriate BMPs
- Overseeing the installation of the selected BMPs
- Modifications/Replacements if BMPs are not performing as intended.
- Collection of field notes will be maintained for every discharge. Photographic documentation of pre-discharge and post-discharge site conditions in the area of the outfall is required for discharges lasting more than 4 continuous days and/or exceeding 0.50 million gallons in any one day. The photographs shall include areas potentially affected by erosion, streambed scour, or sedimentation resulting from the discharge. Post-discharge photographs shall be taken from the same vantage point(s) as pre-discharge photographs. (DMGP Appendix A, Section 5.)
- Potable water discharges shall have data collected on a routine basis during activities.
- Field notes shall include date and time of discharge, the names of the individuals on site, duration of flow, volume of discharge, average rate of discharge, maximum rate of discharge, visual observations,

sampling equipment, sample results; BMPs or treatment technologies in use and other factors as necessary.

- Collection of additional data if necessary.

Staff shall contact the Water Quality Division for assistance if any of the following conditions are near, or expected to potentially exceed, any of the parameters listed below. The following information may be collected on a daily basis, depending on the type of discharge:

- Oil and grease (visual inspection)
- Turbidity
- Constituent of concern
- Total/Free Residual chlorine
- Chlorine residual at the end of the discharge hose (<1.2ppm) when de-chlorinating
- E. coli if expected to exceed 576 cfu
- pH if expected to fall below 6.5 or above 9.0 NTU
- Methyl tert-butal ether (MTBE) if expected to occur above 20 ug/L
- Other constituents which may be present.

Responsible Personnel

Supervisors, or other defined on-site supervisors, will be responsible for ensuring all documentation of the discharge is collected and reported in the Tucson Water Maintenance Management Database (WAM). They are also responsible for ensuring the above mentioned BMPs are adhered to. These records will be maintained in accordance with the General Permit time frames.

ADEQ Reporting

In accordance with the requirements under the Areawide authorization (per DMGP Appendix A, Section B.1.b): For discharges lasting more than four continuous days or exceeding 0.5 million gallons in any one day, and conducted prior to January 1, 2018, documentation and results of all monitoring required by the DMGP must be submitted as required by ADEQ no later than February 28, 2018.

Sediment and Erosion Control

To reduce the amount of erosion, discharges should be directed to hard flat stable surfaces whenever possible such as pavement or concrete. Areas where high velocity and volume discharges could result in erosion the following specific BMPs should be utilized to reduce erosion, turbidity and sedimentation.

Straw Wattles

Manufactured from rice straw and wrapped in tubular plastic netting.

Common wattle types are 9 inches in diameter and 25 feet long and weigh 35 pounds. Wattles may be purchased in a variety of sizes. Wattles shall be placed on contour and staked with 18 or 24-inch stakes at 4 foot intervals from center. The ends will overlap each other. For discharges at a well head, wattles shall be placed at the end of the discharge lay flat to prevent soil from migrating off site.

Images from http://www.strawwattles.com/gallery.html on 9/22/2005

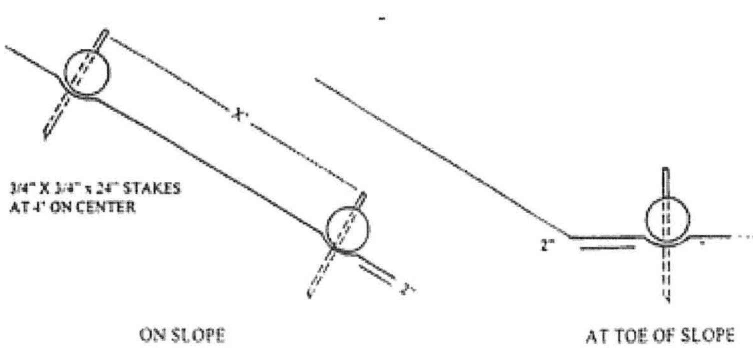


Image taken from http://www.strawwattles.com/graphics/drawing.jpg on 9/22/2005

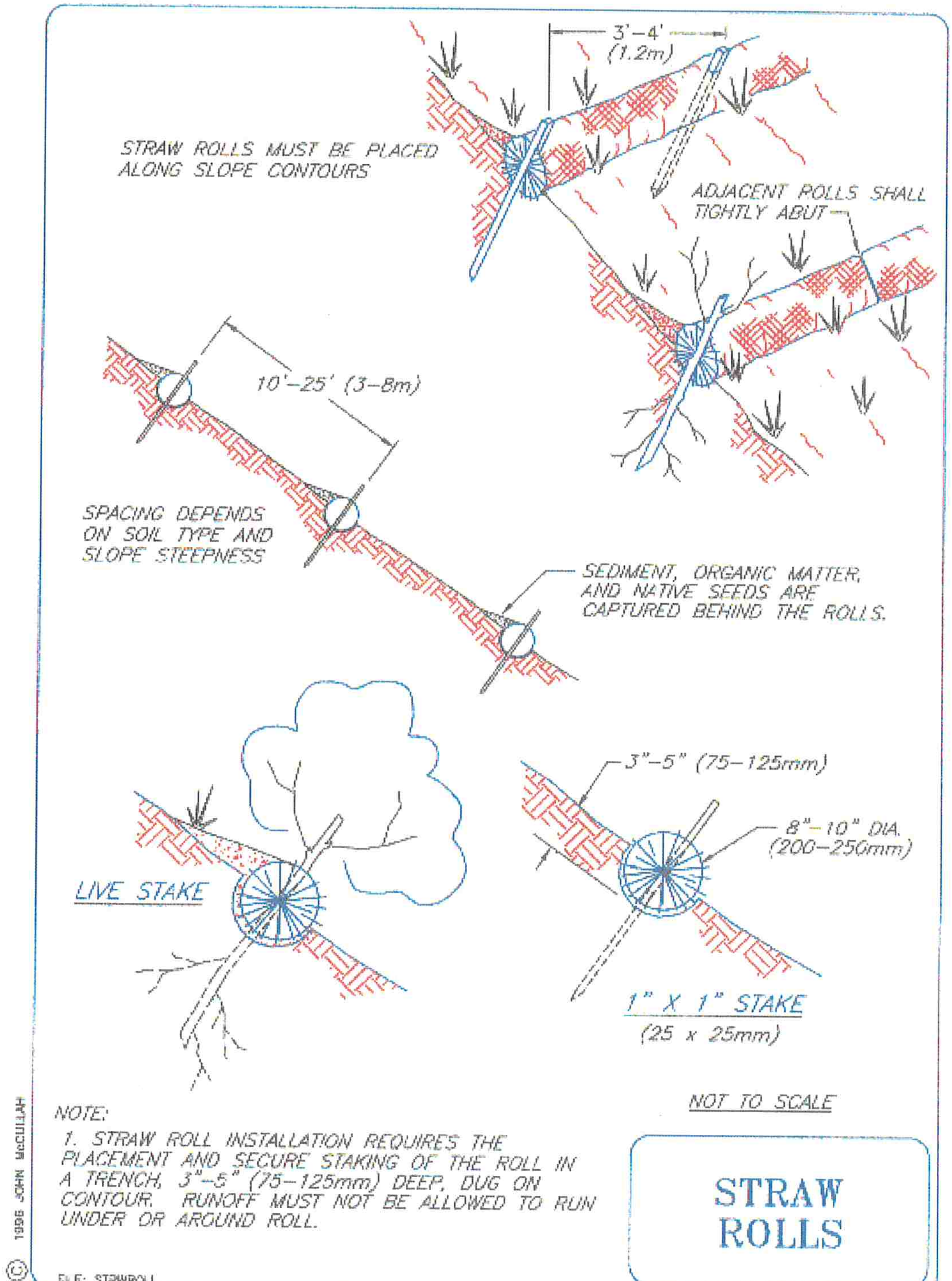


Image taken from http://www.strawwattles.com/erosiondraw/STRWROLL.GIF on 9/22/2005

Straw Wattles and the discharge lay flat at the 36 inch main dewatering.

Reservoir out fall with absorbent socks. Installed to perform similar to straw wattles to capture any oil sheen.
Image from Andy Vanover, Tucson Water (January 2008)

Wetland Filter Bags

Bags are used to contain sand, silt, and fines.

Installation requires a cut in the corner of the bag, inserting the pump discharge hose and firmly clamping the hose to the bag. Filter bags can handle up to an 8 inch discharge hose. The bags discharge capacity should not exceed 1,600 gallons per minute.

After completion of work slit the bag, remove sediment and smoothly grade into the existing topography. Store the bag for future reuse or dispose of at a suitable disposal site.

Image taken from http://www.jmdcompany.com/Enviro-Protection_Bag.htm on 9/22/2005

Tarpoline

Tarpoline is used to protect part of the wash at the piping outfall when no overland flow will occur. This will assist in minimizing the turbidity of the flow as it exits the discharge piping. Flow will be allowed to travel the ephemeral wash.

Geotextile Sediment Trap

Geotextile Sediment Trap is used to capture sediment from discharge flows.

The containment system should provide sufficient volume for capturing sediment and still be able to drain. It consists of a framework which supports a geotextile filter fabric or filter bag placed on top of the framework.

Sediment collected in the trap is removed and disposed of properly and the filter bag is then ready for reuse.

Image from Chuck Faas Tucson Water on 10/05/2005

Other Pollutants

Other common potential pollutants from Tucson Water discharges include chlorine and Volatile Organic Compounds (VOC's). See Appendix A.

Chlorine

Sodium Hypochlorite (NaOCl) is used for disinfection purposes. On average 50-100 ppm is the typical level of NaOCl in water used for the disinfection of wells, pipelines, reservoirs and storage tanks. Most water distribution maintenance activities do not involve disinfection so the NaOCl concentrations are at normal potable levels, averaging between 08-1.2 ppm. Some De Minimus discharges by Tucson Water will never reach a major tributary, waterway or effluent dependent waterway.

For discharges of super chlorinated water (> 4 ppm), Tucson Water retains water on-site or uses a method to de-chlorinate the water before it enters the environment. Test strips are used to confirm the de-chlorination method is successful.

The preferred method of de-chlorination for concentrations below 200 ppm utilizes ascorbic acid and has proven to be safe and effective. The preferred method of de-chlorination for concentrations above 200 ppm is Sodium BiSulfite.

Romac Venturi Device to feed ascorbic acid for de-chlorination. (0-200 ppm)

De Chlorinator used with 3" Ascorbic Acid Tablets
Image from David Marquez , Tucson Water.

Two Venturi Manifold for flows greater than 1800 GPM – CA-009A De Chlorination
Image from Andrew Vanover , Tucson Water.

