PALMDALE WATER DISTRICT
A CENTURY OF SERVICE

2017 WATERSHED SANITARY SURVEY & SOURCE WATER ASSESSMENT UPDATE

Littlerock Reservoir and Lake Palmdale Watersheds

B&V PROJECT NO. 197191

PREPARED FOR

Palmdale Water District

18 DECEMBER 2017

BLACK & VEATCH

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Table of Abbreviations and Acronyms

ADA	Americans with Disabilities Act
AFY	Acre-feet per year
AVEK	Antelope Valley East Kern Water Agency
BATs	Best Available Technologies
BLM	Bureau of Land Management
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
BTEX	Benzene, Toluene, Ethel Benzene and Xylene
CAP	*Cryptosporidium* Action Plan
Cal EMA	California Emergency Management Agency
CCL	Contaminant Candidate List
CCR	California Code of Regulations
CDF	California Department of Forestry and Fire Prevention
CO_2	Carbon Dioxide
CPE	Comprehensive Performance Evaluation
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendment
D/DBPR	Disinfection/Disinfection Byproduct Rule
DBPs	Disinfection Byproducts
DDW	California Division of Drinking Water
District	Palmdale Water District
DLR	Detection Limit of Reporting Purposes
DO	Dissolved Oxygen
DTSC	Department of Toxic Substances Control
DWSAP	Drinking Water Source Assessment and Protection Program
EPA	Environmental Protection Agency
ETBE	Ethyl-tert-butyl ether
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FRAP	Fire and Resource Assessment Program
ft	feet
GAC	Granular Activated Carbon
gal	gallon
GWR	Ground Water Rule
HAA_5	Halo-Acetic Acids
HMIRS	Hazardous Material Incident Reporting System
HPC	Heterotrophic Plate Count
I&I	Infiltration and Inflow
IDSE	Initial Distribution System Evaluation
IESWTR	Interim Enhanced Surface Water Treatment Rule
IOC	Inorganic chemicals
lbs	pounds
LCR	Lead and Copper Rule
LCRMR	Lead and Copper Rule Minor Revisions

LRAA	Locational Running Annual Average
LRSR	Littlerock Reservoir Sediment Removal
LT1ESWTR	Long Term 1 Enhanced Surface Water Treatment Rule
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LUFT	Leaking Underground Fuel Tanks
MCL	Maximum Contaminant Level
MCLGs	Maximum Contaminant Level Goals
mg/L	Milligrams per Liter
MGD	million gallons per day
PWD	Palmdale Water District
mL	milliliter
MPN	Most Probable Number
MRDLGs	Maximum Residual Disinfectant Level Goals
MRDLs	Maximum Residual Disinfectant Levels
MTBE	Methyl Tertiary Butyl Ether
ND	Not Detected
NDMA	N-nitrosodimethylamine
NPDES	National Pollutant Discharge Elimination System
NPDWR	National Primary Drinking Water Regulation
NPS	National Park Service
NTUs	Nephelometric Turbidity Units
OEHHA	Office of Environmental Health Hazard Assessment
OES	Office of Emergency Services
PBE	Physical Barrier Effectiveness
PCA	Potentially Contaminating Activities
pCi/L	Picocuries Per Liter
PHG	Public Health Goals
PLC	Program Logic Controller
POE	Point of Entry
POU	Point of Use
PWS	Public Water System
Qt	quart
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
RV	Recreational Vehicle
RWQCB	Regional Water Quality Control Board
SDWA	Safe Drinking Water Act
SLIC	Spills, Leaks, Investigations and Cleanups
SOC	Synthetic Organic Chemicals
SWAP	Source Water Assessment Program
SWP	State Water Project
SWTR	Surface Water Treatment Rule
TAME	Tert-amyl-methyl ether
TBA	Tert-butyl alcohol
TCP	1,2,3-Tricloropropane
TCR	Total Coliform Rule

TOC	Total Organic Carbon
TON	Threshold Odor Number
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
TTHM	Total tri-halomethanes
UCMR	Unregulated Contaminant Monitoring Regulation
µg/L	Micrograms per Liter
USDA	United States Department Of Agriculture
USFS	United States Forest Service
UST	Underground Storage Tanks
UV	Ultra Violet
WDR	Waste Discharge Requirements
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

Executive Summary

ES.1 Overview

As part of an aggressive program to provide high quality water to customers, Palmdale Water District (PWD, the District) implements a comprehensive source water protection program. The District authorized Black & Veatch to conduct a Sanitary Survey and Source Water Assessment Update to assess potential sources of contamination in the watershed and identify management activities to maintain and improve water quality. This Executive Summary presents highlights from the Sanitary Survey Update.

ES.2 Background

The 1986 Amendments to the Safe Drinking Water Act Surface Water Treatment Rule (SWTR) required watershed sanitary surveys and watershed management plans only for surface water suppliers qualifying for filtration avoidance. The State of California Title 22, Code of Regulations, Article 7, Section 64665, requires all water suppliers to conduct a sanitary survey of their watershed at least once every five years.

Palmdale Water District completed its first Sanitary Survey for Littlerock Reservoir and Lake Palmdale Watersheds in June of 1993. The report was updated in 1997, 2002, 2007, 2012 and 2017. The Survey summarized and provided recommendations regarding the watershed and water supply system, potential contaminant sources, watershed control practices, and water quality.

ES.3 Study Area

The Palmdale Water District uses Littlerock Creek as its local surface water supply source. The watershed is defined by the contributing drainage areas to: Littlerock Reservoir; Palmdale Ditch; and Lake Palmdale. Watershed boundaries are based on those developed in the original 1993 Survey, were updated in 2012, and have been reviewed in this Update. The District's sources also include State Water Project water, which is stored in Lake Palmdale before delivery to the Palmdale Water Treatment Plant, and groundwater.

ES.4 Project Objectives

The principal objective of this project is to further develop and update the existing Sanitary Survey in a manner consistent with the State Surface Water Treatment Rule (SWTR). The primary goals of this project are:

- Satisfy the California Division of Drinking Water (DDW, previously Department of Public Health (DPH)) requirements for updating watershed sanitary surveys at least once every five years.
- Complete the Watershed Sanitary Survey Update in a manner that is consistent with the state SWTR and Source Water Assessment Program guidelines.
- Update the assessment of potentially contaminating activities and water quality.
- Review implementation of recommended management practices.
- Review development trends and their potential impact on water quality.
- Determine management activities to be undertaken to maintain and improve water quality.

ES.5 Delineation of Contributing Areas

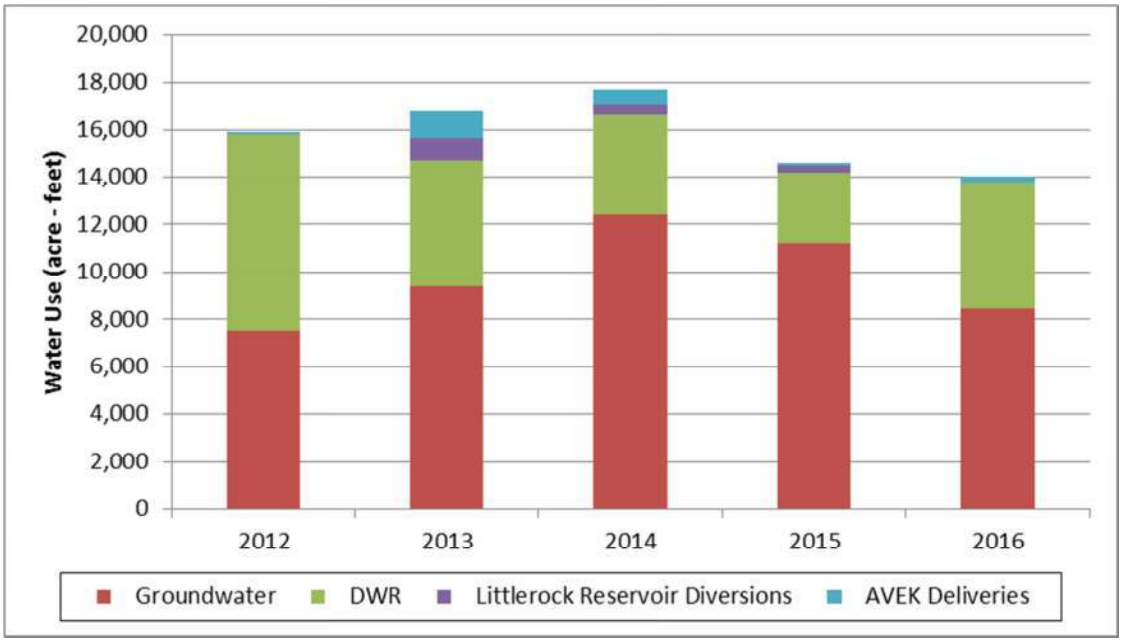
PWD is a public agency formed as an irrigation district under California Water Code that provides water service to the City of Palmdale. The primary watershed is an approximately 90 square mile area, defined by the area tributary to Littlerock Reservoir, Palmdale Ditch and Lake Palmdale. For the 2012 Update, the watershed delineation was expanded to include several segments of the Palmdale Ditch which had fallen outside of the previously defined watershed. A review of the 2012 delineation indicated no necessary changes to the watershed delineation for the 2017 Update. The watershed is predominantly non-urban, with more than 90 percent lying within the Angeles National Forest or unincorporated portions of Los Angeles County, a portion of which was designated as the San Gabriel Mountains National Monument in 2014. The Watershed Base Map is shown in Figure ES-2.

The watershed has an extensive network of tributaries. The primary tributaries that feed Littlerock Reservoir are Littlerock and Santiago Creeks. Water flows from Littlerock Reservoir through the Palmdale Ditch to Lake Palmdale prior to treatment and distribution. The majority of land in the watershed is undeveloped native forest or vegetation, with rural acreages and urban communities accounting for the remainder of land use.

ES.6 Water Supply Infrastructure

The Palmdale Water District system consists mainly of local groundwater and manmade waterways. Littlerock Reservoir and Lake Palmdale are the main water supply and storage reservoirs in the watershed. Water is conveyed to Lake Palmdale from Littlerock Reservoir via the Palmdale Ditch and from the State Water Project via a turn-out on the California Aqueduct. Water supply sources utilized by PWD from 2012 through 2016 are shown in Figure ES-1.

Figure ES-1: PWD Water Use by Source, 2012 – 2016 (PWD)



ES.6.1 Groundwater

The District's water supplies have historically come from deep groundwater wells in the Antelope Valley Groundwater Basin. Annual supplies over the last 20 years have ranged from 7,000 acre-feet to 12,400 acre-feet.

ES.6.2 Littlerock Reservoir and Dam

The Littlerock Dam and Reservoir are located on Littlerock Creek below the confluence of Santiago Canyon in the Angeles National Forest. PWD operates Littlerock Reservoir as a surface water impoundment.

Sediment has accumulated in the Reservoir, which has substantially reduced water storage and flood control capacity. The Littlerock Reservoir Sediment Removal (LRSR) Project will remove over one million cubic yards of sediment in the initial excavation period which is expected to take seven to twelve years beginning in the fall of 2019. Following the initial excavation, the PWD will continue to remove sediment annually in order to restore the reservoir to the design storage capacity.

ES.6.3 Lake Palmdale

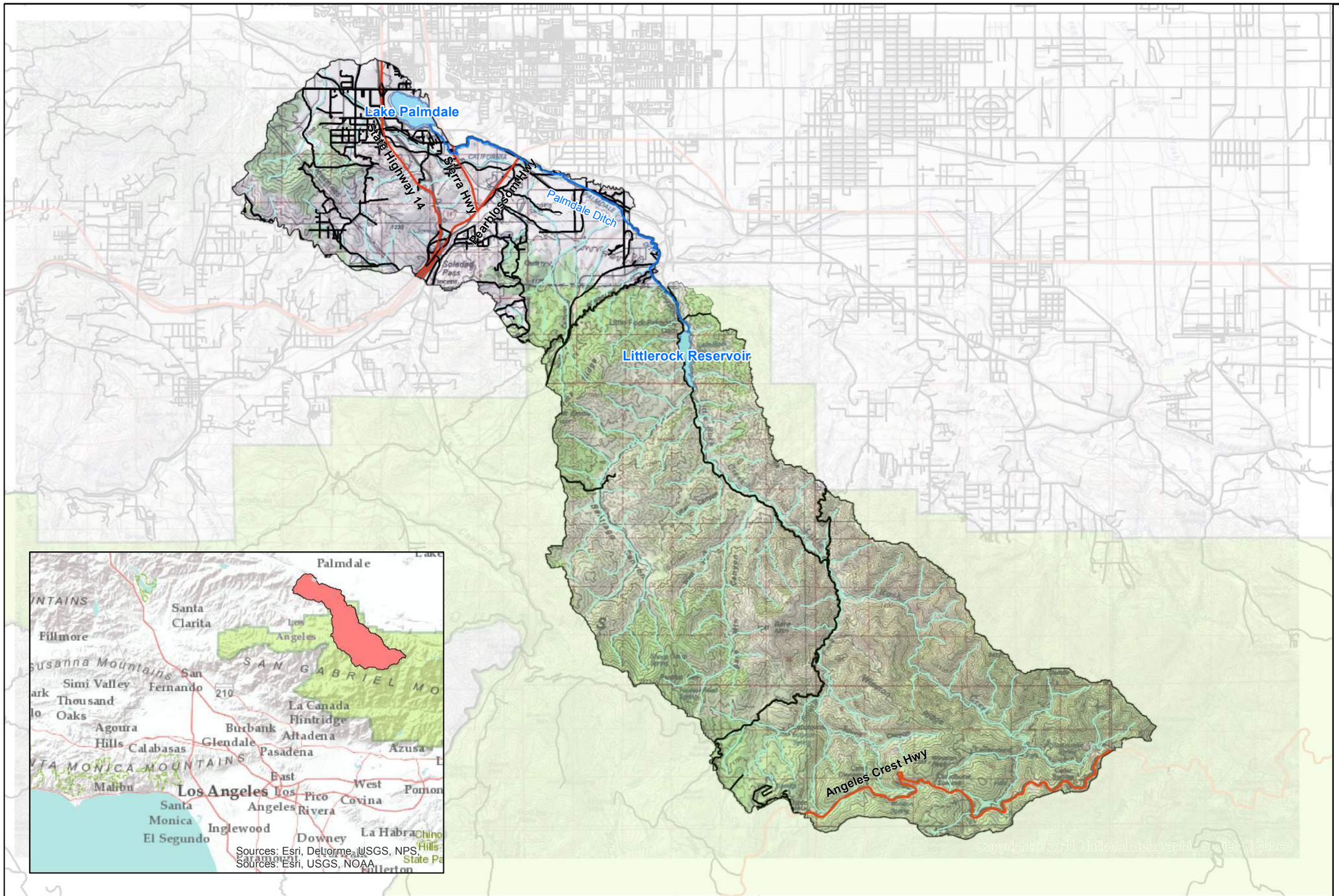
Lake Palmdale is a raw water reservoir that supplies the adjacent Palmdale Water Treatment Plant. The Lake also supports boating, fishing, and hunting. Firefighting aircraft tankers are allowed to draw water from the Lake, but it is designated as a 'no body contact' water body. Lake Palmdale has a surface area of 234 acres, a maximum depth of 25 ft., an average depth of about 18 ft., and a volume of 4200 acre-feet. The Lake regularly experiences high winds.

ES.6.4 Palmdale Ditch

The Palmdale Ditch is used to transfer water from Littlerock Reservoir to Lake Palmdale. Water flows by gravity through the 8 mile-long Ditch from the Littlerock Dam valve house to the southeast end of Lake Palmdale.

ES.6.5 Palmdale Water Treatment Plant (WTP)

Palmdale Water District's Leslie O. Carter Water Treatment Plant was originally commissioned in 1987. The plant was expanded in 1991 to increase the rated capacity from 12 to 30 MGD. A process optimization study was performed in 2001, resulting in the development of upgrades to maximize the plant's effectiveness and increase its nominal capacity to 35 MGD.



Map Projection: Lambert Conformal Conic
Central Meridian: -118
Standard Parallel 1: 34
Standard Parallel 2: 35.47
False Easting: 656166.7
False Northing: 1640416.7

0 0.5 1 2
Miles

BLACK & VEATCH

Watershed Base Map

Palmdale Water District Watershed Sanitary Survey

FIGURE ES-2

ES.7 Inventory of Potentially Contaminating Activities

ES.7.1 Littlerock Reservoir

The Littlerock Recreation Area has been closed to recreation since the spring of 2015 due to detection of mercury in some fish populations. The source of the mercury is unknown. USFS and PWD may reopen the facilities when these issues have been resolved. Access will be restricted for approximately five months annually for the LRSR dredging project. As a result, Potential Contaminating Activities (PCAs) due to recreation are not an immediate concern.

ES.7.2 Lake Palmdale

The Fin and Feather Club has exclusive use of Lake Palmdale for recreational activities such as fishing, hunting, sport shooting, and picnics. No other public recreation is allowed.

ES.7.3 Wildlife/Domestic Animals

The southern portion of the watershed is primarily open land populated by a variety of wildlife. Hunting and fishing are permitted in Angeles National Forest. Hunting dogs are allowed with restrictions at Lake Palmdale. There is a trail system for horseback riding adjacent to the Palmdale Ditch.

ES.7.4 Dumping/Vandalism

"No Trespassing" and "No Dumping" signs have been placed along the Palmdale Ditch in areas where these activities have historically occurred. Despite best efforts, signs have been vandalized, removed, and ignored.

ES.7.5 NPDES Permittees

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. No NPDES permittees were identified in the watershed.

ES.7.6 Wildfire

The quality of water supplies can be dramatically affected by fire. The loss of ground surface cover and forest duff, such as needles and small branches, and the chemical transformation of soil caused by fire significantly increase the watershed's susceptibility to erosion.

All fires reported through the California Department of Forestry and Fire Protection's Fire and Resource Assessment Program which occurred in the watershed during the study period are summarized in Table ES-1.

Table ES-1: Significant Wildfires During the Study Period

Fire Name	Year	Area Within Watershed (acres)
Tovey	2012	68
Vincent	2012	7
Pleasant	2016	14

ES.7.7 Review of Spills

Hazardous waste spills pose a direct or potentially direct threat to water quality. The California Emergency Management Agency maintains and publishes a database of spill notifications. Four

spills were recorded in the vicinity of the watershed since 2012, all of which involved less than 75 gallons of material.

ES.7.8 Underground Storage Tanks

The California Regional Water Quality Control Board requires a permit to install any underground storage tank. Spills or leaks involving these tanks are required to be reported and remediated per Board recommendations. Two historical and one active incident involving storage tanks were identified in the watershed during the study period.

ES.7.9 Recreation

Recreational activities within a watershed can contribute to the degradation of water quality. Both body contact and non-body contact recreation on or near surface waters can lead to higher total and fecal coliforms. Waterside camping and picnicking can also lead to elevated coliform, *Giardia*, and *Cryptosporidium* counts. Negative water quality impacts due to recreation can be minimized with proper management and enforcement of rules and regulations.

ES.7.9.1 Lake Palmdale

The Fin and Feather Club has exclusive use of Lake Palmdale for recreational activities. Activities engaged in by the Club include:

- Boating
- Fishing
- Duck hunting
- Trap shooting

No body contact recreation is allowed. Hunting dogs are allowed at Lake Palmdale but must be kept on leash except when they are retrieving ducks from the Lake. Club rules do require members to pick up dog droppings while recreating at Lake Palmdale.

ES.7.9.2 Littlerock Reservoir

In order to prevent the importation of invasive species, private boating at Littlerock Reservoir was discontinued in 2009. The reservoir has been closed to the public since 2015 due to a few instances of mercury being detected in some fish populations. The source of the mercury is unknown. The reservoir will remain closed until the PWD and US Forest Service decide to reopen the facilities to the public. At a minimum, access will be restricted for approximately five months of each year for the LRSR dredging project, which is expected to last seven to twelve years.

ES.7.10 Animals

A horseback riding trail was observed in the vicinity of Palmdale Ditch, parallel to the Ditch with a limited number of crossings. In general, horses must be prohibited from entering a drinking water source.

Hunting dogs are allowed with restrictions at Lake Palmdale. Owners are required to properly dispose of their animals' feces. Waterfowl also regularly access Lake Palmdale, and their feces are a source of nutrient loading and microbiological contaminants in the Lake.

ES.7.11 Population and Development

The southern portion of the watershed is primarily forest; thus overall population numbers are low. The most densely populated area of the watershed is at the northernmost tip, which includes

a portion of the City of Palmdale. The Palmdale Water District's Strategic 2016 Water System Master Plan projected population growth within the District's service boundaries through 2035, using data from the Southern California Association of Governments. Although this service area does not coincide with the entire watershed, a large portion of the primary service area does overlap with the northern portion of the watershed. Population was projected to increase from 118,227 in 2015 to 157,300 by 2040. The economic downturn beginning 2008 significantly curtailed land development and, according to the PWD, development activities in the District have not returned to previous levels in recent years.

ES.7.12 Traffic

Four California State Highways carry the majority of traffic within the watershed; State Route 14, which connects greater Los Angeles to the rapidly developing Antelope Valley; State Route 2, along the southern edge of the watershed; State Route 138; and the Sierra Highway.

ES.7.13 Dumping

Plants, leaves, and branches are commonly found in the bar screens and trash racks in the upper extent of the watershed. Manmade debris is also regularly recovered at bar screens. A general description of debris other than natural flora recovered from the bar screens is as follows:

- Cardboard (boxes, containers);
- Wood (plywood, old doors, pallets);
- Plastic (bottles, trash bags, toys, kiddy pools, motor oil/antifreeze containers);
- Furniture (couches, cushions, mattresses, chairs, car seats);
- Miscellaneous (old carpet, tires, sleeping bag, golf bag, cans, bottles, plastic trash can);
- Dead animals (rabbits, squirrels, snakes, rats, dogs, cats, mice); and
- Dirty diapers (feces).

ES.8 Summary of Previous Sanitary Surveys

The initial Sanitary Survey of the Littlerock Reservoir and Lake Palmdale watershed was completed in June of 1993. The report provided a comprehensive summary of the watershed that has served as the basis for succeeding surveys conducted in 1997, 2002, 2007, and 2012. A review of key findings of these reports is provided in Section 5.0 of this Update.

ES.9 Water Quality Review

ES.9.1 Turbidity

From 2012 to 2017, raw water turbidity levels have remained relatively stable and in general have shown no clear long-term trend. Monthly averages have varied from less than 1 to just under 7 NTU.

ES.9.2 Total Coliform and E. coli

Total coliform counts are a measure of the concentration of bacteria in a water sample. Bacteria are usually present in raw water samples. Their presence alone is not cause for concern, but their sources should be identified and controlled if possible. Total coliform counts were greater than 500 most probable number (MPN) per 100 milliliters (mL) in 52 percent of the samples, and fecal coliforms exceeded 20 MPN/100mL in 35 percent of samples. This incidence rate is very similar to that for coliforms in the previous sample periods from 2003 to 2007 and from 2007 to 2012.

ES.9.3 Other Parameters

Historically, the pH in Lake Palmdale has been slightly basic with levels generally between 7.5 and 8.5. The yearly average has exceeded 8 every year since 2007, with the exception of partial data from 2017 (January through September).

The raw water alkalinity is moderate, and the Palmdale WTP adds chemicals to stabilize and treat the water.

Algal growth has historically been a water quality concern in Lake Palmdale. The District has taken steps to reduce algae production and the need for chemical treatment with copper sulfate. Lake Palmdale hosts several species of diatoms year-round. The District applies copper sulfate for algae control in Lake Palmdale 6 to 8 times per year.

ES.9.4 Regulatory Discussion

Section 7.0 contains a review of current and pending drinking water regulations pertaining to PWD's water treatment facilities were reviewed. In addition, the impacts of future regulations on these facilities were assessed. Section 7 of the 2012 Update contains this assessment.

ES.9.5 Regulatory Compliance

As required for SWTR compliance, Section 8.0 provides a discussion of the impacts of current, pending and future regulations on PWD.

ES.10 Management Activities Review

PWD actively promotes watershed protection in numerous ways, including education, regulatory review, and best management practices to reduce the potential for source water contamination. The District does not have direct regulatory or enforcement authority over its watershed but instead coordinates with other agencies to protect the watershed.

The District has taken an active role in protecting its sources of water supply from contamination and in preparing to deal with accidents should they occur. Management activities completed since the 2012 report are detailed in Section 9.0.

As part of their lease contract with the District, the Fin and Feather Club provides security for the Lake Palmdale premises including posting signs against trespassing. The Club maintains the premises using volunteers, community service workers, and other personnel as required. Maintenance activities include upkeep of facilities constructed and operated by the Club, reasonable trimming of trees and other landscaping, trash and litter collection, and the clearing of vegetation from the road.

ES.11 Source Protection Opportunities

A comprehensive source water protection program can prevent contaminants from entering the public water supply, reduce treatment costs, and increase public confidence in the quality, reliability and safety of its drinking water. Protection of the source to reduce the risk of contamination is an important element of a multi-barrier approach and helps increase public confidence in the water supply. The potentially contaminating activities of key concern to PWD's surface water supplies are recreation, illegal dumping, and open access to the Palmdale Ditch. Source Protection is discussed in detail in Section 10.0.

1.0 Introduction

1.1. Background

The 1986 Amendments to the Safe Drinking Water Act (SDWA) Surface Water Treatment Rule (SWTR) required watershed sanitary surveys and watershed management plans only for surface water suppliers qualifying for filtration avoidance. The State of California Title 22, Code of Regulations (CCR), Article 7, Section 64665, requires all water suppliers to conduct a sanitary survey of their surface water watersheds at least once every five years.

Palmdale Water District completed its first Sanitary Survey for Littlerock Reservoir and Lake Palmdale Watersheds in June of 1993. The report has since been updated four times: March 1997, June 2002, January 2008 (2007 Update), and December 2012. The current 2017 Update is an amendment to the 2012 report highlighting:

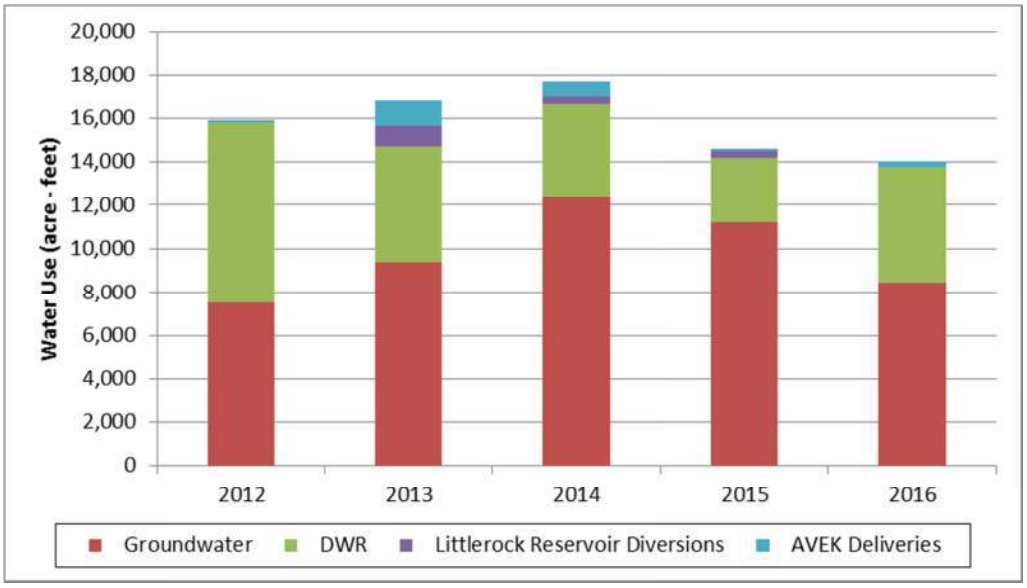
a) key changes that have occurred within the watersheds of Palmdale Water District's surface water supplies,
b) changes to water supply facilities,
c) potentially contaminating activities and incidents that have occurred over the past 5 years, and
d) water quality data from monitoring over the past 5 years.

1.2. Study Area

Palmdale Water District (PWD or the District) has three sources for water supply. The two most prominent water supply sources are groundwater from the Antelope Valley Groundwater Basin and imported water from the State Water Project (SWP). These sources account for 40 percent and 50 percent of PWD's annual water supplies, respectively. The third source of supply is seasonal from Littlerock Reservoir. Littlerock Reservoir's 65 square-mile watershed receives natural runoff from snow pack and rainfall in the Angeles National Forest located to the southeast of the City of Palmdale.

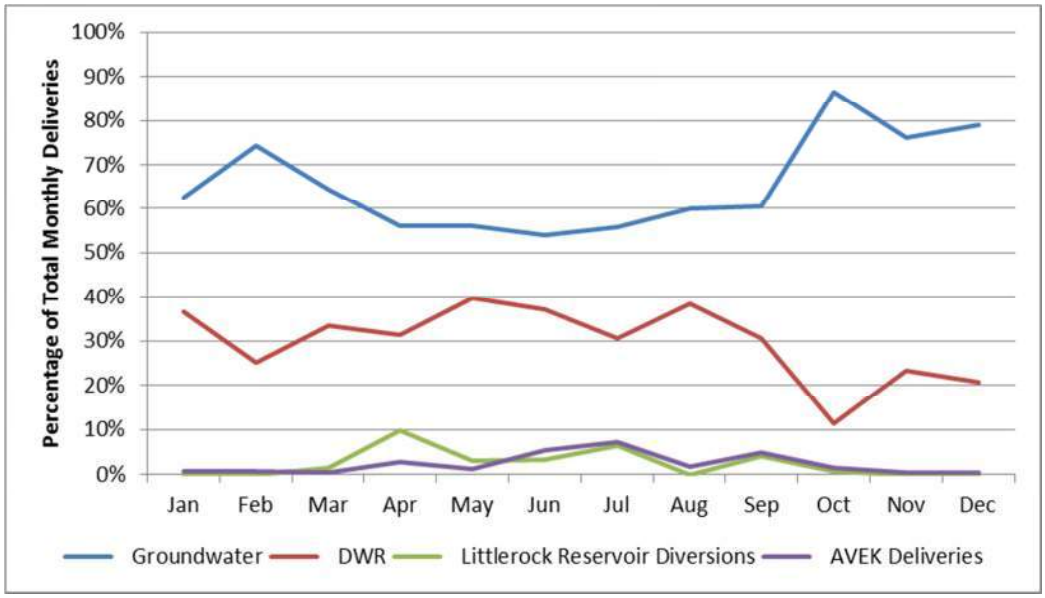
The water supplied to PWD from 2012 to 2016 is shown by source in Figure 1-1.

Figure 1-1: PWD Water Use by Source, 2012 – 2016 (PWD)



The average contribution from each of the major water supply sources as it varies over the year is shown in Figure 1-2.