Sodium Bisulfite is used to de-chlorinate discharges over 200 ppm
Image from Laura Macklin, Tucson Water.

VOC's

VOC's are present in some of the water production and monitor wells that Tucson Water operates. When discharges from wells with known or expected VOC's are near or above the Maximum Contaminate Limit (MCL) for potable water, the following specific BMPs should be utilized to eliminate or reduce the amount of VOC's to below the MCL.

Air Stripper

Image from Chuck Faas Tucson Water on 02/02/2001

Air strippers are used to remove VOC's from water by aerating the water as it drains and is dispersed through the structure. Air strippers should be considered when VOC's are known or expected to be present in discharge waters.

Advantages over a carbon filtration system include its ability to handle much higher discharge rates than a carbon filtration system and cost effectiveness for high volume discharges.

Carbon Filtration System

Carbon filtration systems are used to remove VOCs from water through adsorption from contaminated water. Carbon filtration systems should be considered when VOC's are known or expected to be present in discharge waters.

Carbon filtration systems are ideal for low discharge rates and volumes.

Advantages over an air stripper system include its maneuverability and ease of transport.

Image from Chuck Faas Tucson Water 2012

Spill Prevention and Contaminate Reduction

Most spills can be prevented if material handling practice controls are followed and enforced. Frequent inspection and monitoring of potential sources of contamination should be performed on a routine basis. In the event of a small spill, the City of Tucson Small Spill Response Management Plan should be followed. In the event of large spill 911 is called.

With effective BMPs, contaminates can be reduced or removed from discharges. Where pre-existing contamination exists, measures will be taken to prevent further spreading of contaminates from discharge activities.

References and Additional Information

National Oceanic and Atmospheric Administration, (2015) web page.

http://www.franklin-gov.com/engineering/STORMWATER/tcp.htm
http://www.abe.msstate.edu/csd/p-dm/chapter3.html
http://www.azdeq.gov/environ/water/permits/azpdes.html
http://www.epa.gov/OST/stormwater/
http://www.mtas.utk.edu/bmptoolkit.htm

WAM Entry Process

Planner Scheduler

Add when requesting a WO or SR	Add to WO or SR when in "Active" status	Create a stand alone permit and associate with WO or SR

↓

Assigned crew responsible for entering data into WAM

↓

Place in "Pending Approval" status

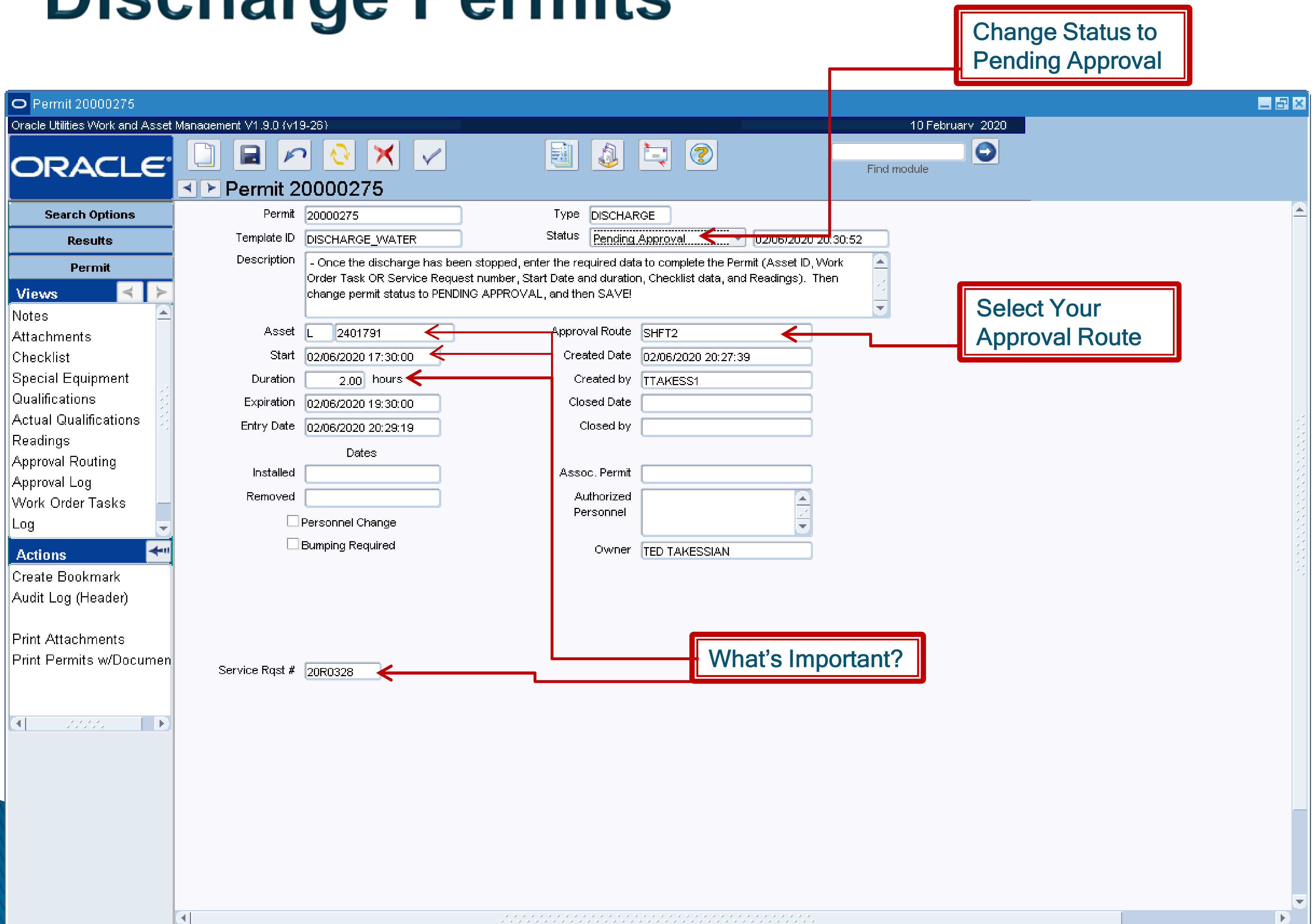
↓

Supervisor Approves Permit or TW_D_PRMT

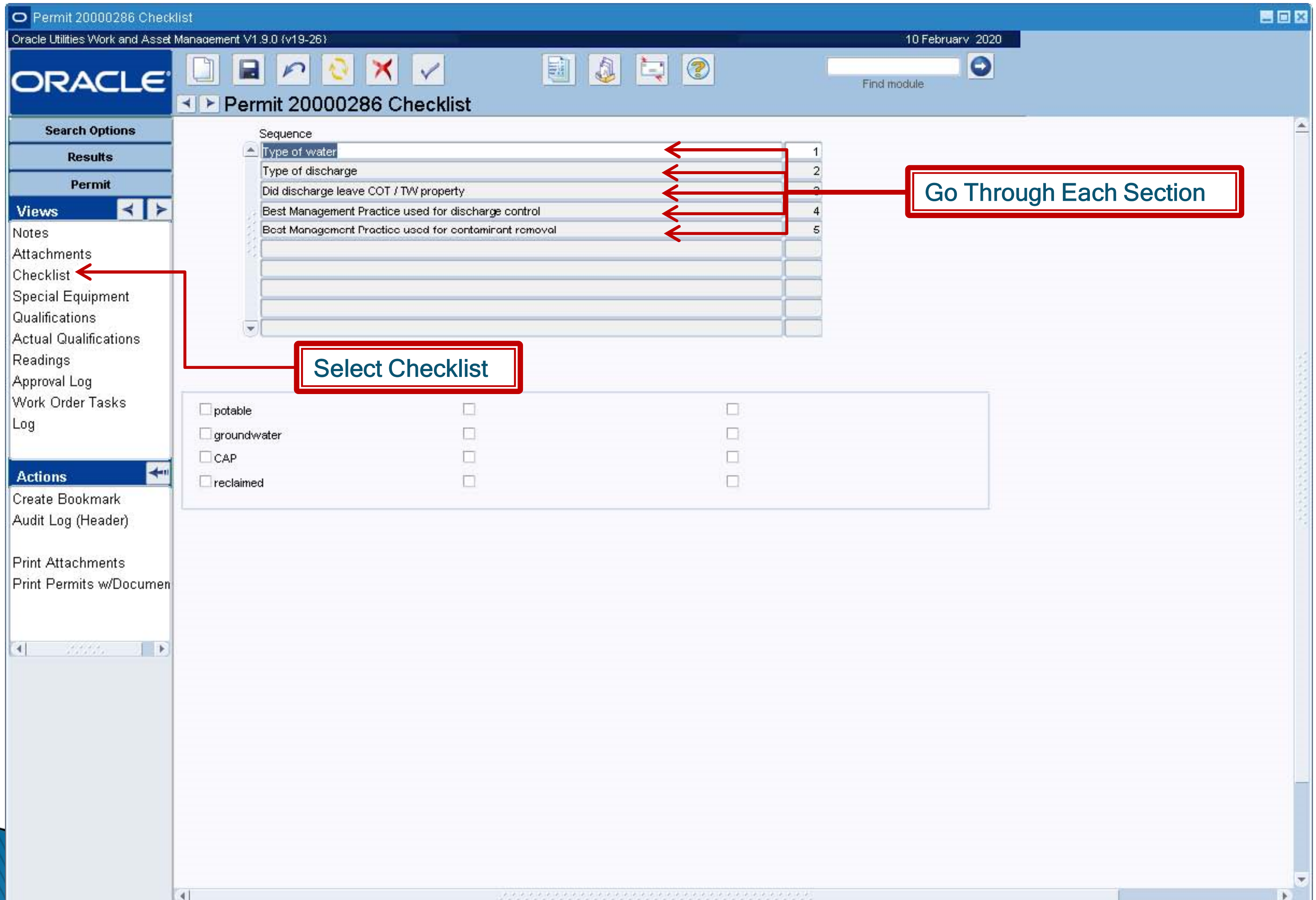
↓

Planner Scheduler or TW_D_PRMT closes out completed permit with completed WO or SR