Figure 1-2: Average Monthly Distribution of Water Deliveries by Source



This 2017 Sanitary Survey Update considers both the local surface water supplies (Littlerock Reservoir) and imported supplies from the PWD turnout on the California Aqueduct. SWP water is conveyed directly from the PWD turnout into Lake Palmdale, which feeds the Leslie O. Carter Water Treatment Plant (WTP). Flows from Littlerock Reservoir are also conveyed into Lake Palmdale via an eight-mile earthen lined canal, referred to as the Palmdale Ditch. The intake for the WTP is located along Lake Palmdale's north shore.

1.3. Project Objectives

The objective of this project is to update the PWD's Sanitary Survey in a manner consistent with the State SWTR. The primary goals of this project are:

- Update all potentially contaminating activities within the watershed,
- present water quality from the previous 5 years,
- review the implementation of management practices recommended in the previous report, and
- Determine additional management activities that may be undertaken to maintain and improve water quality.

1.4. Report Organization

This amendment addresses only changes that have occurred within the watershed over the past five years since the last Watershed Sanitary Survey and Source Water Assessment (2007, 2012). The consultant met with staff to collect data; survey the watershed, intakes and treatment facilities; and review pertinent data regarding water quality

The report is organized as follows:

Section	Description
1.0 Introduction	Introduces the project, describing its purpose and objectives, outlines the scope of the project and the use of results and includes a brief description of the watershed.
2.0 Delineation of Contributing Areas	Provides a detailed geographical description of the watershed. The geographical description addresses changes in land use, topography, vegetation, hydrology, and wildlife. This section compiles information from the maps developed for the project, information and data from existing reports, and the field surveys conducted for the project.
3.0 Water Supply Infrastructure	Provides a detailed description of reservoir, treatment plant and other water supply infrastructure improvements within the watershed.
4.0 Update of Potentially Contaminating Activities	Describes existing point and nonpoint sources of pollution in the watershed and includes an inventory of contaminants by potential source. The sources are evaluated in terms of source magnitude and proximity to sensitive resources such as drinking water intakes, recreational areas, and habitats.
5.0 Summary of Previous Watershed Studies	Summarizes the previous sanitary surveys and the California Department of Public Health (DDW) drinking water source assessment.
6.0 Water Quality Review	Presents an analysis of drinking water quality source trends at the WTP.
7.0 Regulatory Discussion	Summarizes current and pending drinking water quality regulations.
8.0 Discussion of Regulatory Compliance	Describes the required level of treatment based on a comparison of water quality trends and drinking water regulations.
9.0 Management Activities Review	Describes existing water quality protection practices in place in the watershed, including point and nonpoint source controls.
10.0 Source Protection Opportunities	Outlines recommended strategies for assessing and controlling point and nonpoint sources in the watershed.
11.0 Works Cited	Cites reports, documents and web resources used to compose the report.

This report and compilation of the data gathered is intended to supplement the 2012, 2008 and 2002 Watershed Sanitary Survey Updates and the 1997 and 1993 Sanitary Surveys. As such, it documents only the changes in the systems and water quality that have occurred during the past five years. For more detailed descriptions of the watersheds and pre-existing activities, the reader is referred to the 2012, 2007, 2002, 1997 and 1993 reports.

2.0 Delineation of Contribution Areas

2.1. Overview

This section discusses the location, topography, hydrology and land use activities within the watershed and provides detailed maps of the area.

2.2. Location and Extent

PWD is a public agency formed as an irrigation district under California Water Code that provides water service to the City of Palmdale. Their primary water supply source is from the State Water Project. A smaller secondary supply source is an approximately 90 square mile area, which includes the Littlerock Reservoir watershed and lateral inflows along Palmdale Ditch and the Lake Palmdale watershed. The conveying lands of this local supply source are predominately non-urban, with more than 90 percent lying within the Angeles National Forest or unincorporated portions of Los Angeles County. A portion of the Angeles National Forest was designated as the San Gabriel Mountains National Monument in 2014. The location and full extent of the watershed is depicted on Figure 2-1.

2.3. Topography and Hydrology

As shown on Figure 2-1, the watershed has an extensive network of tributaries; the primary tributaries that feed Littlerock Reservoir are Littlerock and Santiago Creeks. From Littlerock Reservoir the Palmdale Ditch flows to Lake Palmdale prior to treatment and distribution.

The terrain varies widely within the watershed from the San Gabriel Mountains at the southeastern edge to the Mojave Desert on the watershed's western edge. The elevation of the watershed similarly varies from over 8,000 feet to just over 2,800 feet at Lake Palmdale.

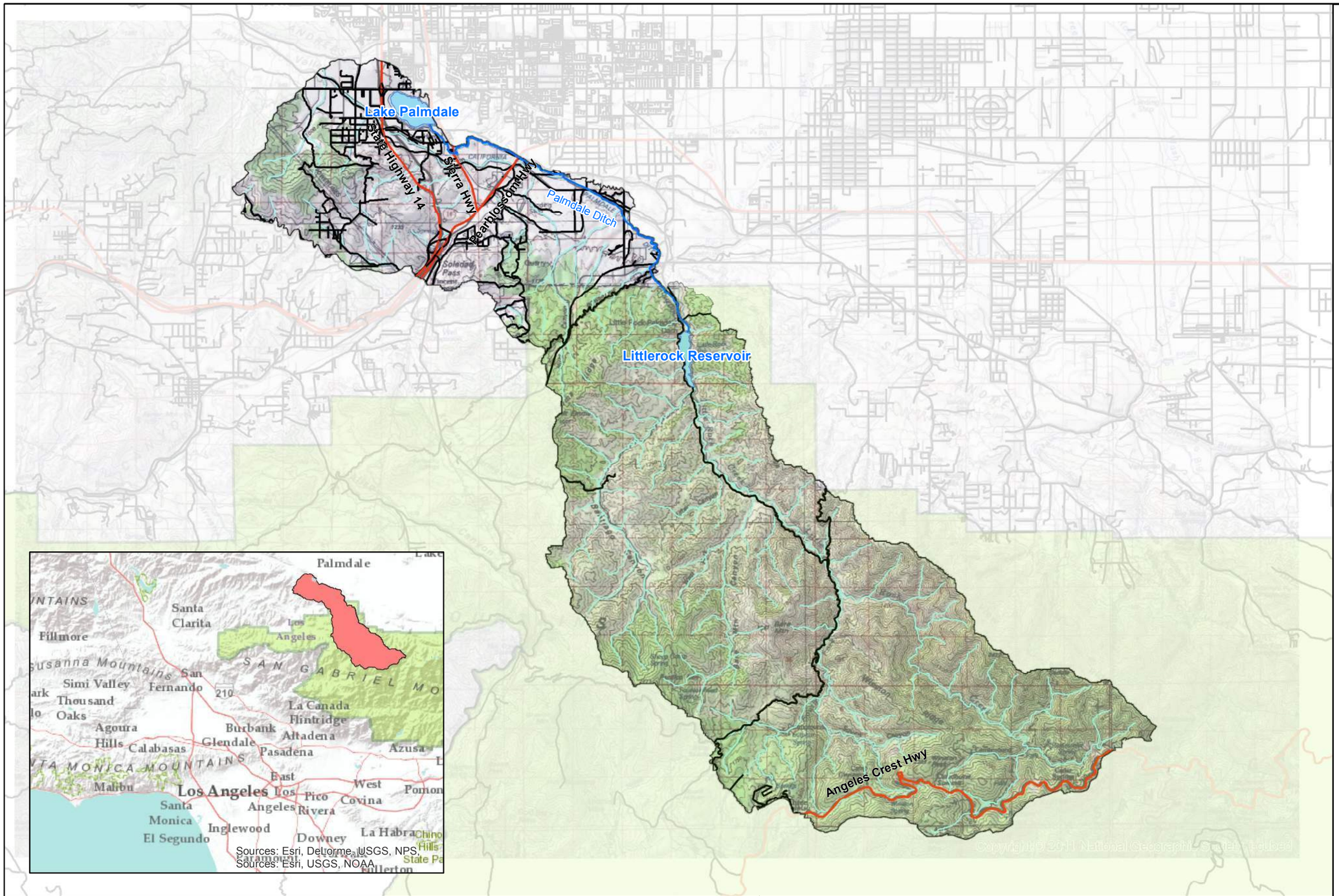
For the 2012 Update, the watershed boundary was expanded to include the entire length of the Palmdale Ditch. A review of the watershed boundary against the most recent National Elevation Dataset (NED) topographic data found no necessary changes to the 2012 watershed delineation.

2.4. Precipitation

Average annual precipitation rates vary widely in the watershed. The mountainous southern portion receives on average over 35 inches per year, while lower elevations near Palmdale receive as little as 5 inches annually. The majority of the watershed area receives about 20 inches of precipitation per year. Isohyetal precipitation zones are shown in Figure 2-2.

2.5. Land Use

In general, the risk of contamination to public water supplies is directly linked to land use and public access within the watershed. The majority of the land use in the watershed can be identified as native forest, vegetation or rural acreages and urban communities. Much of the native forest areas likely receive very little human impact outside of recreation areas controlled by the U.S. Forest Service (USFS). The National Forest and National Monument both allow hunting of deer and bear, but are subject to statewide ammunition laws that restrict the use of lead bullets. There has been little change in land use since the last update. Figure 2-3 indicates land use and land cover throughout the watershed.



LEGEND

- National Park Lands
- Lakes, Reservoirs
- Palmdale Ditch
- Highway
- Local Road
- Rivers, Streams

N
W E
S

Map Projection: Lambert Conformal Conic
Central Meridian: -118
Standard Parallel 1: 34
Standard Parallel 2: 35.47
False Easting: 656166.7
False Northing: 1640416.7

0 0.5 1 2
Miles

BLACK & VEATCH

Watershed Base Map

Palmdale Water District Watershed Sanitary Survey

FIGURE 2-1

LEGEND

PRISM Ave. Annual Precipitation 1981-2010

- 0 - 10"
- 10 - 20"
- 20 - 30"
- 30 - 40"
- 40 - 50"

N
W E
S

Map Projection: Lambert Conformal Conic
Central Meridian: -118
Standard Parallel 1: 34
Standard Parallel 2: 35.47
False Easting: 656166.7
False Northing: 1640416.7

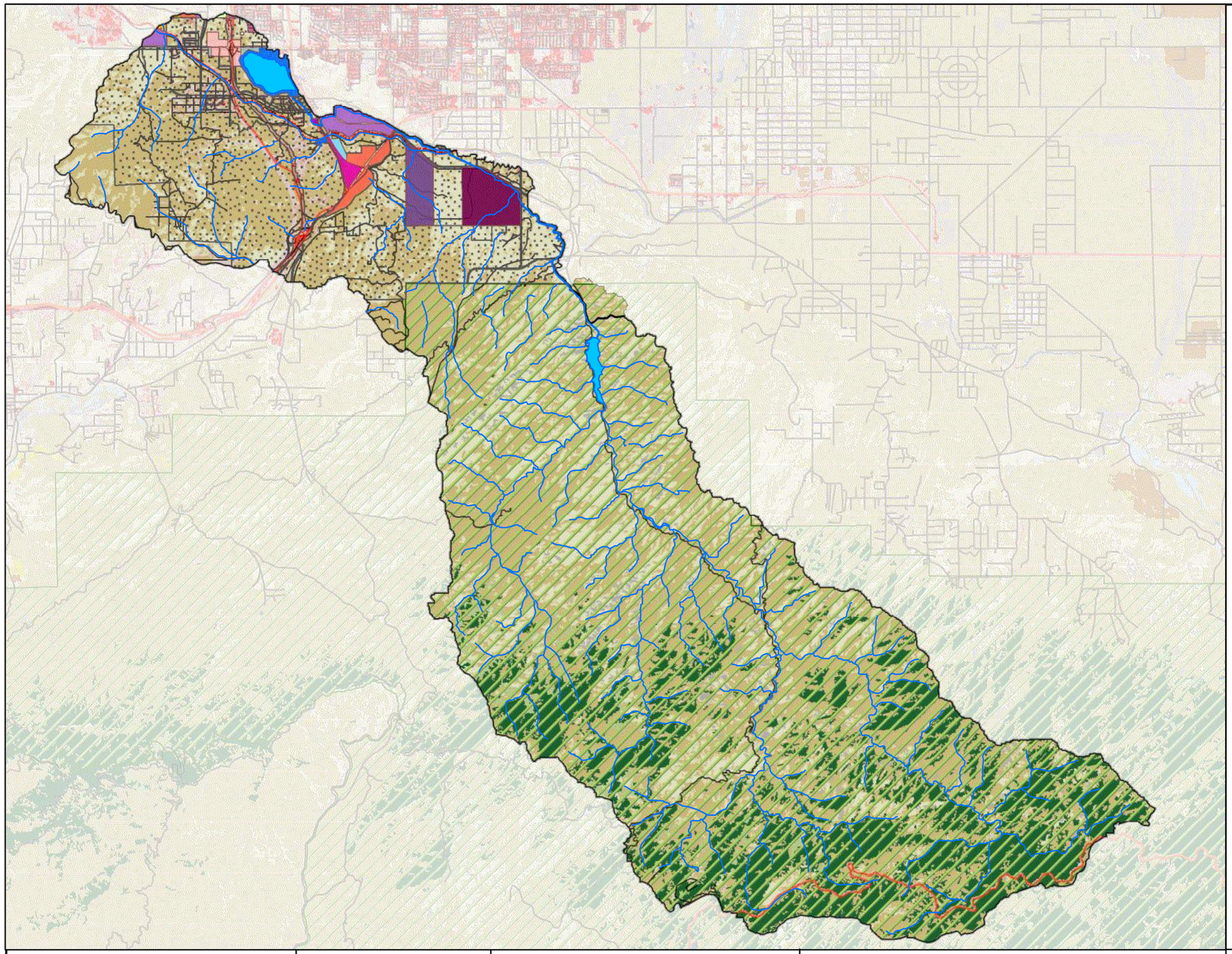
0 0.5 1 2
Miles

BLACK & VEATCH

Precipitation Map

Palmdale Water District Watershed Sanitary Survey

FIGURE 2-2



LEGEND

- Rivers, Streams
- Lakes, Reservoirs
- Watershed Boundary
- San Gabriel Mountains National Monument

National Landcover Database

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

Land Use

- Business Park (BP)
- Commercial Manufacturing (CM)
- Foothill Ranch Specific Plan (SP-17)
- Industrial (IND)
- Low Density Residential (LDR)
- Medium Residential (MR)
- Neighborhood Commercial (NC)
- Open Space (OS)
- Public Facility (PF)
- Public Facility-Basin (PF-B)
- Public Facility-Park and Ride (PF-P&R)
- Public Facility-Water Treatment (PF-W)
- Single Family Residential 1 (SFR-1)
- Single Family Residential 2 (SFR-2)
- Single Family Residential 3 (SFR-3)
- Special Development (SD)

N
W E
S

Map Projection: Lambert Conformal Conic
Central Meridian: -118
Standard Parallel 1: 34
Standard Parallel 2: 35.47
False Easting: 656166.7
False Northing: 1640416.7

0 0.5 1 2
Miles

BLACK & VEATCH

Land Use and Land Cover Map

FIGURE 2-3

Palmdale Water District
Watershed Sanitary Survey

3.0 Water Supply Infrastructure

3.1. Overview

Palmdale Water District's surface water supply system consists of five primary surface-water facilities. These include Littlerock Reservoir, Palmdale Ditch, PWD's California Aqueduct Turnout, Lake Palmdale and Leslie O. Carter Water Treatment Plant (WTP). Littlerock Reservoir and Lake Palmdale are water supply and storage reservoirs within the watershed. Water is conveyed to Lake Palmdale from Littlerock Reservoir via the Palmdale Ditch. Lake Palmdale also receives State Water Project water via PWD's turnout on the California Aqueduct, which runs just south of Lake Palmdale.