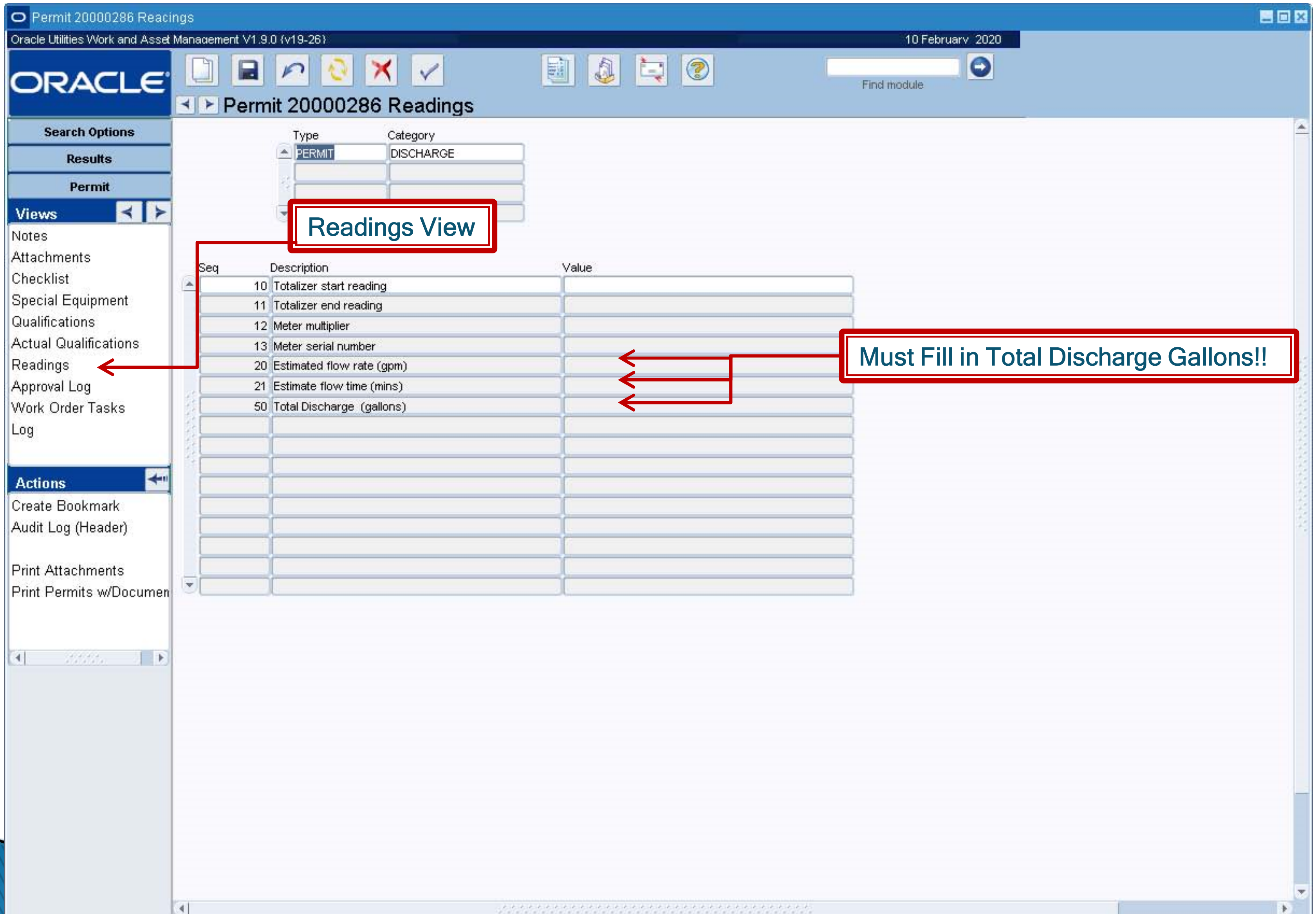
Discharge Permits



Checklist

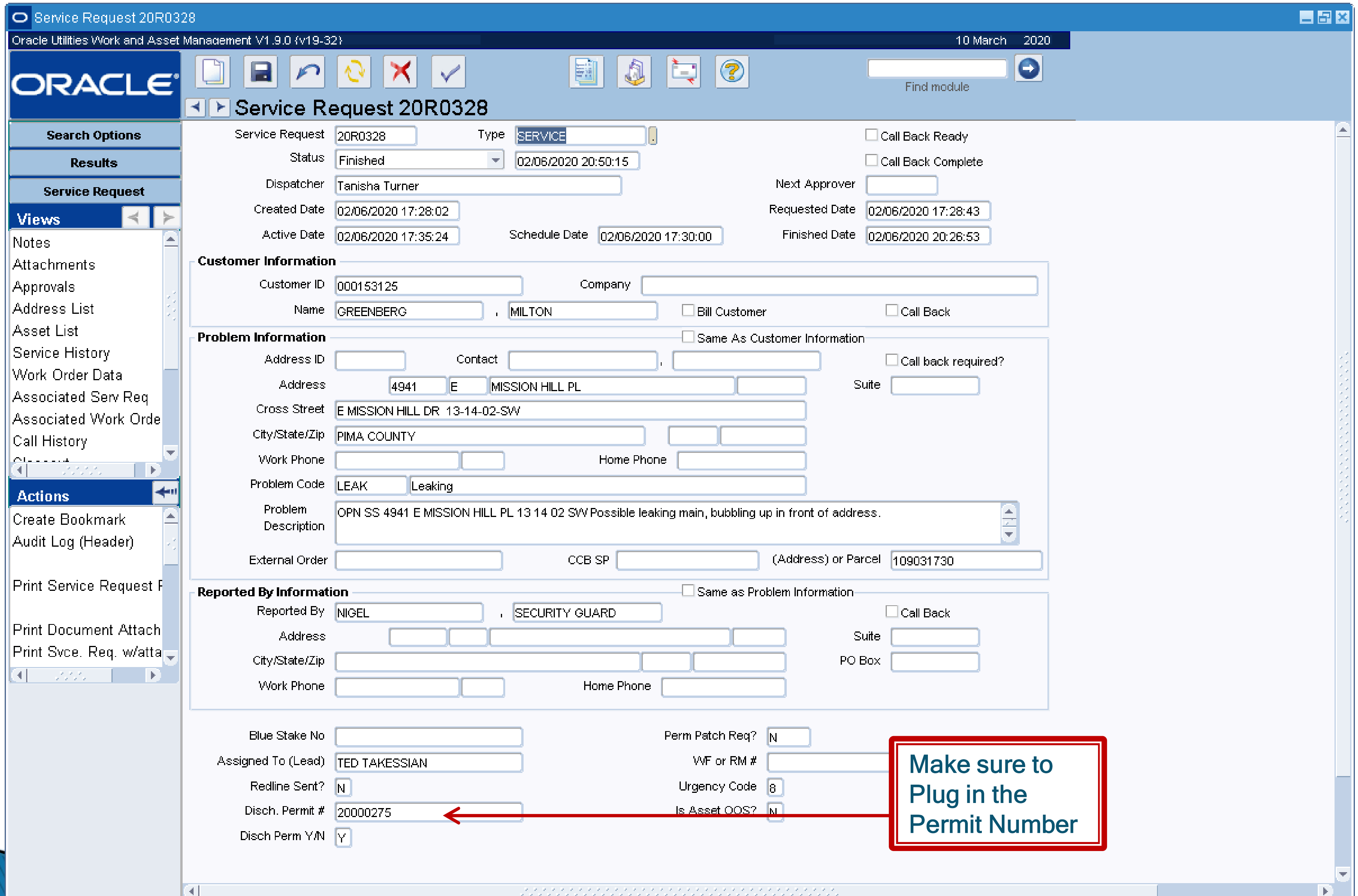

Permit 20000286 Checklist
Oracle Utilities Work and Asset Management V1.9.0 (v19-26)
10 February 2020
ORACLE
Find module
Permit 20000286 Checklist
Search Options
Results
Permit
Views
Notes
Attachments
Checklist
Special Equipment
Qualifications
Actual Qualifications
Readings
Approval Log
Work Order Tasks
Log
Actions
Create Bookmark
Audit Log (Header)
Print Attachments
Print Permits w/Documen
Sequence
Type of water 1
Type of discharge 2
Did discharge leave COT / TW property 3
Best Management Practice used for discharge control 4
Best Management Practice used for contaminant removal 5
potable
groundwater
CAP
reclaimed
Go Through Each Section
Select Checklist

Readings



Permit 20000286 Readings
Oracle Utilities Work and Asset Management V1.9.0 (v19-26)
10 February 2020
ORACLE
Find module
Permit 20000286 Readings
Search Options
Results
Permit
Views
Notes
Attachments
Checklist
Special Equipment
Qualifications
Actual Qualifications
Readings
Approval Log
Work Order Tasks
Log
Actions
Create Bookmark
Audit Log (Header)
Print Attachments
Print Permits w/Documen
Type
Category
PERMIT
DISCHARGE
Readings View
Seq
Description
Value
10 Totalizer start reading
11 Totalizer end reading
12 Meter multiplier
13 Meter serial number
20 Estimated flow rate (gpm)
21 Estimate flow time (mins)
50 Total Discharge (gallons)
Must Fill in Total Discharge Gallons!!

Service Request - Discharge Permits



NRW/AZPDES Dual Discharge Paper Form

NRW or AZPDES DISCHARGE FORM

Provide text and/or ✔ applicable boxes

1. LOCATION **Asset ID, WO# or SR#** ______________________________

Location Description: ____

____

2. TYPE OF WATER

- ☐ potable
- ☐ groundwater/well purging
- ☐ CAP

3. TYPE OF DISCHARGE

- ☐ fire hydrant / fire service
- ☐ well
- ☐ reservoir
- ☐ booster(s)
- ☐ PRV
- ☐ tank, hydro-tank
- ☐ water quality sampling
- ☐ curbstop / meter
- ☐ line break
- ☐ other (description) ____________

4. DATE / TIME of DISCHARGE ____/____/ 20__ **Time:** ____________

5. Did the discharge leave COT/Tucson Water property? ☐ YES ☐ NO

6. VOLUME of DISCHARGE *Use any of these 3 options to give a Total Discharge*

Totalizer start ________ end ________ Estimated flowrate ________ gpm

Meter multiplier ____________ and time ________ min

Meter serial number __________

Total Discharge:

____________ gallons

(continue on reverse side)

NRW/AZPDES Dual Discharge Form

7. Best Management Practice (BMP) used:

☐ street / hard surface ☐ straw wattles ☐ filter bags ☐ woven sack / tarpoline

☐ geotextile sediment trap ☐ straw bale / check dam ☐ other ______________________________

8. Contaminant removal BMP (if necessary):

☐ air stripper ☐ carbon filtration ☐ dechlorination

☐ other ____________________________________

9. Description of activity – time and comment (include samples taken and field measurements)

____

____

____

10. On-Site Supervisor

Name _______________________________________ **Date:** __/___ / _____

____

OFFICE USE: Input Date ____________________________________ Initials:__________________________

Appendix E

TUCSON WATER SENTRY PROGRAM RESULTS

CONTAMINANTS OF EMERGING CONCERN SENTRY PROGRAM

March 22, 2021

2020 RESULTS SUMMARY

Tucson Water Quality and Operations Division ● P.O. Box 27210 ● Tucson, AZ 85726

TUCSON WATER
A proud part of the City of Tucson

CONTAMINANTS OF EMERGING CONCERN SENTRY PROGRAM

2020 RESULTS SUMMARY

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1.0 EXECUTIVE SUMMARY

Recent scientific research has indicated that exposure to contaminants of emerging concern (CECs) may pose risks to human health. To respond to these potential health concerns, Tucson Water established the "Sentry Program" in 2008 under the direction of the City Manager. The Sentry Program has detected trace levels of CECs in the drinking water system and Tucson Water has been tracking the annual sampling results to proactively identify and address potential CECs contamination issues. The Sentry Program is a proactive, voluntary monitoring component of the routine water quality management program. Results of the 2020 Sentry Program are summarized in this report and are largely consistent with historical CECs data.