3.2. Littlerock Reservoir and Dam

The Littlerock Dam and Reservoir are located on Littlerock Creek below the confluence of Santiago Canyon in the Angeles National Forest (ANF). The Palmdale Water District (PWD) operates the Littlerock Reservoir as a local surface water impoundment, and water is conveyed from the reservoir to Lake Palmdale. Inflow into the Reservoir is seasonal and varies widely depending on stream flows and snowmelt within the watershed. Approximately 10 percent of PWD's raw water supply comes from Littlerock Reservoir.

The Reservoir was constructed in 1924 with an initial design capacity of 4,300 acre-feet. By 1991, the capacity of the Reservoir had been reduced by siltation to approximately 1,600 acre-feet. The 1992 Littlerock Dam and Reservoir Restoration Project raised the height of the Dam and recovered approximately 1,723 acre-feet of storage capacity.

PWD is pursuing the Littlerock Reservoir Sediment Removal (LRSR) Project in partnership with Angeles National Forest, USDA Forest Service. LRSR is in the regulatory permitting process at the time of writing. Given approval, LRSR will remove over one million cubic yards of sediment over the initial seven to twelve years in order to restore the Reservoir to the 1992 design storage capacity, and will continue to remove an estimated 38,000 cubic yards of sediment annually to maintain capacity.

Figure 3-1: Littlerock Reservoir

A subterranean grade-control device will be installed within the reservoir prior to dredging activities. The structure will include soil cement bed and banks protection made from natural sand materials from the reservoir bed. The soil cement structure and banks protection will span approximately 250

Figure 3-2: Littlerock Dam

to 476 feet of channel, bank to bank, anchored up to 35 feet underground.

Construction activities associated with the grade-control device are expected to last approximately 20 weeks. A temporary coffer dam will be constructed to collect runoff from precipitation events during construction, and dewatering wells will be installed above and below the excavation perimeter. The disturbed area is estimated at 3.5 acres.

Sediment removal is anticipated to last approximately 60 days each year, between September and mid- to late November, and will require restricted access to the reservoir each year. Sediment removal will be suspended at the onset of the seasonal refill of the reservoir, which typically begins between mid-November and January.

The Environmental Impact Report/Environmental Impact Statement (developed together) for this project states that, based on sampling and observations, there are no native fish species supported by the Littlerock Reservoir. Additionally, in 2014 the Lahontan Regional Water Quality Control Board found fish within the reservoir to be contaminated with mercury, and have been designated by the California Office of Environmental Health Hazard Assessment as unsafe for consumption. The Environmental Impact Report (2017) prepared for the LRSR reported on additional testing which confirmed the presence of mercury in fish tissues.

The Little Rock Creek upstream of the Reservoir provides habitat for the federally-endangered arroyo toad (*Anaxyrus californicus*). Sediment removal operations have been designed to minimize adverse impacts on the arroyo toad's habitat and the possibility of a "take," but some risk remains. When the sediment removal activities begin, water will be diverted from the reservoir and the non-native fish will be stranded and disposed of under the supervision of a qualified biologist. Any native reptiles and amphibians will be relocated upstream.

Figure 3-3: Palmdale Ditch

3.3. Palmdale Ditch

Palmdale Ditch is a gravity-flow, primarily earthen canal which conveys water from Littlerock Reservoir to Lake Palmdale (Figure 2-1). During periods when water is being transferred water flows through the 8-mile long Ditch from the Littlerock Dam valve house via two velocity breaking cone valves into the southeast end of Lake Palmdale. The maximum practical flow rate through the Ditch is approximately

25 cubic feet per second (cfs).

Flow loss due to flow infiltration/seepage along the base of the unlined canal occurs along much of the canal's 8 miles from Littlerock Dam to Lake Palmdale. Additionally, portions of Palmdale Ditch are below grade and do receive stormwater runoff from adjacent lands. The flow is measured by two parshall flumes; one located just off Cheseboro Rd. approximately 1/4 mile north of Littlerock Dam and the second located at the lower end of the Ditch as it enters Lake Palmdale. The two flumes can be used to evaluate the Ditch system: higher than expected flow could indicate possible runoff intrusion, and lower than expected flows could indicate a breach in the Ditch banks.

Two YSI Water Quality Probes have been installed in Palmdale Ditch which transmit data via SCADA back to the treatment plant. The probes are used to monitor for any significant changes in water quality as the water flows through the Ditch. This enables PWD to react to changes in raw water quality and identify contaminants which may be introduced to the system along the Palmdale Ditch.

In 2009 approximately one mile of the Palmdale Ditch at its downstream-most end was replaced by a buried 48-inch-diameter Reinforced Concrete Pipe (RCP). The buried pipe was placed within the bed of the existing Ditch and discharges directly into Lake Palmdale. The enclosure of this section of the canal, which was previously endemic with dumping, has significantly reduced the presence of garbage in the canal.

Figure 3-4: Palmdale Ditch & Bar Screen

Each Season prior to running water through the Ditch the entire Ditch is walked and cleared of all debris. When the water flow is started a crew walks the Ditch again clearing debris from the bar screens as the flow reaches the individual screens. After the flow has begun the Ditch is checked twice daily on weekdays and weekends (morning and afternoon) by District personnel.

3.4. California Aqueduct Turnout

PWD receives nearly 50 percent of its raw water supplies from the State Water Project via their turnout in the California Aqueduct. The aqueduct runs just to the south of Lake Palmdale.

Palmdale Water District has an arrangement with the local water wholesaler, Antelope Valley East Kern (AVEK) Water Agency that began in 2012. PWD treats between 500 and 1,000 acre-feet per year of AVEK's SWP water for AVEK's use. AVEK's SWP water is conveyed from AVEK's turnout on the California Aqueduct into Lake Palmdale via the Palmdale Ditch.

3.5. Lake Palmdale

Lake Palmdale is a raw water reservoir that supplies the adjacent Leslie O. Carter Water Treatment Plant. The Lake supports boating, fishing, and hunting, managed by the Fin and Feather Club, but it is designated as a 'no body contact' water body. A diversion ditch protects Lake Palmdale from local runoff. Firefighting aircraft tankers are allowed to draw water from the Lake. Lake Palmdale's surface area is 234 acres, maximum depth is 25 ft., average depth is about 18 ft., and the volume is 4,200 acre-feet.

As a result of the presence/operation of Solar Bees installed in 2002, water clarity has improved significantly and the need to add copper sulfate has decreased. However, the improved water clarity has led to an increased presence of submerged weeds such as milfoil, the proliferation of which has been difficult to control.

Figure 3-5: Lake Palmdale

3.6. Leslie O. Carter Water Treatment Plant

The Leslie O. Carter WTP was originally commissioned in 1987 to process 12 MGD. The plant was expanded in 1991 to increase the rated capacity from 12 to 30 MGD.

Beginning in 2009, PWD implemented a two-phased program to upgrade and improve efficiencies to their water treatment plant. Phase I included installation of a Carbon Dioxide (CO_2) storage and feed system, and addition of inclined plate settlers to the sedimentation basins.

Phase II improvements included the addition of two filters, bringing the total number of filters to twelve and increasing the total filter surface area from 3,445 ft2 to 4,134 ft^2. Additionally, the original filter media was upgraded to 36 inches of anthracite coal with an effective size of 1.0 mm and 12 inches of silica sand with an effective size of 0.60 mm, increasing the L/d ratio (the ratio of the bed depth, L, to the average filter grain affective diameter, d), from 800 up to 1,422. Eight constant level Granular Activated Carbon (GAC) contactors with influent flow splitting weirs were added. Each contactor has a surface area of 880 ft^2 with a total GAC contactor surface area of 7,040 ft^2. Five new concrete lined, rectangular sludge lagoons were constructed. The surface area of each of the new lagoons is 42,000 ft^2 with a total new lagoon surface area of 210,000 ft^2.

As a result of the program, the WTPs nominal capacity increased to 35 Million Gallons per Day (MGD), a gain of 5 MGD. A detailed discussion of upgrades is included in the 2012 PWD Sanitary Survey.

The raw water intake for PWD's Leslie O. Carter Water Treatment Plant (WTP) is located along Lake Palmdale's north shore. The specific location is: 34.56N, 118.12 W.

In the two year dry period between 2015 and 2016, PWD added a 2% solution of Potassium Permanganate at the Lake outlet structure with a target dosage of 0.80 mg/l - 1.0 mg/l for algae control and enhanced coagulation as follows: 06/25/2015 through 10/29/2015, and 08/10/2016 through 11/19/2016.

4.0 Update of Potentially Contaminating Activities

4.1. Overview

This section presents the results of an inventory of potentially contaminating activities for the watershed. Inventory methods are described, and any relevant findings from the site visit are included. Changes to Potential Contaminating Activities (PCAs) within the watershed and the existing conditions of the area are also summarized.

4.2. Inventory Methods

An essential element of the drinking water source assessment and protection program is an inventory of PCAs. PCAs are any activities, facilities or land uses that can be origins of significant contamination in delineated source protection areas.

An inventory of PCAs serves the following functions:

- Identifies past and present activities that may pose a threat to the drinking water supplies based on their potential to cause significant contamination of groundwater and surface waters.
- Provides information on the locations of PCAs that present the greatest risks to the water supply.

PCAs were inventoried and assigned a risk ranking based on the same criteria as the California Drinking Water Source Assessment and Protection Program (DWSAP). The risk rankings of activities are based on Environmental Protection Agency (EPA)- and California-specific historic information on releases of contaminants, and potential contaminant characteristics. The potential risk rankings are assigned based on an assumption that the facilities or activities do not employ best management practices (BMPs) or pollution prevention measures.

PWD staff survey the Palmdale Ditch twice daily when the Ditch is operating as a supply and two times per week during the off-season. Lake Palmdale is observed almost daily, due to the proximity of the Lake to the water treatment plant. Site survey work is conducted several times a year by District staff to identify specific potential contamination problems at specific sites. During the off-season (September to February), maintenance activities are performed by PWD staff twice each year at the Palmdale Ditch. BMPs and more site-specific potential problems can be identified and corrected in the process of developing protection plans and thereby help reduce the risk ranking of a facility or activity.

Contact was made with agencies responsible for operating or regulating facilities in the watershed either directly or through their websites. The Los Angeles Regional Water Quality Control Board (RWQCB), the US Department of Agriculture's (USDA) Forest Service and Los Angeles County were contacted for information. State databases of spills, fires, and other PCAs were reviewed. General conditions were then assessed by reconnaissance on foot and by car. The field assessment allowed for data validation and offered insights into large scale activities affecting source water quality.

4.3. Summary of Watershed Activities and Changes

This section reviews and discusses any changes that have occurred in the watershed since the previous Sanitary Survey Update. Changes within a watershed relate to many items. Examples include population growth, new/expanded industrial areas, wildfires, recreational activities and chemical spills/leaks.

4.3.1. NPDES Permit and Waste Discharge Requirement Holders

As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters (EPA, 2003). Construction sites which disturb more than one acre of soil must apply for coverage under California's National Pollutant Discharge Elimination System (NPDES) Construction General Permit. Point sources that discharge pollutants onto land are governed by Waste Discharge Requirements (WDRs).

No NPDES permittees were identified within the watershed. One WDR site with an active permit, Kinneloa Mesa Homes, was identified. However, no details on what activity necessitated the permit were given in the permit tracking system.

4.3.2. Wildfire

The quantity and quality of water supplies can be dramatically affected by fire. The loss of ground surface cover and forest duff, such as needles and small branches, and the chemical transformation of soil caused by fire increase the watershed's susceptibility to erosion. The increased rate of movement of soil, ash, and nutrients into waterways following a fire can result in significant increases in turbidity and total dissolved solids in raw water supplies.

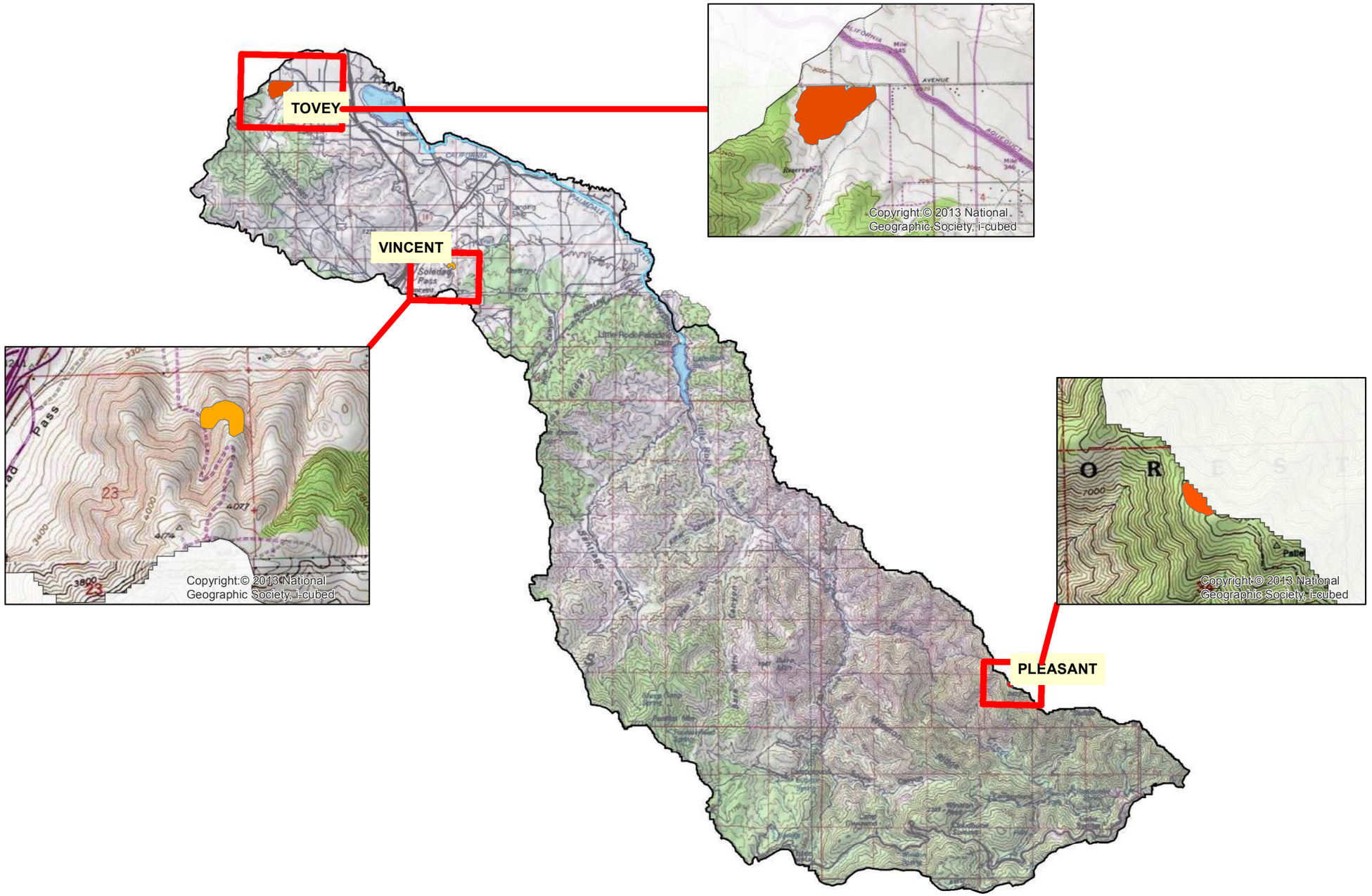
Water yields may also be impacted. Recent fires can change a watershed's response to precipitation. Peak runoff volumes may occur more quickly and be greater in magnitude than in the watershed undisturbed by fire. Future overall yields may also be lower. At moderately high altitudes, this can occur because the rate of snowmelt is accelerated due to the removal or reduction of shade. Water may be released too rapidly to be stored in the soil or captured in reservoirs.