Tucson Water has expanded its Sentry Program to keep its water supplies safe and protect public health. The following Sentry Program enhancements were implemented:

- Expanded the CECs investigation by increasing the number of both potable and nonpotable from 9 to 18 sampling locations.
- Accelerated CECs data collection by increasing the sampling frequency from an annual to a semi-annual basis; sampling performed in the months of June-July and December 2020.
- Collaborated with other local water utilities, stakeholders, and partners to set priorities, direct resource uses, and develop projects, programs, and policies concerning CECs issues.
- Shared information on the City of Tucson Internet to improve our Sentry Program and maintain our reputation as a trusted source of drinking water.

2.0 BACKGROUND

CECs can best be described as newly identified or emerging manufactured or naturally occurring compounds that may have lacked public health impact data or may not have an applicable regulatory maximum contaminant level (MCL) or health advisory (HA) established for drinking water by federal and state regulatory agencies. The lack of regulatory drinking water standards is driven by a cumbersome regulatory rule making process and critical research gaps in toxicity information associated with individual CECs, mixtures of CECs, and cumulative exposure over time. Typically, CECs are categorized by their type and source, and the most common categories are fire retardants and other per- and polyfluoroalkyl substances (PFAS), industrial chemicals, personal care products, pesticides, and pharmaceuticals. State-of-the-art advances in analytical technologies and instrumentation have made it possible to identify trace concentrations of CECs measured in parts per trillion (ppt). A list of all 114 CECs analyzed under the 2020 Sentry Program is provided (**Table 1**).

3.0 SAMPLING SITES

As part of the 2020 Sentry Program, water samples were collected at single entry points to the distribution system (EPDS) representing native groundwater wells and at combined entry points to the distribution system (CEPDS) that represent combined groundwater well flows from blended groundwater sources. Water samples were collected in June-July and December 2020 from a total of 18 sample locations as follows (**Figure 1**).

Samples were collected at four EPDS sampling sites located at native groundwater wells located in close proximity to the Santa Cruz River, downstream of Pima County's Agua Nueva Water Reclamation and Tres Rios Water Reclamation facilities. These four samples represent drinking water wells impacted by treated wastewater.

1. EPDS 109 (Z-013A) represents an out of service potable well – inactive
2. EPDS 166 (Y-001B) represents an out of service potable well – inactive
3. EPDS 160 (Y-004A) represents a standby emergency use only potable well
4. EPDS 232 (W-001C) represents an active potable well

Samples were collected at four CEPDS sampling sites comprised of combined flow of groundwater wells that represent the blended drinking water supply entering the distribution system at different locations.

5. CEPDS 124 (167R) represents the Southern Avra Valley Storage and Recovery Project (SAVSARP) wellfield
6. CEPDS 125 (310) represents the Santa Cruz wellfield
7. CEPDS 159 (EP1) represents the Central Avra Valley Storage and Recovery Project (CAVSARP) and SAVSARP wellfields
8. CEPDS 171 (198R) represents the Tucson Airport Remediation Project/Advanced Oxidation Process (TARP/AOP) Water Treatment Plant wellfield

Samples were collected at four EPDS and one reservoir sampling sites that represent the drinking water supply entering the distribution system at different locations.

9. EPDS 013 (A-055A) represents a standby emergency use only potable well
10. EPDS 054 (C-046B) represents an active potable well
11. EPDS 147 (B-110A) represents an active potable well
12. EPDS 245 (F-006A) represents an active potable well
13. Escalante Reservoir (EP21) represents an active potable reservoir

Samples were collected at two locations at the Tucson Airport Remediation Project/Advanced Oxidation Process (TARP/AOP) Water Treatment Plant. Tucson Water's AOP Water Treatment Facility uses state-of-the-art technology to effectively remove trichloroethylene (TCE), 1,4-dioxane, and PFAS from water.

The facility operates in conjunction with the adjacent TARP facility to produce up to seven million gallons of purified water a day. The two samples represent groundwater before and after treatment prior to entering the distribution system.

14. TA-030A (influent) represents untreated groundwater collected at the influent booster station
15. TP-021T (effluent) represents treated groundwater collected after the granular activated carbon (GAC) vessels prior to the packed column aeration system

Tucson Water uses some of its recycled water to produce reclaimed water, which is specially treated for applications such as irrigation, dust control, firefighting, and industrial uses. Reclaimed water is not treated for use in drinking or bathing. Three samples were collected at locations that represent reclaimed water before and after treatment prior to entering the Sweetwater wetlands and/or the reclaimed water distribution system.

16. 510 (influent) represents untreated reclaimed water
17. 522 (effluent) represents treated reclaimed water
18. EW-007A (influent) represents untreated groundwater from an extraction well

4.0 DETECTED CECs

Trace levels of CECs were detected in all 36 samples collected in the June-July and December 2020 sampling events (**Table 2**).

- Within active wells serving Tucson Water customers, all 2020 trace detections were well below any established health-based MCLs or HAs, if applicable **(Table 2 - Potable)**.
- Within water sources not serving Tucson Water customers, 2020 trace detections were above the HA of 0.35 part per billion (ppb) for 1,4-dioxane at the following sample locations: 510, 522, EW-007A, TA-030A, Y-001B, Y-004A, and Z-013A **(Table 2 - Nonpotable)**.
- Within water sources not serving Tucson Water customers, 2020 trace detections were above the HA of 70 ppt for PFOS and PFOA at the following sample locations: 522, EW-007A, TA-030A, Y-001B, Y-004A, and Z-013A **(Table 2 - Nonpotable)**.

The types of CECs and concentrations detected in the 2020 Sentry Program were generally consistent with historical data, with no CECs showing discernable trends.

5.0 REGULATORY OUTLOOK

Tucson Water takes seriously the detection of CECs in its drinking water. However, it is important to put their presence into context. The EPA has not determined whether standards are necessary for many CECs. EPA uses the Unregulated Contaminant Monitoring Rule (UCMR) to collect data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water Act (SDWA). The UCMR program was developed in coordination with the Contaminant Candidate List (CCL). The CCL is a list of contaminants that:

- Are not regulated by the National Primary Drinking Water Regulations
- Are known or anticipated to occur at public water systems
- May warrant regulation under the SDWA

Tucson Water completed the fourth Unregulated Contaminant Monitoring Rule (UCMR4) sampling in 2020 and some of the Sentry Program CECs are listed on the UCMR4 CCL. The UCMR program provides a basis for future EPA regulatory actions to protect public health. The previous and current UCMR CCL results are being and will be reviewed by EPA. Depending on the outcome of the EPA review, some of the Sentry Program CECs may or may not be considered for regulation in the future. On February 14, 2019, EPA announced a Nationwide PFAS Action Plan and stated plans to move ahead with establishing an MCL for PFOS and PFOA, two of the most well-known and prevalent PFAS chemicals. In March 2020, EPA proposed a positive determination for PFOA and PFOS and released a pre-publication version of the final determination on January 19, 2021. This 2021 notice indicates the EPA will be initiating evaluation of regulations for PFOA and PFOS only.

6.0 CONTINUED ACTION PLAN

As previously stated, Tucson Water will continue to enhance the Sentry Program. CECs monitoring frequency is currently performed twice per year at total of 18 selected sampling locations. These semi-annual sampling events will continue to be conducted in the summer months and then repeated in the winter months. Both potable and nonpotable sample locations will continue to be sampled in 2021. In addition, Tucson Water plans to actively engage local utilities and other key partners in investigation programs that focus on monitoring and treatment of CECs and any potential health impacts that may be associated with the presence of these contaminants in source water and drinking water.