In a large, forested watershed, as found in parts of the study area, fire activity must be closely monitored and documented to predict future water quality and supply issues. BMPs include the thinning of dense forest stands, removal of highly flammable underbrush, and the use of carefully controlled burns to prevent excessive accumulations of fuel.

Fire perimeter data developed as part of the California Fire Plan the Fire and Resource Assessment Program (FRAP) are shown on Figure 4-1, and all fires reported by FRAP in the watershed during the study period are summarized in Table 4-1. The data are from a variety of sources including the California Department of Forestry, the US Department of Agriculture Forest Service Region 5 Remote Sensing Lab, the Bureau of Land Management (BLM), and the National Park Service (NPS).

Table 4-1: Significant Wildfires During the Study Period

Fire Name	Year	Area Within Watershed (acres)
Tovey	2012	68
Vincent	2012	7
Pleasant	2016	14



LEGEND

Fires (2012-2017)

- Pleasant
- Tovey
- Vincent

N
W E
S

Map Projection: Lambert Conformal Conic
Central Meridian: -118
Standard Parallel 1: 34
Standard Parallel 2: 35.47
False Easting: 656166.7
False Northing: 1640416.7

0 0.5 1 2
Miles

BLACK & VEATCH

Fire Perimeters

Palmdale Water District Watershed Sanitary Survey

FIGURE 4-1

4.3.3. Review of Spills

Hazardous waste spills pose a direct or potentially direct threat to water quality. The California Emergency Management Agency (Cal EMA) maintains and publishes a database of spill notifications. Table 5-2 summarizes details on spills reported to Cal EMA within the watershed since 2012. Not all spill incidents contain precise location information, complicating placement within the watershed. However, selected records are in close proximity to the watershed and representative of spills reported in the database.

Table 4-2: Summary of Hazardous Spill Reports

Spill Control Number	Notification Date	Substance	Amount	Comments	Water Involved
12-1587	3/17/2012	Non-PCB Mineral Oil	4 gallons	A pole-topped transformer was knocked down which resulted in the release of substance to a parking lot, then into a storm drain.	Yes
13-1905	3/29/2013	Sewage Water	60 gallons	Release occurred due to tank flow.	No
14-7390	12/24/2014	Unleaded Gasoline	4-5 gallons	Fuel spilled at a service station.	No
17-0049	1/4/2017	Non-PCB Mineral Oil	1 gallon	Transformer failed and released the substance to the ground.	No

4.3.4. UST, LUST, and SLIC Sites

Underground storage tanks (UST), leaking underground storage tanks (LUST), and other spills, leaks, investigations, and cleanup (SLIC) sites all pose a threat to water quality. Gasoline and chemical spills are typically of greatest concern for groundwater quality; however, runoff and groundwater plumes from contaminated sites can also impact surface waters. Precipitation may wash spills into drainage ways feeding larger streams, rivers, and lakes. Moreover, contaminated groundwater plumes may re-emerge from the subsurface, contaminating surface waters.

Table 4-3 presents a list of the past and current sites from California's GeoTracker database as of November, 2017, which contains information about permitted facilities and cleanup sites.

Table 4-3: LUST Site Details

Site ID	Business Name	Status	Status Date	Contaminants Of Concern	Potential Media Affected
T0603760955	JASONS AUTO PARTS	Completed - Case Closed	9/21/2010	Tetrachloroethylene (PCE), Waste Oil / Motor / Hydraulic / Lubricating	Under Investigation
T0603700082	KRATKA RIDGE SKI AREA	Open - Site Assessment	12/16/1992	Other Solvent or Non-Petroleum Hydrocarbon	Soil
T0603700286	JILL R RATCLIFFE	Completed - Case Closed	11/21/1991	Gasoline	Soil

4.3.5. Recreation

Recreational activities within a watershed can contribute to the degradation of water quality within that watershed. Both body contact and non-body contact recreation on or near surface waters can lead to higher total and fecal coliforms. Waterside camping and picnicking can also lead to elevated coliform, *Giardia*, and *Cryptosporidium* counts, even if proper restroom facilities are provided. Negative water quality impacts due to recreation can be minimized with proper management and enforcement of rules and regulations.

4.3.5.1. Littlerock Reservoir

In order to prevent the importation of invasive species, private boating at Littlerock Reservoir was discontinued in 2009.

In 2011, the United States Forest Service (USFS) issued a permit to a concessionaire to track visitor counts at Littlerock Reservoir. 147,800 day use visitors were recorded in 2011. Public access to Littlerock Reservoir has been prohibited since 2015 due to detection of mercury in some fish populations. The source of the mercury is unknown.. The reservoir may be reopened when the PWD and USFS feel these issues have been mitigated. However, the LRSR dredging project will require closure of the reservoir for approximately 60 days each fall for the next seven to 12 years.

In October of 2014 the San Gabriel Mountains National Monument was created. The extent of the monument and the Angeles National Forest are shown in Figure 2-1. No significant changes to watershed management have resulted from the creation of the National Monument.

4.3.5.2. Lake Palmdale

The Fin and Feather Club has exclusive use of Lake Palmdale for recreational activities. Activities engaged in by the Club include:

- Boating
- Fishing
- Duck hunting
- Trap shooting

Recreational use of Lake Palmdale is seasonal, with duck hunting from October through January and fishing February through September. The Club's activities occur predominantly along the Lake's south shore, as this is where most of the docks and all of the duck blinds are sited. The south shore is approximately 2,700 to 2,800 feet from PWD's headworks.

Fin and Feather staff inform members that only steel ammunition is allowed, and that the use of lead ammunition is prohibited. Hunting dogs are allowed at Lake Palmdale but must be kept on leash except when they are retrieving ducks from the Lake. Club rules do require members to pick up dog droppings while recreating at Lake Palmdale. As of 2017, the Fin and Feather Club has approximately 1,750 members. The number of annual visitors to Lake Palmdale has been estimated previously at 4,860.

In addition to maintaining their recreational facilities at Lake Palmdale, the Club's on site caretaker also provides some site security and actively maintains the lands around Lake Palmdale by trimming trees and bushes and collecting windblown trash and debris. A diversion ditch reduces local runoff into Lake Palmdale. The Club has instituted "no activity" zones between the

buoys and the dam on the east side of the Lake and has fenced and buoyed off areas near the WTP intake structure, with is located on the north shore.

In 2009, the PWD and the Club instituted a program to prevent the importation of invasive species to Lake Palmdale from private boats. Boats must be cleaned, drained, dried, inspected, and quarantined before being allowed on the Lake.

4.3.6. Animals

4.3.6.1. Horses

A horseback riding trail was observed in the vicinity of Palmdale Ditch, parallel to the Ditch with a limited number of crossings. In general, horses must be prohibited from entering a drinking water source. Potential BMPs include prohibiting trails that are set back less than 100 feet from the high water line, requiring the owner of each pet to retrieve fecal matter and properly dispose of it in sanitary facilities, and signage for trails that prohibits horses in the Ditch.

4.3.6.2. Dogs and Service Animals

As indicated, hunting dogs are allowed at Lake Palmdale and are allowed to swim in the Lake to retrieve waterfowl. The Fin and Feather Club does have policies in place which require the dogs to otherwise be on leash and requires dog owners to retrieve and dispose of their animals' fecal matter.

4.3.6.3. Wildlife

Waterfowl regularly access Lake Palmdale. The feces of ducks and geese that frequent Lake Palmdale are a source of nutrient loading to the Lake. The Angeles National Forest and San Gabriel Mountain National Monument are home to deer and bears, which may impact the upper portions of the watershed. Hunting is permitted in season, but is subject to statewide ammunition laws restricting the use of lead bullets.

4.3.7. Population and Development

The upstream portion of the watershed is primarily forest; thus overall population numbers are low. The most densely populated area of the watershed is at the northernmost tip, which includes a portion of the City of Palmdale. The Palmdale Water District 2016 Water System Master Plan projected population growth within the District's service boundaries through 2040, using data from the Southern California Association of Governments.

These projections are provided in Table 4-4. Although the service area does not coincide with the entire watershed, a large portion of the primary service area does overlap with the northern portion of the watershed, and the rate of growth is considered representative of the watershed.

Table 4-4: Palmdale Water District Service Area Population Projections

Year	2015	2020	2025	2030	2035	2040
Service Area Population	118,227	131,200	137,700	144,300	150,800	157,300

4.3.8. Traffic

Vehicles, both in water and on land, introduce many potential pollutants to a watershed. Brake dust and particles produced by tire wear accumulate on roadways and are carried to water bodies by stormwater runoff. Accidental spills and leaks of automotive fluids like gasoline, oil, and antifreeze may also find their way into water bodies and degrade water quality. The majority of hazardous material spills noted in Section 4.3.3 are associated with vehicular collisions. It is important to maintain an assessment of the traffic and driving conditions of any watershed and continually check for problem areas.

Four California State Highways carry the majority of traffic within the watershed; State Route 14, which connects greater Los Angeles to the rapidly developing Antelope Valley; State Route 2, along the southern edge of the watershed; State Route 138; and the Sierra Highway.

Records from the Hazardous Materials Incident Reporting System, maintained by the Bureau of Transportation Statistics, were reviewed to enumerate hazardous material spills on these highways. While some of the records do not contain enough information to determine whether spills occur within the watershed boundary, there were four hazardous material incidents reported in the vicinity of Palmdale since 2012.

4.3.9. Dumping

In the upper extents of the watershed plants, leaves and branches are commonly found in the bar screens and trash racks. However, manmade debris is also regularly recovered at bar screens. A general description of debris other than natural flora recovered from the bar screens is as follows:

- Cardboard (boxes, containers, etc);
- Wood (plywood, old doors, pallets, etc);
- Plastic (bottles, trash bags, toys, kiddy pools, motor oil/antifreeze containers, etc);
- Household furniture (couches, couch cushions, mattresses, pillows, reclining chairs, car seats, etc);
- Miscellaneous (old carpet, tires, sleeping bag, golf bag, cans, bottles, plastic trash can, etc);
- Dead animals (rabbits, squirrels, snakes, rats, dogs, cats, mice, etc);
- Dirty diapers (feces).

Figure 4-2: 'No Littering' Signage

PWD staff surveys and cleans-out the Ditch twice per year: at the end of the water year (September), and in February during the off-season. The District maintains documentation of findings on types of debris found during Ditch surveys.

5.0 Summary of Previous Watershed Studies

5.1. Overview

The first Sanitary Survey for Littlerock Reservoir and Lake Palmdale Watershed was completed in June of 1993. The Report provided a comprehensive summary of the watershed and has served as the basis for subsequent surveys prepared in 1997, 2002, 2007, and 2012.

5.2. Watershed Description

The Palmdale Water District uses water stored in Littlerock Reservoir as a local surface water supply. In addition to available water in Littlerock Reservoir, PWD also receives some stormwater runoff from lands adjacent to the Palmdale Ditch and Lake Palmdale although a diversion ditch is intended to limit local runoff into Lake Palmdale.

The watershed of this local surface water supply covers approximately 93 square miles and is located in North Los Angeles County on the northeastern foothills of the San Gabriel Mountains and the western edge of the Mojave Desert between the seismically active San Andreas and Garlock fault zones. Running roughly from southeast to northwest in direction, its overall length is 20 miles and width varies from 2.5 miles to about 6 miles. The majority of the watershed lies in either the Angeles National Forest or unincorporated portions of Los Angeles County.

The watershed extends into the San Gabriel Mountains southeast of the City of Palmdale with elevations at around 8,000 ft., while Littlerock Reservoir is at an elevation of 3,200 ft. From Littlerock Reservoir, Palmdale Ditch flows generally northwest for approximately 8 miles to Lake Palmdale which is at an elevation just over 2,800 ft.

The sub-basin to Littlerock Dam and Reservoir covers approximately 64 square miles, while the Palmdale Ditch to Lake Palmdale sub-basin covers 29 square miles. The water area of Littlerock Reservoir and Lake Palmdale combined covers only about 0.5 square miles.

5.3. Summary of Watershed Activities

The erosion potential of soils upstream of Littlerock Dam is rated as either high or very high. Increased turbidity due to erosion could degrade the District's water quality.

Previous reports have highlighted the following potentially contaminating activities (PCAs) that could result in surface water contamination by human enteric viruses and turbidity include:

- Recreational use along the Angeles Forest highway
- Stormwater runoff from Mt. Emma Road and an undeveloped area near the California Aqueduct entering the Palmdale Ditch
- Septic tank systems on the south side of Lake Palmdale
- Limited recreational access to Lake Palmdale by the Palmdale Fin & Feather Club
- Fires within the watershed
- Trash and debris dumped into the Palmdale ditch near the intersection of Barrel Springs Road and the Sierra Highway.

Recreational use in and around Littlerock Reservoir has been a PCA in previous reports, but recreational access has not been allowed and will not be allowed during the LRSR dredging project, which is expected to last between seven and twelve years.

Previous reports pay special attention to the contamination potential from natural disasters and transportation corridors. The reports indicate that the San Andreas Fault, flooding, railroads and highways, including the Antelope Valley Freeway (State Route 14), the Sierra Highway, and the Pearblossom Highway, are significant contamination risks.

Previous reports also noted that no waterborne disease outbreaks are known to have occurred that could be attributed to the Palmdale water supply system.

The 2007 and 2012 reports included a vulnerability assessment to activities within the watershed.

Activities at the top of the District's Vulnerability Ranking included: illegal activities, such as unauthorized dumping; recreation; highways; railroads; and sewer collection systems. Due to the enclosure of the last mile of the Palmdale Ditch, illegal dumping has been reduced and generally poses less of a risk to PWD's water quality.

The 2002 Report identified several changes in Activities and characteristics, which are still relevant today. These are:

- Recreation - In February 2001 the United States Fish and Wildlife Service designated 182,000 acres of Central and Southern California Streams as critical habitat for the endangered Arroyo Toad. The protected area includes approximately 9.5 km (5.9 mi.) of Littlerock Creek and adjacent uplands from the South Fork confluence downstream to the upper end of Littlerock Reservoir (in the vicinity of Rocky Point Picnic Ground and approximately 1.8 km (1.1 mi.) of Santiago Creek and adjacent uplands upstream from the confluence with Littlerock Reservoir. The total area of the closed area is approximately 600 ha (1,480 ac). The area was deemed essential to the toad because it supports a unique, isolated population on the periphery of the species range (50 CFR Part 17). In general, the impacts of the closure will be positive for the District's raw water quality.
- Recreation - The entire Littlerock Canyon area was converted to a day-use area only in response to vandalism.
- Transportation corridors - There were five potentially hazardous materials spills in the watershed associated with transportation corridors between 2008 and 2012.
- Illegal dumping of debris continues in the watershed.
- Maintenance - The District used the following chemicals to reduce weeds and algae in the Ditch and Lake: Rodeo, Copper Sulfate, Cutrine Plus and Potassium Permanganate.
- Stormwater drainage is not allowed to enter Lake Palmdale. Water is diverted around the Lake in a canal installed to protect source water quality.