Figure 1. CECs Sentry Program Sampling Plan - 2020

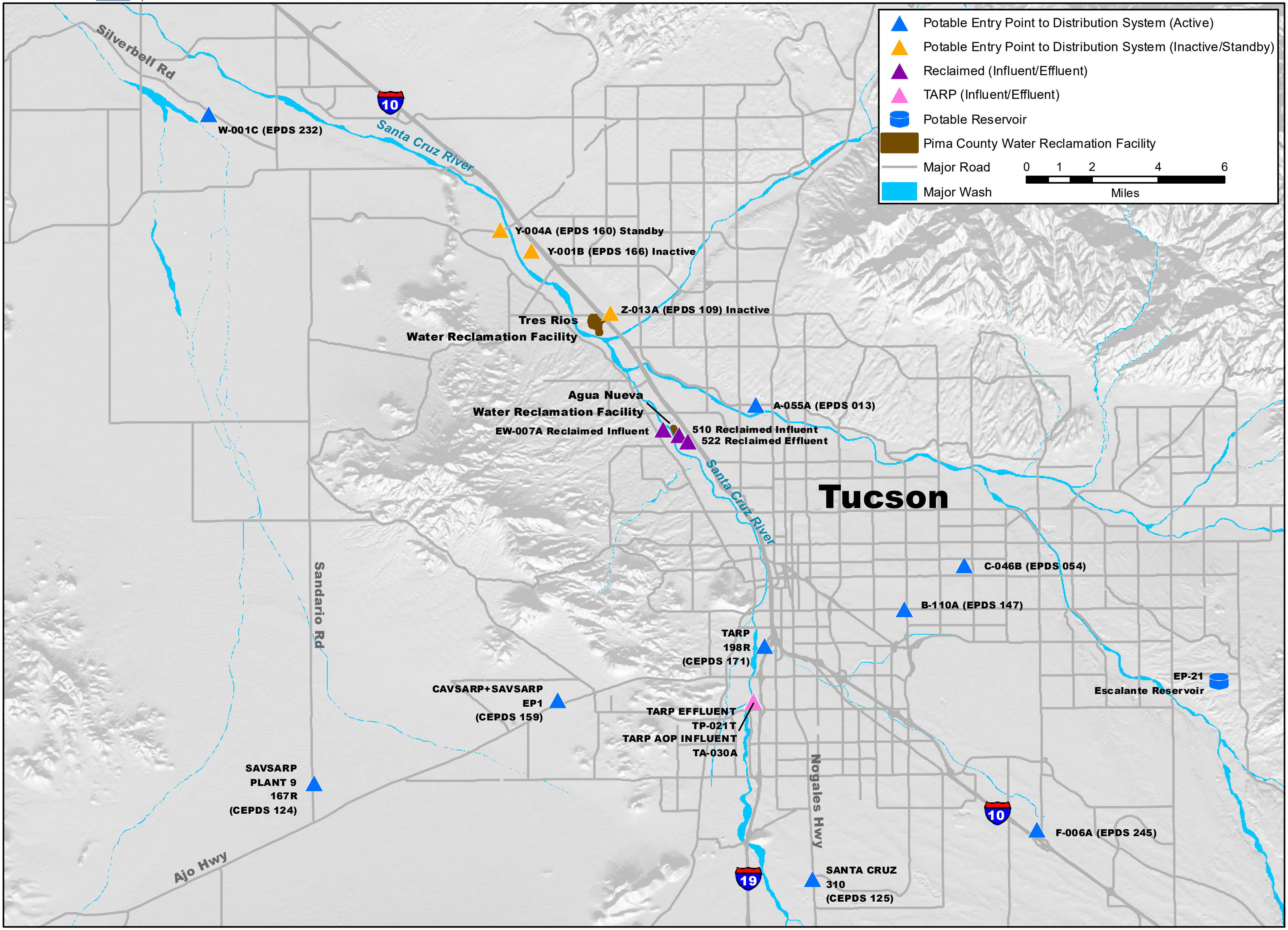

TABLE 1. 2020 SENTRY PROGRAM - CECs ANALYZED

No.	Contaminant of Emerging Concern (CEC) Parameter Name	General Category
1	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC	Fire Retardant and Other PFAS
2	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC	
3	PERFLUORO OCTANESULFONIC ACID - PFOS	
4	PERFLUORO OCTANOIC ACID - PFOA	
5	PERFLUORO-1-BUTANESULFONIC ACID - PFBS	
6	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS	
7	PERFLUORODODECANOIC ACID	
8	PERFLUOROHEPTANOIC ACID - PFHpA	
9	PERFLUORO-N-DECANOIC ACID	
10	PERFLUORO-N-HEXANOIC ACID	
11	PERFLUORO-N-NONANOIC ACID - PFNA	
12	PERFLUOROTETRADECANOIC ACID	
13	PERFLUOROTRIDECANOIC ACID	
14	PERFLUOROUNDECANOIC ACID	
15	ACESULFAME-K	Food Additive
16	SUCRALOSE	
17	1,4-DIOXANE	Industrial Chemical
18	4-TERT-OCTYLPHENOL	
19	BIS PHENOL A (BPA)	
20	CHROMIUM, HEXAVALENT	
21	QUINOLINE	
22	TCEP	
23	TCPP	
24	TDCPP	
25	BUTYLPARABEN	Personal Care Product
26	ETHYLPARABEN	
27	ISOBUTYLPARABEN	
28	PROPYLPARABEN	
29	TRICLOSAN	
30	2,4-D	Pesticide
31	4-NONYLPHENOL	
32	ATRAZINE	
33	BROMACIL	
34	CHLORIDAZON	
35	CHLOROTOLURON	
36	CLOFIBRIC ACID	
37	CYANAZINE	
38	DACT	
39	DEA	
40	DEET	
41	DIA	
42	DIURON	
43	ISOPROTURON	
44	LINURON	
45	METAZACHLOR	
46	METOLACHLOR	
47	PROPAZINE	
48	SIMAZINE	
49	SULFOMETURON METHYL	
50	THIABENDAZOLE	
51	ACETAMINOPHEN	
52	ALBUTEROL	

TABLE 1. 2020 SENTRY PROGRAM - CECs ANALYZED

No.	Contaminant of Emerging Concern (CEC) Parameter Name	General Category
53	AMOXICILLIN	Pharmaceutical
54	ANDROSTENEDIONE	
55	ATENOLOL	
56	BENDROFLUMETHIAZIDE	
57	BEZAFIBRATE	
58	BUTALBITAL	
59	CAFFEINE	
60	CARBADOX	
61	CARBAMAZEPINE	
62	CARISOPRODOL	
63	CHLORAMPHENICOL	
64	CIMETIDINE	
65	DIAZEPAM	
66	DICLOFENAC	
67	DILANTIN	
68	DILTIAZEM	
69	ERYTHROMYCIN	
70	ESTRADIOL	
71	ESTRIOL	
72	ESTRONE	
73	ETHINYL ESTRADIOL-17 ALPHA	
74	FLUMEQUINE	
75	FLUOXETINE	
76	GEMFIBROZIL	
77	IBUPROFEN	
78	IOHEXAL	
79	IOPROMIDE	
80	KETOPROFEN	
81	KETOROLAC	
82	LIDOCAINE	
83	LINCOMYCIN	
84	LOPRESSOR	
85	MECLOFENAMIC ACID	
86	MEPROBAMATE	
87	METFORMIN	
88	METHYLPARABEN	
89	NAPROXEN	
90	NIFEDIPINE	
91	NORETHISTERONE	
92	OXOLINIC ACID	
93	PENTOXIFYLLINE	
94	PHENAZONE	
95	PRIMIDONE	
96	PROGESTERONE	
97	SALICYLIC ACID	
98	SULFACHLOROPYRIDAZINE	
99	SULFADIAZINE	
100	SULFADIMETHOXINE	
101	SULFAMERAZINE	
102	SULFAMETHAZINE	
103	SULFAMETHIZOLE	
104	SULFAMETHOXAZOLE	
105	SULFATHIAZOLE	

TABLE 1. 2020 SENTRY PROGRAM - CECs ANALYZED

No.	Contaminant of Emerging Concern (CEC) Parameter Name	General Category
106	TESTOSTERONE	
107	THEOBROMINE	
108	THEOPHYLLINE	
109	TRICLOCARBAN	
110	TRIMETHOPRIM	
111	WARFARIN	
112	1,7-DIMETHYLXANTHINE	**Pharmaceutical (Metabolite of Caffeine)**
113	COTININE	**Pharmaceutical (Metabolite of Nicotine)**
114	DEHYDRONIFEDIPINE	**Pharmaceutical (Metabolite of Nifedipene)**

Acronym/Abbreviations:
PFAS = Perfluorinated alkylated substances

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
POTABLE						
310	12/28/2020	1,7-DIMETHYLXANTHINE		8.3	5	ppt
310	7/6/2020	ACESULFAME-K		20	20	ppt
310	12/28/2020	CAFFEINE		20	10	ppt
310	7/6/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.29	0.02	ppb
310	12/28/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.46	0.02	ppb
310	12/28/2020	METHYLPARABEN		67	20	ppt
310	12/28/2020	PROPYLPARABEN		35	5	ppt
167R	6/29/2020	ACESULFAME-K		65	20	ppt
167R	12/28/2020	ACESULFAME-K		21	20	ppt
167R	12/28/2020	CAFFEINE		16	10	ppt
167R	6/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.72	0.02	ppb
167R	12/28/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.53	0.02	ppb
167R	12/28/2020	METHYLPARABEN		31	20	ppt
167R	12/28/2020	PROPYLPARABEN		19	5	ppt
167R	6/29/2020	SUCRALOSE		190	100	ppt
167R	12/28/2020	SUCRALOSE		130	100	ppt
198R	6/30/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	2.6	0.02	ppb
198R	12/24/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	2.6	0.02	ppb
198R	6/30/2020	PERFLUORO-N-HEXANOIC ACID		3	2	ppt
B-110A	6/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	7	0.02	ppb
B-110A	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	7	0.02	ppb
C-046B	6/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.084	0.02	ppb
C-046B	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.13	0.02	ppb
C-046B	12/18/2020	PROPYLPARABEN		7.3	5	ppt
EP1	12/29/2020	4-NONYLPHENOL		520	400	ppt
EP1	6/29/2020	ACESULFAME-K		100	20	ppt
EP1	6/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.49	0.02	ppb
EP1	12/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.42	0.02	ppb
EP21	6/30/2020	ACESULFAME-K		27	20	ppt
EP21	12/29/2020	ACESULFAME-K		28	20	ppt
EP21	6/30/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.46	0.02	ppb
EP21	12/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.42	0.02	ppb
EP21	6/30/2020	DEET		11	10	ppt
F-006A	12/29/2020	CAFFEINE		140	10	ppt
F-006A	6/30/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.47	0.02	ppb
F-006A	12/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.4	0.02	ppb
F-006A	7/28/2020	METHYLPARABEN		220	20	ppt
F-006A	7/28/2020	PROPYLPARABEN		150	5	ppt
F-006A	7/28/2020	SALICYLIC ACID		270	200	ppt
TP-021T	6/30/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	3.5	0.02	ppb
TP-021T	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	3.3	0.02	ppb
TP-021T	12/18/2020	ERYTHROMYCIN		20	10	ppt
TP-021T	6/30/2020	PERFLUORO-N-HEXANOIC ACID		4.7	2	ppt
TP-021T	12/18/2020	PROPYLPARABEN		7.3	5	ppt
W-001C	12/18/2020	1,4-DIOXANE	HA 0.35	0.13	0.1	ppb
W-001C	6/29/2020	ACESULFAME-K		48	20	ppt
W-001C	12/18/2020	ACESULFAME-K		640	200	ppt
W-001C	6/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.13	0.02	ppb
W-001C	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.1	0.02	ppb
W-001C	6/29/2020	DACT		72	20	ppt