5.4. Vulnerability Analysis

The vulnerability analysis conducted during 2012 was reviewed. The most significant changes for water quality in the watershed since the previous update are the enclosure of the last mile of the Palmdale Ditch, an area which was endemic to illegal dumping, and the closure of Littlerock Reservoir to recreation use. The current closure is due to water quality issues, and the recreation area may be reopened when the PWD and USFS determine the issues have been resolved. However, the LRSR dredging project will necessitate closure of the reservoir for approximately 60 days each fall for seven to twelve years.

Table 5-1 presents an updated vulnerability analysis. The table applies a matrix approach to estimate the vulnerability of the watershed and water supply facilities to each source of PCAs, based on the impact of the PCAs, their location relative to intakes, and physical barriers in place to reduce contamination.

Although PWD's surface water supplies are now less vulnerable to body contact recreation and illegal dumping in the Palmdale Ditch, there is still the potential for illegal activities/unauthorized dumping at Lake Palmdale and at further upstream reaches of the Palmdale Ditch. For this reason, the PCA "Illegal activities/unauthorized dumping" in Zone A remains high on the vulnerability list.

Table 5-1: Vulnerability Summary Table

Zone	Type of PCA	PCA Points VH = 7 H = 5 M = 3 L = 1	Zone Points* *A = 5, B = 3, Watershed = 1* Unknown = 0	PBE Points* L= 5 M = 3 H = 1	Vulnerability Score PCA points + Zone points + PBE points
A	Illegal activities/unauthorized dumping	5	5	5	15
A	Housing – high density (>1 house/0.5 acres)	3	5	5	13
B	Illegal activities/ unauthorized dumping	5	3	5	13
B	Recent (< 10 years) Burn Areas	5	3	5	13
A	Parking lots/malls (>50 spaces)	3	5	3	11
A	Campgrounds and Recreational areas	3	5	3	11
B	Freeways/state highways	3	3	5	11
B	Mining - Sand/Gravel	5	3	3	11
B	Railroads	3	3	5	11
B	Campgrounds and Recreational areas	3	3	5	11
B	Sewer collection system	5	3	3	11
Watershed	Illegal activities/ unauthorized dumping	5	1	5	11
Watershed	Recent (< 10 years) Burn Areas	5	1	5	11
Watershed	Campgrounds and Recreational areas	4	1	5	10
B	Parking lots/malls (>50 spaces)	3	3	3	9
Watershed	Mining - Sand/Gravel	5	1	3	9

PCA Points: VH = Very High, H = High, M = Medium, L = Low.
Zone Points: Zone A = 400 feet from reservoir banks or intakes; Zone B = 2,500 feet from reservoir banks or intakes.
Physical Barrier Effectiveness (PBE): H = High, M = Medium, L = Low

5.5. Watershed Management Recommendations

Each of the previous Sanitary Surveys and Updates has presented recommendations to PWD, which may assist the District in reducing the risks of contamination to their surface water supplies. The recommendations established within each document are provided below. Refer to Chapter 9 for a brief overview of any programs that the District currently has in place to further safeguard its surface water supplies.

5.5.1. 1993 Watershed Sanitary Survey

The 1993 report identifies the following measures to reduce the risk of contamination to source water:

Littlerock Reservoir Area

- Maintain communication with Angeles National Forest Service staff regarding the importance of protecting the quality of water in Littlerock Reservoir.
- Offer to assist Forest Service staff with surveillance of Littlerock Reservoir during peak use months when the District is using water from the reservoir.
- Participate in all available planning procedures with the Forest Service staff regarding short-term and long-term management practices in the Littlerock Reservoir watershed.

Palmdale Ditch to Lake Palmdale Area

- Participate in all related planning meetings and procedures.
- Coordinate with the Los Angeles County Department of Public Works to prevent storm runoff from entering the Palmdale Ditch in the two locations identified.
- Protect Palmdale Ditch from runoff and unauthorized activities by covering it or replacing it with a pipeline, in phases, as development occurs around it.
- Support the implementation of present low-density residential development in the watershed.

Water Quality Monitoring

- Begin monitoring for coliform and turbidity of water from the Palmdale Ditch as it enters Lake Palmdale.
- Conduct a study to determine if *Giardia* and *Cryptosporidium* are found in Lake Palmdale during summer months.

Emergency Response Program

- Add the names and telephone numbers of people responsible for cleanup of hazardous substance spills that may occur into the Palmdale Ditch.
- Public Education Program
- Develop a flyer or brochure for distribution at Littlerock Reservoir and Lake Palmdale.
- Participate in regularly scheduled meetings of the Fin & Feather Club and civic groups in the Palmdale area.

5.5.2. 1997 Watershed Sanitary Survey Update

In March 1997, the Sanitary Survey was updated and the report made the following conclusions.

The following changes in the Littlerock Reservoir recreation facilities should help protect the water quality of the Reservoir: improvements to stormwater controls, improvements to toilet facilities, and improved operation of the facilities.

Opening of the biking/riding trail along the Palmdale Ditch has improved the overall condition of the area, since it discourages dumping trash and debris into and around the Ditch through

increased traffic. In addition the Dam Restoration Project included piping of the water leaving the Dam for a quarter of a mile before entering the open Ditch.

There were no other changes of note in the watersheds.

Reviews of the microbiological data and turbidity for the past four years indicate that a treatment level of 3-log *Giardia* removal/inactivation and 4-log virus removal/inactivation is appropriate for meeting USEPA and State SWTR regulations. Of the *Giardia* and *Cryptosporidium* samples analyzed, none were confirmed positive for the presence of cysts and/or oocysts.

Since the 1993 Sanitary Survey the District has taken steps to implement the recommendations of the report aimed at developing a better source quality database, and implementing source control and emergency preparedness programs.

The District maintains regular communications with the City of Palmdale and with the Forest Service. District staff review any proposed development and facilities in the watersheds to ensure that they do not adversely impact water quality, and that operation and maintenance of existing facilities is protective of water quality.

The 1997 report identified the following actions to augment the list of watershed control activities included in the 1993 report:

- Water quality monitoring should be performed to better assess sources of contaminants. Contaminants studies should include total and fecal coliform, *Giardia*, *Cryptosporidium*, turbidity, total organic carbon, dissolved organic carbon, UV absorbance, ammonia, pH, chlorine demand, total trihalomethane formation potential, and bromide. Sampling location and timing guidelines were also outlined.
- Evaluate the effects of any unusual events on the watershed (i.e. fire, new development, etc.)
- Collect and analyze Lake Palmdale water and Littlerock Reservoir for the presence of Methyl Tertiary Butyl Ether (MTBE).
- Designate a Watershed Management Coordinator.
- Develop and implement a public education program dedicated to source control, watershed management, and drinking water quality
- Continue the effort to pipe the Palmdale Ditch
- Continue involvement with agencies that may impact water quality in the watershed
- Be alert for signs of failing septic tanks in the Palmdale Ditch watershed and take corrective actions as necessary.

5.5.3. 2002 Watershed Sanitary Survey Update

The 2002 report identified the following actions to augment the list of watershed control activities included in the previous reports.

- The District should begin monitoring for the presence of algae toxins in source water. Tests should be run prior to application of algae control substances as a control, during application, and following application. When combined with information on the species

of algae present, the data will help the District optimize application of algae control products to minimize creation of algae toxins.

- The District should continue to protect water sources from illegal activities through signage, patrols and education.
- Develop and implement a public education program dedicated to source control, watershed management, and drinking water quality
- Continue the effort to pipe the Palmdale Ditch
- Continue involvement with agencies that may impact water quality in the watershed
- Continue to evaluate the effects of any unusual events on the watershed (i.e. fire, new development, etc.)

5.5.4. 2007 Watershed Sanitary Survey Update

The 2007 report identified the following actions to augment the list of watershed control activities included in the previous reports.

- The District should monitor for the presence of protozoa and enteric pathogens at Littlerock Reservoir, especially during summer months and high use weekends.
- The District should work with USFS to provide educational materials and signage to discourage activities in the Littlerock Reservoir watershed that may negatively impact water quality.
- The District should work with USFS to provide additional garbage cans at the Littlerock Reservoir facilities.
- The District should regularly replace/update "No Trespassing" and water awareness signage throughout the watershed.
- The District should investigate opportunities to enclose all of Palmdale Ditch
- The District should continue to be involved with agencies that may impact water quality in the watershed
- The District should continue to evaluate the effects of any unusual events on the watershed (i.e. fire, new development, etc.)

5.5.5. 2012 Watershed Sanitary Survey Update

The 2012 report identified the following actions to augment the list of watershed control activities included in the previous reports.

Monitoring

- The District should continue to monitor total/fecal coliform and *E. coli* in beach areas prior to and during months when the Littlerock Reservoir supply is in use. PWD should encourage USFS to close beaches if/when concentrations exceed recommended limits.
- Inform the public when incidents where concentrations exceed recommended limits occur and close beaches.

- Develop electronic databases for all their water quality data and prepare an annual review for trends and unusual data outliers. Data in electronic form could provide operators with nearly immediate understanding of trends in the quality of water in their system.
- Following wildfire incidents and major storms or spills, BMPs should be implemented rapidly including water quality monitoring.

Communication/Education

- The District should work with USFS to provide educational materials and signage to discourage activities in the Littlerock Reservoir watershed that may negatively impact water quality.
- The District should regularly replace/update "No Trespassing" and water awareness signage throughout the watershed.
- The District should continue to be involved with agencies that may impact water quality in the watershed
- Continue an open discussion with the counties to get their support in the effort of protecting the source.

Operations

- The District should work with the USFS to ensure adequate staffing during both peak and non-peak times to promote high water quality at Littlerock Reservoir.
- District should consider the feasibility of enclosing all or part of Palmdale Ditch, prioritizing locations where dumping is an issue, where wildlife are more active, and where stormwater runoff into the Ditch is prevalent
- The District should consider requiring that Equestrian trails adjacent to Palmdale Ditch be set back from the high water line by more 100 feet per DDW regulatory guidelines. Additionally, consider coordinating with the company that runs the trail to require that the owner of each horse retrieves fecal matter and properly disposes of it in sanitary facilities, signage and plastic bag dispensers could be installed at each end of the trail to encourage compliance.
- Oppose the issuance of permits for discharges to surface water and provide discharge alternatives to the appropriate RWQCB to aid in their decision-making.
- Install and maintain fencing along the Palmdale Ditch right-of-way to prevent access.
- Limit access at Ditch locations currently designated for livestock and equipment crossing by installing gates.
- Grade the Palmdale Ditch right-of-way to minimize runoff.

6.0 Water Quality Review

6.1. Overview

This section presents a summary of available water quality data for the Palmdale WTP from January, 2012 through September of 2017. Data on both raw and treated water is presented, focusing upon microbial contaminants and turbidity levels. Additionally, brief review of trace metals, physical constituents, and organic/inorganic contaminants with enforceable maximum contaminant levels, is included.

6.2. Raw Water Quality

Raw water quality data was collected as part of the normal operation of the WTP. No project specific monitoring was completed.

6.2.1. Turbidity

Turbidity, is a measure of the clarity of water, it is caused by suspended matter in the water such as clay, silt, plankton, and other particulates. Turbidity is measured in nephelometric turbidity units (NTUs), which is a measure of the amount of light transmittance. The higher the amount of suspended matter in a water sample, the lower the light transmittance and the higher the turbidity. Finished water from filtration plants (i.e. the combined filtered turbidity) must be 0.3 NTU or less for 95 percent of the monthly samples collected, and cannot exceed 1.0 NTU at any time, as per the Interim Enhanced Surface Water Treatment Rule. There is no standard for raw water turbidity.

PWD measures raw water turbidity levels on a daily basis. Data from the last 5 years shows a daily maximum of 15.3 NTU and a 5-year average of about 2.54 NTU. Figure 6-1 presents this information. Over this 5 year period, turbidity levels have remained relatively stable and in general have shown no clear long-term trend. Monthly averages have varied from less than 1 to just under 7 NTU. Table 6-1 presents a yearly summary of the average raw water turbidity level. The 2012 average shown is for the full year, whereas the 2012 Survey only included data through September.

Figure 6-1: Raw Water Turbidity, Daily, Monthly and 5 Year Average

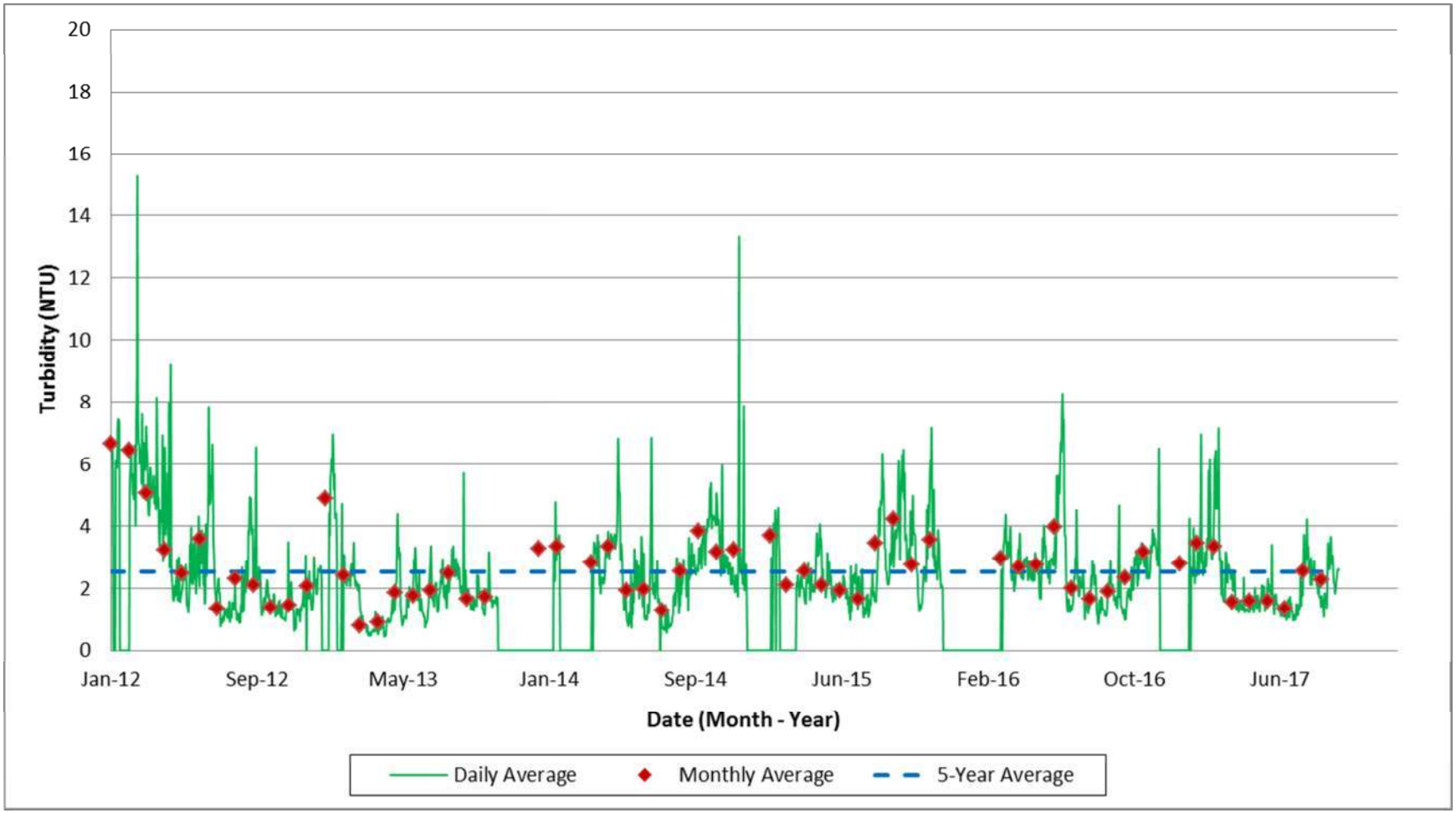


Table 6-1: Average Raw Water Turbidity

Contaminant	DDW MCL	Current DLR	Year Sampled						5-Year Average
			2012	2013	2014	2015	2016	2017	
Turbidity (NTU)	5	0.1	3.17	2.04	2.79	2.79	2.60	2.27	**2.54**

Notes:
MCL=Maximum Contaminant Level is for Surface Water, based on DDW Criteria for Avoiding Filtration
DLR=CA Division of Drinking Water (DDW) Detection Limit of Reporting Purposes
2017 values based on data through September

6.2.2. Total Coliform

Total coliforms are a measure of the concentration of bacteria in a water sample. Bacteria are usually present in raw water samples. Their presence alone is not cause for concern but their source should be identified and controlled if possible.

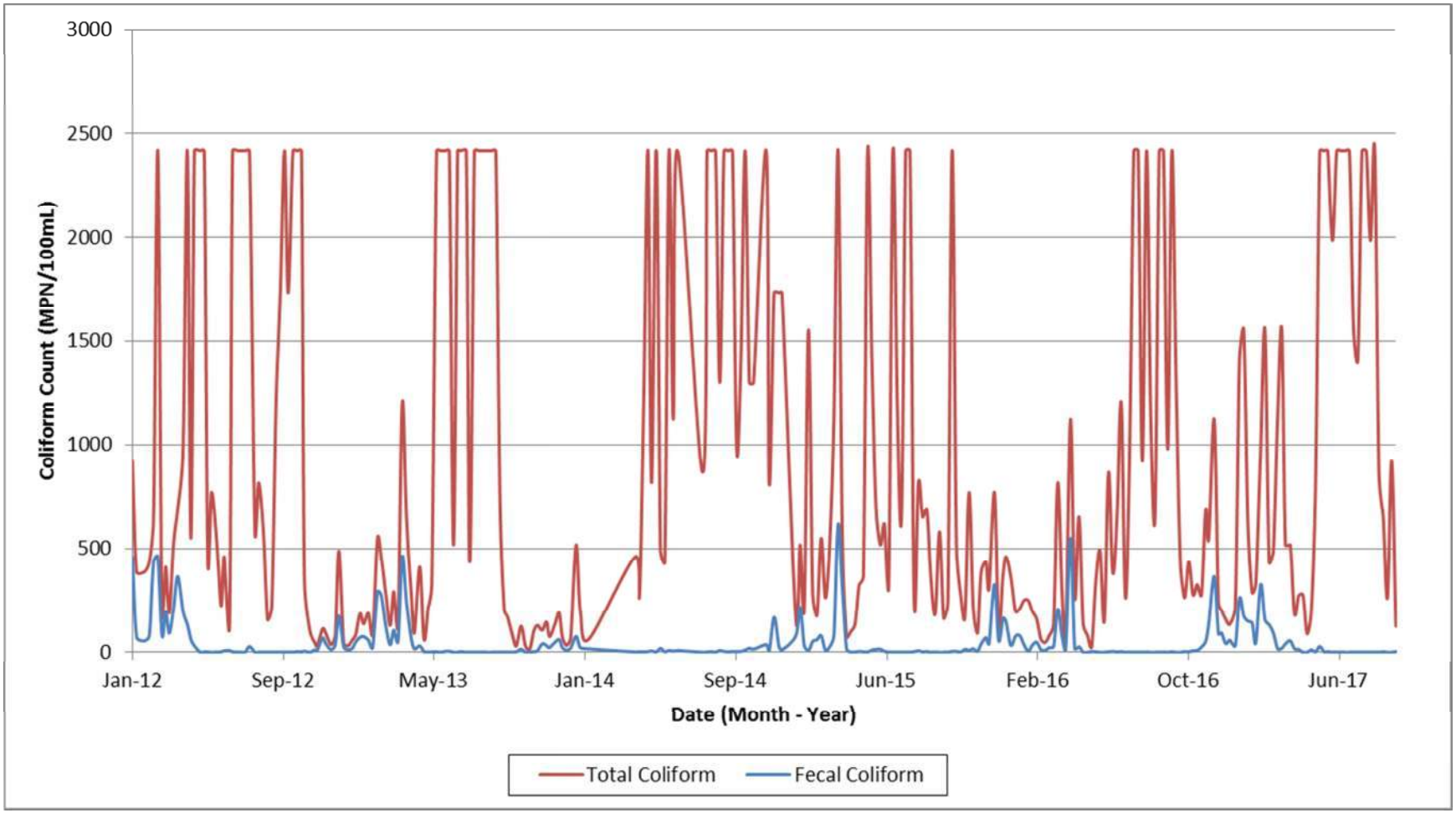
Coliform data for the Palmdale WTP raw water were sampled an average of 5 days per month from January 2012 through September 2017. Total coliform counts were greater than 500 most probable number (MPN) per 100 milliliters (mL) in 52 percent of the samples. Occurrences of significantly elevated total coliform counts occur throughout the year. Figure 6-2 shows both total and *E. coli* data.

6.2.3. *E. coli*

E. coli are also a measure of the concentration of bacteria in a water sample, but are focused on bacteria found in human (and other animals) intestinal tracts. Hence, it is assumed that the presence of these bacteria in water samples is indicative of the presence of fecal matter and possible pathogenic organisms, which may be of human origin (Tchobanoglous, 140).

Figure 6-2 details historical *E. coli* counts. The data available for *E. coli* span the same sampling dates as total coliforms, covering 5 years. During this period of time, *E. coli* exceeded 20 MPN/100mL in 35 percent of samples. This incidence rate is very similar to that for *E. coli* in the previous sample periods from 2003 to 2007 and from 2007 to 2012.

Figure 6-2: Raw Water Total Coliform and *E. coli* Counts.



6.2.4. *Giardia* and *Cryptosporidium*

Giardiasis and *Cryptosporidiosis* are both serious waterborne diseases caused by the protozoa *Giardia lamblia* and *Cryptosporidium parvum,* respectively. The protozoa are found in the intestinal tracts of infected humans and animals and can be passed in their stool. The protozoa can survive for a long period of time outside the body, making water an ideal medium for the protozoa to spread. Both show a fairly high resistance to typical disinfection chemicals, such as chlorine. Effects of the diseases can range from mild intestinal cramps in healthy individuals to serious and life threatening problems in persons with compromised immune systems.

PWD has maintained records of tests for *Giardia* and *Cryptosporidium* from Lake Palmdale. Samples were collected between April 2015 and April 2017. The LT2ESWTR (Long-Term 2 Enhanced Surface Water Treatment Rule) required collection of *Cryptosporidium, E. coli* and turbidity samples at least monthly for 24 months. Round 1 required monitoring to begin by October 2006 and Round 2 required monitoring to begin by April 2015. Therefore, the samples collected from April 2015 to April 2017 satisfied the monitoring requirements for LT2ESWTR Round 2 and the samples collected prior to 2012 satisfied the monitoring requirements for LT2ESWTR Round 1. In the 25 samples from this time period, there were no detects of *Giardia* or *Cryptosporidium*. The detection method used was EPA Method 1623.

6.2.5. pH

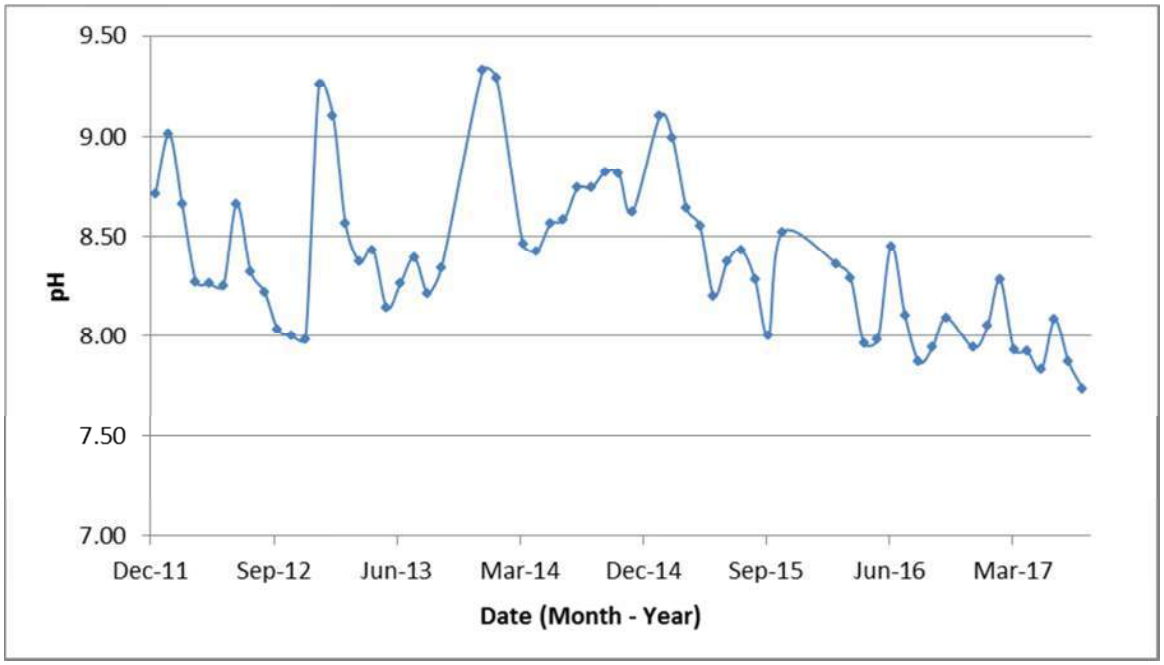
Historically, the pH in the Palmdale Lake has been slightly basic with levels generally between 7.5 and 8.5. The yearly average has exceeded 8 every year since 2007. Raw water pH has shown no significant trend since 2012, as shown on Figure 6-3. Monthly and yearly average values are summarized in Table 6-2.

Table 6-2: Raw Water pH Summary

Month\Year	pH Raw Water					
	2012	2013	2014	2015	2016	2017
January	8.71	9.26	9.33			7.94
February	9.01	9.10	9.29	9.10		8.05
March	8.66	8.56		8.99	8.36	8.28
April	8.27	8.37	8.46	8.64	8.29	7.93
May	8.26	8.43	8.42	8.55	7.96	7.92
June	8.25	8.14	8.56	8.20	7.98	7.83
July	8.66	8.26	8.58	8.37	8.45	8.08
August	8.32	8.39	8.74	8.43	8.10	7.87
September	8.22	8.21	8.74	8.28	7.87	7.74
October	8.03	8.34	8.82	8.00	7.94	
November	8.00	NA	8.81	8.52	8.09	
December	7.98	NA	8.62			
Annual Average	**8.36**	**8.51**	**8.76**	**8.51**	**8.12**	**7.96**

Note:
NA = Not Available. This report was prepared during October and November 2017. Thus data was not available from the fourth quarter of 2017.

Figure 6-3: Average Monthly Raw Water pH



6.2.6. Alkalinity

Table 6-3 summarizes the monthly and annual average alkalinity of raw water from Lake Palmdale. The raw water alkalinity is moderate, and the Palmdale WTP adds chemicals to stabilize and treat the water.

Table 6-3: Annual Average Raw Water Alkalinity

Month\Year	Alkalinity Raw Water (mg/L as $CaCO_3$)					
	2012	2013	2014	2015	2016	2017
January	78.3	74.7	83.5			80.0
February	84.7	79.0	80.0	100.0		80.0
March	81.4	82.0		100.0	110.3	79.4
April	84.5	86.3	93.3	111.2	108.8	77.0
May	90.9	89.2	96.0	117.0	103.3	76.6
June	90.9	99.5	96.3	118.8	107.2	73.5
July	87.2	105.0	103.8	118.0	103.8	61.8
August	80.7	98.8	112.0	117.0	100.4	57.3
September	74.5	91.8	108.5	113.6	87.8	58.3
October	71.0	112.4	106.4	112.8	87.0	
November	72.0	108.5	104.8	113.3	87.8	
December	74.8	101.8	104.7			
Annual Average	**80.9**	**94.1**	**99.0**	**112.2**	**99.6**	**71.5**

6.2.7. MTBE and BTEX

A limited review of MTBE and Benzene, Toluene, Ethel Benzene and Xylene (BTEX) was performed on the available data. The detection limit for reporting (DLR) of MTBE is 3.0 µg/L.

There have been no detects of MTBE in Lake Palmdale since June 2005. Since the withdrawal of MTBE as a fuel additive in California in 2003, prospective contaminant sources have dwindled considerably so it can be assumed that MTBE levels in the source water have likewise decreased.

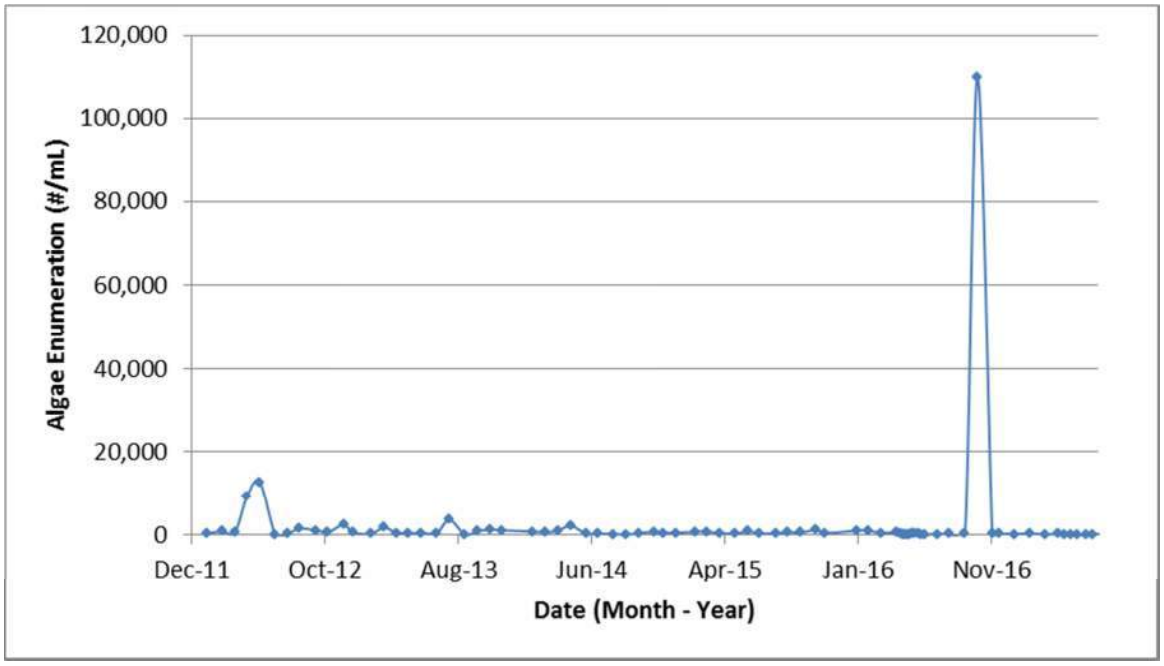
Limited BTEX constituents were detected in Lake Palmdale during the current study period. The DLR for BTEX compounds is 0.5 µg/L. Xylene has been detected two times and benzene and ethyl benzene have each been detected once in the vicinity of the Lake Palmdale boat ramp since January 2012. In each instance these constituents were present at concentrations well below their respective drinking water MCLs. BTEX compounds were not detected at the WTP intake during the current study period.