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
W-001C	12/18/2020	DACT		29	20	ppt
W-001C	6/29/2020	DIA		12	5	ppt
W-001C	12/18/2020	DIA		8.5	5	ppt
W-001C	6/29/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	2.8	2	ppt
W-001C	12/18/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	2.38	2	ppt
W-001C	12/18/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		2.1	2	ppt
W-001C	12/18/2020	PRIMIDONE		9	5	ppt
W-001C	6/29/2020	PROPYLPARABEN		6.4	5	ppt
W-001C	12/18/2020	PROPYLPARABEN		13	5	ppt
W-001C	6/29/2020	SIMAZINE	MCL 4,000	9.7	5	ppt
W-001C	12/18/2020	SIMAZINE	MCL 4,000	9.4	5	ppt
NONPOTABLE						
510	7/2/2020	1,4-DIOXANE	HA 0.35	**0.64**	0.1	ppb
510	12/23/2020	1,4-DIOXANE	HA 0.35	**0.77**	0.1	ppb
510	7/2/2020	1,7-DIMETHYLXANTHINE		22	5	ppt
510	12/23/2020	1,7-DIMETHYLXANTHINE		43	5	ppt
510	7/2/2020	4-NONYLPHENOL		2,600	400	ppt
510	12/23/2020	4-NONYLPHENOL		1,500	400	ppt
510	7/2/2020	4-TERT-OCTYLPHENOL		91	25	ppt
510	12/23/2020	4-TERT-OCTYLPHENOL		92	25	ppt
510	7/2/2020	ACESULFAME-K		78	20	ppt
510	7/2/2020	ALBUTEROL		10	5	ppt
510	7/2/2020	ATENOLOL		270	5	ppt
510	12/23/2020	ATENOLOL		240	5	ppt
510	7/2/2020	BEZAFIBRATE		5.4	5	ppt
510	7/2/2020	BUTALBITAL		69	10	ppt
510	12/23/2020	BUTALBITAL		79	10	ppt
510	7/2/2020	CARBAMAZEPINE		360	50	ppt
510	12/23/2020	CARBAMAZEPINE		270	5	ppt
510	7/2/2020	CARISOPRODOL		19	5	ppt
510	12/23/2020	CARISOPRODOL		20	5	ppt
510	7/2/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.023	0.02	ppb
510	12/23/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.064	0.02	ppb
510	7/2/2020	COTININE		37	10	ppt
510	12/23/2020	COTININE		36	10	ppt
510	7/2/2020	DEET		53	10	ppt
510	12/23/2020	DEET		58	10	ppt
510	12/23/2020	DEHYDRONIFEDIPINE		5	5	ppt
510	7/2/2020	DIA		11	5	ppt
510	7/2/2020	DICLOFENAC		590	125	ppt
510	12/23/2020	DICLOFENAC		250	5	ppt
510	7/2/2020	DILANTIN		65	20	ppt
510	12/23/2020	DILANTIN		81	20	ppt
510	7/2/2020	DILTIAZEM		110	5	ppt
510	12/23/2020	DILTIAZEM		100	50	ppt
510	7/2/2020	DIURON		89	5	ppt
510	12/23/2020	DIURON		1,200	50	ppt
510	7/2/2020	ERYTHROMYCIN		22	10	ppt
510	12/23/2020	ERYTHROMYCIN		240	10	ppt
510	7/2/2020	ESTRONE		13	10	ppt
510	12/23/2020	ESTRONE		31	10	ppt
510	7/2/2020	FLUOXETINE		86	10	ppt
510	7/2/2020	GEMFIBROZIL		46	5	ppt

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
510	12/23/2020	GEMFIBROZIL		26	5	ppt
510	7/2/2020	IOHEXOL		3,600	500	ppt
510	12/23/2020	IOHEXOL		15,000	2000	ppt
510	12/23/2020	IOPROMIDE		16	10	ppt
510	7/2/2020	KETOROLAC		7.9	5	ppt
510	7/2/2020	LIDOCAINE		1,600	50	ppt
510	12/23/2020	LIDOCAINE		1,200	50	ppt
510	7/2/2020	LOPRESSOR		330	20	ppt
510	12/23/2020	LOPRESSOR		1,000	20	ppt
510	7/2/2020	MEPROBAMATE		68	5	ppt
510	12/23/2020	MEPROBAMATE		73	5	ppt
510	7/2/2020	NAPROXEN		72	20	ppt
510	12/23/2020	NAPROXEN		31	20	ppt
510	7/2/2020	OXOLINIC ACID		12	10	ppt
510	7/2/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	3	2	ppt
510	12/23/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	2.11	2	ppt
510	7/2/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	8.6	2	ppt
510	12/23/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	6.78	2	ppt
510	7/2/2020	PERFLUORO-N-HEXANOIC ACID		26	2	ppt
510	12/23/2020	PERFLUORO-N-HEXANOIC ACID		12.7	2	ppt
510	7/2/2020	PRIMIDONE		240	5	ppt
510	12/23/2020	PRIMIDONE		260	5	ppt
510	7/2/2020	SALICYLIC ACID		580	200	ppt
510	12/23/2020	SALICYLIC ACID		210	200	ppt
510	7/2/2020	SIMAZINE	MCL 4,000	440	50	ppt
510	12/23/2020	SIMAZINE	MCL 4,000	14	5	ppt
510	7/2/2020	SUCRALOSE		69,000	2500	ppt
510	12/23/2020	SUCRALOSE		58,000	1000	ppt
510	12/23/2020	SULFADIAZINE		44	5	ppt
510	7/2/2020	SULFAMETHOXAZOLE		1,400	50	ppt
510	12/23/2020	SULFAMETHOXAZOLE		790	50	ppt
510	7/2/2020	TCEP		120	10	ppt
510	12/23/2020	TCEP		160	10	ppt
510	7/2/2020	TCPP		1,100	200	ppt
510	12/23/2020	TCPP		860	200	ppt
510	7/2/2020	TDCPP		830	100	ppt
510	12/23/2020	TDCPP		360	100	ppt
510	7/2/2020	THEOPHYLLINE		20	10	ppt
510	12/23/2020	THEOPHYLLINE		88	10	ppt
510	7/2/2020	THIABENDAZOLE		9.7	5	ppt
510	12/23/2020	THIABENDAZOLE		22	5	ppt
510	7/2/2020	TRIMETHOPRIM		36	5	ppt
510	12/23/2020	TRIMETHOPRIM		48	5	ppt
522	7/2/2020	1,4-DIOXANE	HA 0.35	**0.75**	0.1	ppb
522	12/23/2020	1,4-DIOXANE	HA 0.35	**0.73**	0.1	ppb
522	7/2/2020	ACESULFAME-K		140	20	ppt
522	12/23/2020	ACESULFAME-K		74	20	ppt
522	7/2/2020	ATENOLOL		71	5	ppt
522	7/2/2020	BUTALBITAL		25	10	ppt
522	7/2/2020	CARBAMAZEPINE		280	5	ppt
522	7/2/2020	CARISOPRODOL		13	5	ppt
522	12/23/2020	CARISOPRODOL		16	5	ppt
522	7/2/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.057	0.02	ppb

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
522	12/23/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.092	0.02	ppb
522	7/2/2020	DEET		20	10	ppt
522	7/2/2020	DIA		5.3	5	ppt
522	7/2/2020	DICLOFENAC		110	5	ppt
522	7/2/2020	DILANTIN		27	20	ppt
522	7/2/2020	DILTIAZEM		10	5	ppt
522	7/2/2020	DIURON		32	5	ppt
522	12/23/2020	DIURON		9.5	5	ppt
522	7/2/2020	FLUOXETINE		20	10	ppt
522	7/2/2020	GEMFIBROZIL		10	5	ppt
522	12/23/2020	IOHEXOL		49	20	ppt
522	7/2/2020	LIDOCAINE		200	5	ppt
522	7/2/2020	LOPRESSOR		95	20	ppt
522	7/2/2020	MEPROBAMATE		53	5	ppt
522	12/23/2020	MEPROBAMATE		16	5	ppt
522	7/2/2020	NAPROXEN		22	20	ppt
522	7/2/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**67**	2	ppt
522	12/23/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**70.6**	2	ppt
522	7/2/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**17**	2	ppt
522	12/23/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**17.8**	2	ppt
522	7/2/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		6.5	2	ppt
522	12/23/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		11.8	2	ppt
522	7/2/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		17	2	ppt
522	12/23/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		21.6	2	ppt
522	7/2/2020	PERFLUOROHEPTANOIC ACID - PFHpA		6.5	2	ppt
522	12/23/2020	PERFLUOROHEPTANOIC ACID - PFHpA		8.2	2	ppt
522	7/2/2020	PERFLUORO-N-DECANOIC ACID		2.3	2	ppt
522	12/23/2020	PERFLUORO-N-DECANOIC ACID		2.27	2	ppt
522	7/2/2020	PERFLUORO-N-HEXANOIC ACID		22	2	ppt
522	12/23/2020	PERFLUORO-N-HEXANOIC ACID		21.2	2	ppt
522	7/2/2020	PERFLUORO-N-NONANOIC ACID - PFNA		3.7	2	ppt
522	12/23/2020	PERFLUORO-N-NONANOIC ACID - PFNA		3.92	2	ppt
522	7/2/2020	PRIMIDONE		160	5	ppt
522	12/23/2020	PRIMIDONE		110	5	ppt
522	7/2/2020	SALICYLIC ACID		200	200	ppt
522	7/2/2020	SIMAZINE	MCL 4,000	120	5	ppt
522	7/2/2020	SUCRALOSE		22,000	1000	ppt
522	12/23/2020	SUCRALOSE		7,200	100	ppt
522	7/2/2020	SULFAMETHOXAZOLE		7.2	5	ppt
522	7/2/2020	TCEP		52	10	ppt
522	12/23/2020	TCEP		33	10	ppt
522	7/2/2020	TCPP		400	200	ppt
522	7/2/2020	TDCPP		220	100	ppt
522	7/2/2020	THIABENDAZOLE		7.3	5	ppt
A-055A	7/2/2020	1,7-DIMETHYLXANTHINE		5.3	5	ppt
A-055A	7/2/2020	ATRAZINE	MCL 3,000	18	5	ppt
A-055A	12/29/2020	ATRAZINE	MCL 3,000	17	5	ppt
A-055A	7/2/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.026	0.02	ppb
A-055A	12/29/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.046	0.02	ppb
A-055A	12/29/2020	DACT		21	20	ppt
A-055A	7/2/2020	DEA		9.5	5	ppt
A-055A	12/29/2020	DEA		16	5	ppt

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
A-055A	7/2/2020	DIA		69	5	ppt
A-055A	12/29/2020	DIA		76	5	ppt
A-055A	7/2/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	3.8	2	ppt
A-055A	12/29/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	4.54	2	ppt
A-055A	7/2/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	5.6	2	ppt
A-055A	12/29/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	6.32	2	ppt
A-055A	7/2/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		4.8	2	ppt
A-055A	12/29/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		6.48	2	ppt
A-055A	7/2/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		5.2	2	ppt
A-055A	12/29/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		7.04	2	ppt
A-055A	7/2/2020	PERFLUOROHEPTANOIC ACID - PFHpA		2.3	2	ppt
A-055A	12/29/2020	PERFLUOROHEPTANOIC ACID - PFHpA		2.76	2	ppt
A-055A	7/2/2020	PERFLUORO-N-HEXANOIC ACID		2	2	ppt
A-055A	12/29/2020	PERFLUORO-N-HEXANOIC ACID		2.25	2	ppt
A-055A	7/2/2020	SIMAZINE	MCL 4,000	6.7	5	ppt
A-055A	12/29/2020	SIMAZINE	MCL 4,000	7.5	5	ppt
A-055A	7/2/2020	THEOPHYLLINE		10	10	ppt
EW-007A	7/2/2020	1,4-DIOXANE	HA 0.35	**0.72**	0.1	ppb
EW-007A	12/23/2020	1,4-DIOXANE	HA 0.35	**0.81**	0.1	ppb
EW-007A	7/2/2020	ACESULFAME-K		170	20	ppt
EW-007A	7/2/2020	ATRAZINE	MCL 3,000	5.2	5	ppt
EW-007A	12/23/2020	ATRAZINE	MCL 3,000	6.1	5	ppt
EW-007A	7/2/2020	BIS PHENOL A (BPA)		18	10	ppt
EW-007A	7/2/2020	BUTALBITAL		13	10	ppt
EW-007A	12/23/2020	BUTALBITAL		25	10	ppt
EW-007A	7/2/2020	CARBAMAZEPINE		240	5	ppt
EW-007A	12/23/2020	CARBAMAZEPINE		150	5	ppt
EW-007A	7/2/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.2	0.02	ppb
EW-007A	12/23/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.17	0.02	ppb
EW-007A	7/2/2020	DEA		5.2	5	ppt
EW-007A	12/23/2020	DEA		5.2	5	ppt
EW-007A	12/23/2020	DEET		11	10	ppt
EW-007A	12/23/2020	DIA		6.3	5	ppt
EW-007A	7/2/2020	DIURON		5.7	5	ppt
EW-007A	12/23/2020	DIURON		11	5	ppt
EW-007A	12/23/2020	ERYTHROMYCIN		14	10	ppt
EW-007A	7/2/2020	IOHEXOL		23	20	ppt
EW-007A	7/2/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	43	2	ppt
EW-007A	12/23/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**51.7**	2	ppt
EW-007A	7/2/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	24	2	ppt
EW-007A	12/23/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**19.7**	2	ppt
EW-007A	7/2/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		12	2	ppt
EW-007A	12/23/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		14.1	2	ppt
EW-007A	7/2/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		49	2	ppt
EW-007A	12/23/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		47.6	2	ppt
EW-007A	7/2/2020	PERFLUOROHEPTANOIC ACID - PFHpA		9.2	2	ppt
EW-007A	12/23/2020	PERFLUOROHEPTANOIC ACID - PFHpA		7.86	2	ppt
EW-007A	7/2/2020	PERFLUORO-N-HEXANOIC ACID		22	2	ppt
EW-007A	12/23/2020	PERFLUORO-N-HEXANOIC ACID		22.5	2	ppt
EW-007A	7/2/2020	PRIMIDONE		81	5	ppt
EW-007A	12/23/2020	PRIMIDONE		100	5	ppt
EW-007A	12/23/2020	SIMAZINE	MCL 4,000	5.4	5	ppt

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
EW-007A	7/2/2020	SUCRALOSE		2,800	100	ppt
EW-007A	12/23/2020	SUCRALOSE		2,900	100	ppt
EW-007A	7/2/2020	SULFAMETHOXAZOLE		27	5	ppt
EW-007A	12/23/2020	SULFAMETHOXAZOLE		32	5	ppt
EW-007A	12/23/2020	TCEP		12	10	ppt
TA-030A	6/30/2020	1,4-DIOXANE	HA 0.35	**1.13**	0.1	ppb
TA-030A	12/18/2020	1,4-DIOXANE	HA 0.35	**1.13**	0.1	ppb
TA-030A	6/30/2020	BROMACIL		7.9	5	ppt
TA-030A	12/18/2020	BROMACIL		9.8	5	ppt
TA-030A	6/30/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	3.1	0.02	ppb
TA-030A	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	3.2	0.02	ppb
TA-030A	6/30/2020	DEA		8.5	5	ppt
TA-030A	12/18/2020	DEA		12	5	ppt
TA-030A	12/18/2020	DILTIAZEM		5.3	5	ppt
TA-030A	12/18/2020	ERYTHROMYCIN		25	10	ppt
TA-030A	6/30/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	9.8	2	ppt
TA-030A	12/18/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	11.7	2	ppt
TA-030A	12/24/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	13.2	2	ppt
TA-030A	6/30/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	3.3	2	ppt
TA-030A	12/18/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	4.34	2	ppt
TA-030A	12/24/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	4.57	2	ppt
TA-030A	6/30/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		7.4	2	ppt
TA-030A	12/18/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		10.5	2	ppt
TA-030A	12/24/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		10.6	2	ppt
TA-030A	6/30/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		43	2	ppt
TA-030A	12/18/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		58.4	2	ppt
TA-030A	12/24/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		63	2	ppt
TA-030A	6/30/2020	PERFLUOROHEPTANOIC ACID - PFHpA		2.8	2	ppt
TA-030A	12/18/2020	PERFLUOROHEPTANOIC ACID - PFHpA		3.45	2	ppt
TA-030A	12/24/2020	PERFLUOROHEPTANOIC ACID - PFHpA		3.54	2	ppt
TA-030A	6/30/2020	PERFLUORO-N-HEXANOIC ACID		10	2	ppt
TA-030A	12/18/2020	PERFLUORO-N-HEXANOIC ACID		12.2	2	ppt
TA-030A	12/24/2020	PERFLUORO-N-HEXANOIC ACID		12.3	2	ppt
TA-030A	12/18/2020	PROPYLPARABEN		8.6	5	ppt
Y-001B	7/1/2020	1,4-DIOXANE	HA 0.35	**0.76**	0.1	ppb
Y-001B	12/18/2020	1,4-DIOXANE	HA 0.35	**0.77**	0.1	ppb
Y-001B	7/1/2020	ACESULFAME-K		67	20	ppt
Y-001B	12/18/2020	ACESULFAME-K		150	20	ppt
Y-001B	7/1/2020	ATRAZINE	MCL 3,000	7.2	5	ppt
Y-001B	12/18/2020	ATRAZINE	MCL 3,000	6.4	5	ppt
Y-001B	7/1/2020	CARBAMAZEPINE		140	5	ppt
Y-001B	12/18/2020	CARBAMAZEPINE		95	5	ppt
Y-001B	7/1/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.099	0.02	ppb
Y-001B	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.14	0.02	ppb
Y-001B	7/1/2020	DEA		5	5	ppt
Y-001B	12/18/2020	DIA		6.3	5	ppt
Y-001B	7/1/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**81**	20	ppt
Y-001B	12/18/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**72**	2	ppt
Y-001B	7/1/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**18**	2	ppt
Y-001B	12/18/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**12**	2	ppt
Y-001B	7/1/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		5.6	2	ppt

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
Y-001B	12/18/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		5.09	2	ppt
Y-001B	7/1/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		51	2	ppt
Y-001B	12/18/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		44.8	2	ppt
Y-001B	7/1/2020	PERFLUOROHEPTANOIC ACID - PFHpA		5.5	2	ppt
Y-001B	12/18/2020	PERFLUOROHEPTANOIC ACID - PFHpA		3.81	2	ppt
Y-001B	7/1/2020	PERFLUORO-N-HEXANOIC ACID		11	2	ppt
Y-001B	12/18/2020	PERFLUORO-N-HEXANOIC ACID		6.93	2	ppt
Y-001B	7/1/2020	PERFLUORO-N-NONANOIC ACID - PFNA		2.2	2	ppt
Y-001B	7/1/2020	PRIMIDONE		32	5	ppt
Y-001B	12/18/2020	PRIMIDONE		27	5	ppt
Y-001B	7/1/2020	SIMAZINE	MCL 4,000	8.2	5	ppt
Y-001B	12/18/2020	SIMAZINE	MCL 4,000	6.1	5	ppt
Y-001B	7/1/2020	SULFAMETHOXAZOLE		10	5	ppt
Y-001B	12/18/2020	SULFAMETHOXAZOLE		6.6	5	ppt
Y-004A	7/1/2020	1,4-DIOXANE	HA 0.35	**0.75**	0.1	ppb
Y-004A	12/18/2020	1,4-DIOXANE	HA 0.35	**1.04**	0.1	ppb
Y-004A	7/1/2020	ACESULFAME-K		130	20	ppt
Y-004A	7/1/2020	CARBAMAZEPINE		210	5	ppt
Y-004A	12/18/2020	CARBAMAZEPINE		160	5	ppt
Y-004A	7/1/2020	CARISOPRODOL		5.3	5	ppt
Y-004A	12/18/2020	CARISOPRODOL		9.4	5	ppt
Y-004A	7/1/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.08	0.02	ppb
Y-004A	12/18/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.18	0.02	ppb
Y-004A	7/1/2020	DIA		7.4	5	ppt
Y-004A	12/18/2020	DIA		8.7	5	ppt
Y-004A	7/1/2020	DILANTIN		21	20	ppt
Y-004A	12/18/2020	DILANTIN		31	20	ppt
Y-004A	7/1/2020	DIURON		11	5	ppt
Y-004A	7/1/2020	MEPROBAMATE		12	5	ppt
Y-004A	12/18/2020	MEPROBAMATE		13	5	ppt
Y-004A	7/1/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**55**	2	ppt
Y-004A	12/18/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	47.5	2	ppt
Y-004A	7/1/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**19**	2	ppt
Y-004A	12/18/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	14.3	2	ppt
Y-004A	7/1/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		8.8	2	ppt
Y-004A	12/18/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		8.12	2	ppt
Y-004A	7/1/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		25	2	ppt
Y-004A	12/18/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		24.7	2	ppt
Y-004A	7/1/2020	PERFLUOROHEPTANOIC ACID - PFHpA		5.2	2	ppt
Y-004A	12/18/2020	PERFLUOROHEPTANOIC ACID - PFHpA		3.81	2	ppt
Y-004A	7/1/2020	PERFLUORO-N-DECANOIC ACID		2	2	ppt
Y-004A	7/1/2020	PERFLUORO-N-HEXANOIC ACID		14	2	ppt
Y-004A	12/18/2020	PERFLUORO-N-HEXANOIC ACID		9.34	2	ppt
Y-004A	7/1/2020	PERFLUORO-N-NONANOIC ACID - PFNA		2.7	2	ppt
Y-004A	7/1/2020	PRIMIDONE		64	5	ppt
Y-004A	12/18/2020	PRIMIDONE		50	5	ppt
Y-004A	7/1/2020	SIMAZINE	MCL 4,000	34	5	ppt
Y-004A	12/18/2020	SIMAZINE	MCL 4,000	32	5	ppt
Y-004A	7/1/2020	SUCRALOSE		4,400	100	ppt
Y-004A	12/18/2020	SUCRALOSE		1,700	100	ppt
Y-004A	7/1/2020	SULFAMETHOXAZOLE		57	5	ppt
Y-004A	12/18/2020	SULFAMETHOXAZOLE		57	5	ppt
Z-013A	7/1/2020	1,4-DIOXANE	HA 0.35	**1.31**	0.1	ppb

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units
Z-013A	12/28/2020	1,4-DIOXANE	HA 0.35	**1.39**	0.1	ppb
Z-013A	7/1/2020	4-NONYLPHENOL		4,500	400	ppt
Z-013A	7/1/2020	4-TERT-OCTYLPHENOL		140	25	ppt
Z-013A	12/28/2020	4-TERT-OCTYLPHENOL		36	25	ppt
Z-013A	7/1/2020	ACESULFAME-K		3,200	200	ppt
Z-013A	12/28/2020	ACESULFAME-K		2,700	200	ppt
Z-013A	7/1/2020	ATRAZINE	MCL 3,000	11	5	ppt
Z-013A	12/28/2020	ATRAZINE	MCL 3,000	12	5	ppt
Z-013A	7/1/2020	CARBAMAZEPINE		180	5	ppt
Z-013A	12/28/2020	CARBAMAZEPINE		120	5	ppt
Z-013A	7/1/2020	CARISOPRODOL		64	5	ppt
Z-013A	12/28/2020	CARISOPRODOL		62	5	ppt
Z-013A	12/28/2020	CHROMIUM, HEXAVALENT	[1]MCL 100	0.038	0.02	ppb
Z-013A	7/1/2020	DEA		6.6	5	ppt
Z-013A	12/28/2020	DEA		7.5	5	ppt
Z-013A	7/1/2020	DILANTIN		53	20	ppt
Z-013A	12/28/2020	DILANTIN		65	20	ppt
Z-013A	7/1/2020	MEPROBAMATE		220	5	ppt
Z-013A	12/28/2020	MEPROBAMATE		250	5	ppt
Z-013A	7/1/2020	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC		7.3	2	ppt
Z-013A	12/28/2020	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC		7.83	2	ppt
Z-013A	7/1/2020	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC		2.7	2	ppt
Z-013A	12/28/2020	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC		3.05	2	ppt
Z-013A	7/1/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**120**	20	ppt
Z-013A	12/28/2020	PERFLUORO OCTANESULFONIC ACID - PFOS	[2]HA 70	**146**	2	ppt
Z-013A	7/1/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**27**	2	ppt
Z-013A	12/28/2020	PERFLUORO OCTANOIC ACID - PFOA	[2]HA 70	**28.2**	2	ppt
Z-013A	7/1/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		10	2	ppt
Z-013A	12/28/2020	PERFLUORO-1-BUTANESULFONIC ACID - PFBS		11.4	2	ppt
Z-013A	7/1/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		53	2	ppt
Z-013A	12/28/2020	PERFLUORO-1-HEXANESULFONIC ACID - PFHxS		67.5	2	ppt
Z-013A	7/1/2020	PERFLUOROHEPTANOIC ACID - PFHpA		6.8	2	ppt
Z-013A	12/28/2020	PERFLUOROHEPTANOIC ACID - PFHpA		6.79	2	ppt
Z-013A	7/1/2020	PERFLUORO-N-HEXANOIC ACID		13	2	ppt
Z-013A	12/28/2020	PERFLUORO-N-HEXANOIC ACID		11.5	2	ppt
Z-013A	7/1/2020	PERFLUORO-N-NONANOIC ACID - PFNA		2.8	2	ppt
Z-013A	12/28/2020	PERFLUORO-N-NONANOIC ACID - PFNA		2.95	2	ppt
Z-013A	7/1/2020	PRIMIDONE		80	5	ppt
Z-013A	12/28/2020	PRIMIDONE		86	5	ppt
Z-013A	7/1/2020	SULFAMETHOXAZOLE		52	5	ppt
Z-013A	12/28/2020	SULFAMETHOXAZOLE		39	5	ppt

Footnotes, Acronyms, and Abbreviations:

Bold Font indicates the sample result exceeds the HA

[1]Total Chromium MCL =100 ppb; There is no MCL for Hexavalent Chromium

[2]HA 70 ppt combined PFOS + PFOA

CEC = Contaminant of Emerging Concern

HA = Health Advisory

MCL = Maximum Contaminant Level

Nonpotable: Drinking water **NOT** being served to Tucson Water customers; Inactive well or emergency use only

Potable: Drinking water being served to Tucson Water customers; Active well

ppb = parts per billion

ppt = parts per trillion

TABLE 2. 2020 SENTRY PROGRAM - CECs DETECTED

Sample Point	Sample Date	CEC Parameter Name	Water Quality Standard	Result	Detection Limit	Units

Nonpotable Sources:

510, 522, EW-007A Reclaimed Water

A-055A Standby Emergency Use Only 1/16/2020

TA-030A TARP AOP Plant Influent

TP-021T TARP AOP Effluent

Y-001B Out of Service Date 9/22/2016

Y-004A Stand By Emergency Use Only 1/16/2020

Z-013A Out of Service Date 9/9/2016

Appendix F

OUT-OF-SERVICE WELLS

OUT-OF-SERVICE WELLS - LOST AND AT-RISK ASSETS

Table 1: Out of Service (OOS) Wells (as of July 2019) that are impacted by contaminants - PFAS, 1,4-dioxane, and TCE

				Most Recent Concentrations							
#	Well Name	Flow (gpm)	OOS Date	PFOA+PFOS (ppt)	Sampling Date	PFHxS+PFHxA (ppt)	Sampling Date	1,4-dioxane (ppb)	Sampling Date	TCE (ppb)	Sampling Date
1	A-009B	379	10/31/2018	2	3/6/2019	2.3	3/6/2019	-	-	-	-
2	A-036A	330	11/16/2018	2.7	3/6/2019	2	3/6/2019	-	-	-	-
3	A-057B	558	7/18/2018	15	3/6/2019	9.5	3/6/2019	-	-	-	-
4	B-048B	713	11/16/2018	5.5	3/7/2019	3.3	3/7/2019	-	-	-	-
5	C-007A	235	3/20/2018	2950	3/20/2018	-	-	-	-	-	-
6	C-008B	680	10/24/2018	195	3/4/2019	164	3/4/2019	-	-	-	-
7	C-014B	312	3/20/2018	158	3/19/2019	690	3/19/2019	-	-	-	-
8	C-036B	313	2/5/2019	131	12/27/2018	224	12/27/2018	-	-	-	-
9	SS-001A	321	7/27/2018	23	10/5/2017	-	-	-	-	-	-
10	Y-001B	740	9/22/2016	108	10/15/2018	69	10/15/2018	0.66	10/15/2018	-	-
11	Y-004A	935	NA	82	10/15/2018	43	10/15/2018	0.71	10/15/2018	-	-
12	Z-002A	389	3/9/2016	<2	10/30/2018	<2	10/30/2018	-	-	2.5	3/3/2016
13	Z-005A	315	9/19/2016	<2	3/6/2018	-	-	0.19	10/15/2018	-	-
14	Z-013A	477	9/19/2016	148	10/15/2018	73	10/15/2018	1.26	10/15/2018	-	-
15	Z-014B	814	8/22/2016	<2	10/16/2018	<2	10/16/2018	<0.1	10/16/2018	-	-
16	Z-015A	801	9/19/2016	93	10/16/2018	123	10/16/2018	0.32	10/16/2018	-	-
	Total (gpm)	8312									

Table 2: Out of Service (OOS) Wells (as of July 2019) that are impacted by PFAS and 1,4-dioxane

				Most Recent Concentrations					
#	Well Name	Flow (gpm)	OOS Date	PFOA+PFOS (ppt)	Sampling Date	PFHxS+PFHxA (ppt)	Sampling Date	1,4-dioxane (ppb)	Sampling Date
1	Y-001B	740	9/22/2016	108	10/15/2018	69	10/15/2018	0.66	10/15/2018
2	Y-004A	935	NA	82	10/15/2018	43	10/15/2018	0.71	10/15/2018
3	Z-005A	315	9/19/2016	<2	3/6/2018	-	-	0.19	10/15/2018
4	Z-013A	477	9/19/2016	148	10/15/2018	73	10/15/2018	1.26	10/15/2018
5	Z-014B	814	8/22/2016	<2	10/16/2018	<2	10/16/2018	<0.1	10/16/2018
6	Z-015A	801	9/19/2016	93	10/16/2018	123	10/16/2018	0.32	10/16/2018
	Total (gpm)	4082							

Table 3: Out of Service (OOS) Wells (as of July 2019) that are impacted by PFAS only

				Most Recent Concentrations			
#	Well Name	Flow (gpm)	OOS Date	PFOA+PFOS (ppt)	Sampling Date	PFHxS+PFHxA (ppt)	Sampling Date
1	A-009B	379	10/31/2018	2	3/6/2019	2.3	3/6/2019
2	A-036A	330	11/16/2018	2.7	3/6/2019	2	3/6/2019
3	A-057B	558	7/18/2018	15	3/6/2019	9.5	3/6/2019
4	B-048B	713	11/16/2018	5.5	3/7/2019	3.3	3/7/2019
5	C-007A	235	3/20/2018	2950	3/20/2018	-	-
6	C-008B	680	10/24/2018	195	3/4/2019	164	3/4/2019
7	C-014B	312	3/20/2018	158	3/19/2019	690	3/19/2019
8	C-036B	313	2/5/2019	131	12/27/2018	224	12/27/2018
9	SS-001A	321	7/27/2018	23	10/5/2017	-	-
	Total (gpm)	3841					

Table 4: At-Risk Wells (as of May 2019)(1)

				Most Recent Concentrations			
#	Well Name	Flow (gpm)	OOS Date	PFOA+PFOS (ppt)	Sampling Date	PFHxS+PFHxA (ppt)	Sampling Date
1	A-053A	243	7/18/2018	<2	3/6/2019	4	3/6/2019
2	B-026B	385	11/16/2018	<2	3/7/2019	2.1	3/7/2019
3	C-082A	289	12/14/2018	<2	3/7/2019	<2	3/7/2019
4	E-029A	1040		<2	10/17/2018	-	-
	Total (gpm)	1957					

Notes:

(1) At-Risk Wells are wells that were taken out of service but have since been returned to service