6.2.8. Algae

Algal growth has historically been a water quality concern in Lake Palmdale and the District has taken steps to reduce algae production and the need for chemical treatment with copper sulfate. Lake Palmdale appears to be home to several species of diatoms year round. The District typically applies copper sulfate six to eight times per year.

Algae enumeration is summarized in Figure 6-4. Algal concentrations in Lake Palmdale were consistently low during periods when copper sulfate was added. A sharp spike in algal cell counts were observed in October of 2016.

Figure 6-4: Lake Palmdale Algae Enumeration



6.3. Treated Water Quality

6.3.1. Turbidity

Finished water from filtration plants (i.e. the combined filtered turbidity) must be 0.3 NTU or less for 95 percent of the monthly samples collected, and cannot exceed 1.0 NTU at any time, as per the Interim Enhanced Surface Water Treatment Rule.

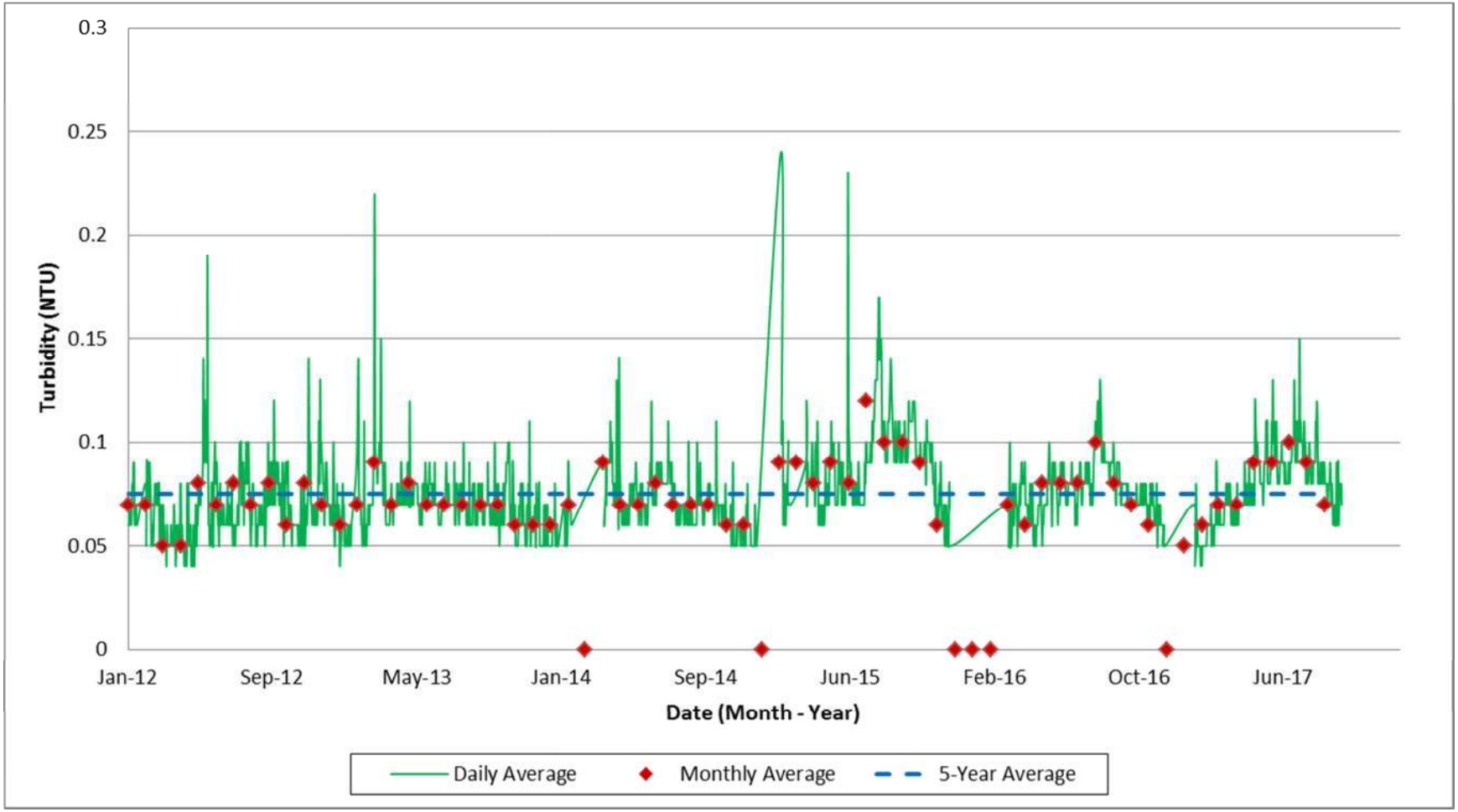
Turbidity levels in the treated water were consistently well under 1 NTU, with no daily averages exceeding 0.25 NTU. Compiled data from the last 5 years shows monthly averages at or below 0.1 NTU; and the 5-year average of all data close to 0.08 NTU. Refer to Table 6-4, and Figure 6-5 for a summary of treated water turbidity levels.

Table 6-4: Average Turbidity Values

Turbidity	Current DDW MCL (NTU)	Current DLR (NTU)	Year Sampled						5-Year Average
			2012	2013	2014	2015	2016	2017	
Treated Water	0.3	0.1	0.07	0.07	0.07	0.09	0.08	0.08	0.08

Notes:
DLR=CA DDW)Detection Limit of Reporting Purposes
MCL=Maximum Contaminant Level

Figure 6-5: Treated Water Turbidity, Daily, Monthly and 5 year Average



6.3.2. Total Organic Carbon

Figure 6-6 shows the raw and treated water TOC values at the Palmdale WTP. In 2009, GAC treatment was added, resulting in increased TOC removal. Treated water TOC values show no significant trend. Table 6-5 summarizes the average TOC concentration for the Palmdale WTP before and after treatment for the last five years.

Figure 6-6: TOC Comparison

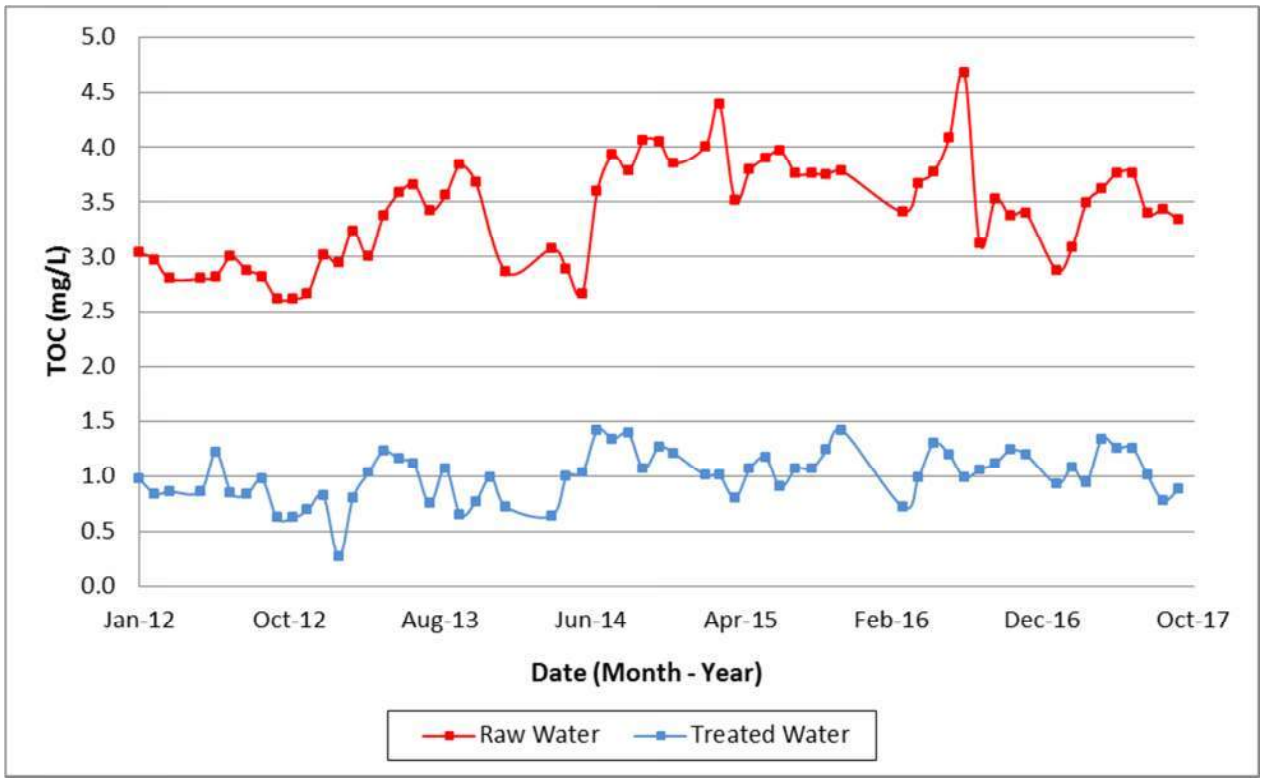


Table 6-5: Average Total Organic Carbon in Treated Water

Month/Year	2012		2013		2014		2015		2016		2017	
	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)
January	1.0	68.1	0.8	72.8	0.7	74.8	N/A	N/A	N/A	N/A	0.9	67.7
February	0.8	71.7	0.3	91.2	N/A	N/A	1.0	74.8	N/A	N/A	1.1	65.0
March	0.9	69.3	0.8	75.3	N/A	N/A	1.0	77.0	0.7	78.9	0.9	73.1
April	N/A	N/A	1.0	65.7	0.6	79.2	0.8	77.3	1.0	73.0	1.3	63.0
May	2.0	28.6	1.2	63.6	1.0	65.4	1.1	71.8	1.3	65.5	1.3	66.5
June	1.2	56.7	1.2	67.6	1.0	61.4	1.2	70.0	1.2	70.7	1.3	66.5
July	0.9	71.7	1.1	69.7	1.4	60.6	0.9	77.3	1.0	78.8	1.0	70.3
August	0.8	71.2	0.8	78.1	1.3	65.9	1.1	71.5	1.1	66.0	0.8	77.3
September	1.0	65.6	1.1	69.9	1.4	63.2	1.1	71.5	1.1	68.3	0.9	73.7
October	0.6	76.3	0.7	83.1	1.1	73.6	1.2	66.9	1.2	63.2	N/A	N/A
November	0.6	76.3	0.8	79.1	1.3	68.6	1.4	62.4	1.2	64.7	N/A	N/A
December	0.7	74.2	1.0	N/A	1.2	68.6	N/A	N/A	N/A	N/A	N/A	N/A
Annual Average	**1.0**	**66.3**	**0.9**	**74.2**	**1.1**	**68.1**	**1.1**	**72.1**	**1.1**	**69.9**	**1.1**	**69.2**
NA – Not available												

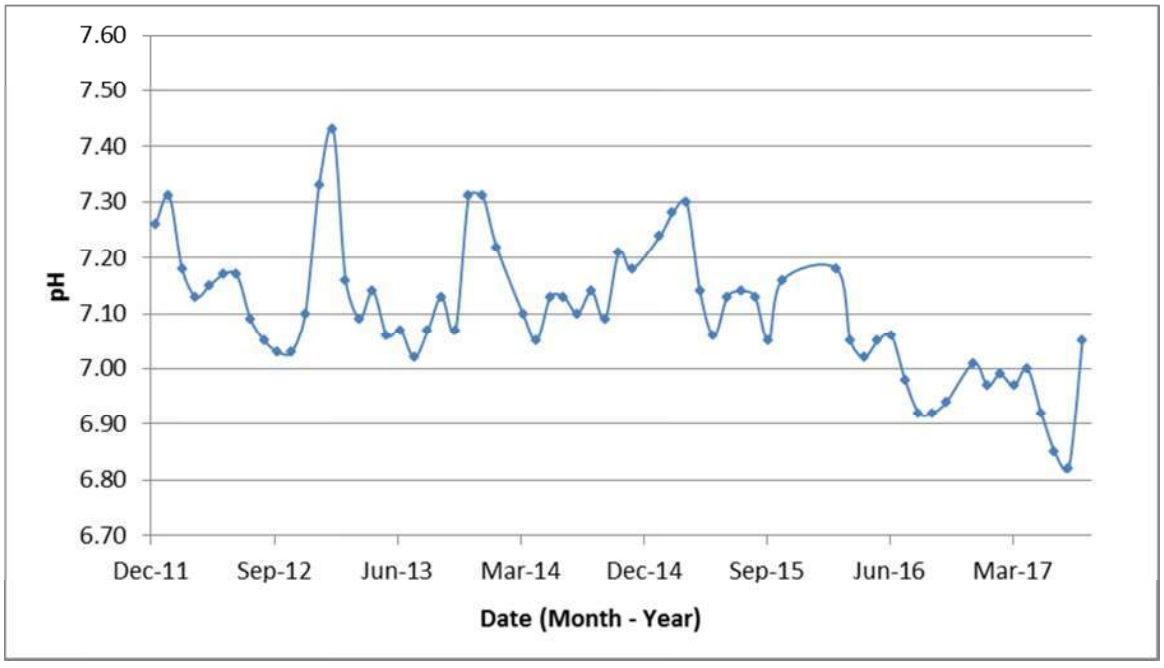
6.3.3. pH

The pH of treated water is consistently lower than that of raw water, primarily due to coagulant addition during pretreatment. Treated water pH shows a slightly decreasing trend over the past 5 years. See Table 6-6 for a summary of average monthly and annual treated water pH values and Figure 6-7 for a graph of the trend.

Table 6-6: Treated Water pH Summary

Month\Year	pH Treated Water					
	2012	2013	2014	2015	2016	2017
Jan	7.26	7.33	7.31			7.01
Feb	7.31	7.43	7.22	7.24		6.97
Mar	7.18	7.16		7.28	7.18	6.99
Apr	7.13	7.09	7.10	7.30	7.05	6.97
May	7.15	7.14	7.05	7.14	7.02	7.00
Jun	7.17	7.06	7.13	7.06	7.05	6.92
Jul	7.17	7.07	7.13	7.13	7.06	6.85
Aug	7.09	7.02	7.10	7.14	6.98	6.82
Sep	7.05	7.07	7.14	7.13	6.92	7.05
Oct	7.03	7.13	7.09	7.05	6.92	
Nov	7.03	7.07	7.21	7.16	6.94	
Dec	7.10	7.31	7.18			
Annual Average	**7.14**	**7.16**	**7.15**	**7.16**	**7.01**	**6.95**

Figure 6-7: Treated Water pH Trend



6.3.4. Alkalinity

Table 6-7 summarizes the monthly and annual average alkalinity of treated water at the Palmdale WTP. Alkalinity tends to decrease due to the addition of alum during coagulation. Annual averages have remained below 90 mg/L as Calcium Carbonate ($CaCO_3$), except for the four months April through July of 2015. On average, alkalinity has increased slightly since the 2012 Survey except for 2017. PWD notes that the changes in alkalinity may be attributed to the lower alkalinity in State Water Project (California Aqueduct) water that sources Lake Palmdale. Lower alkalinity in the State Water Project is related to an influx of freshwater that is introduced due to snowmelt from the Sierra Nevada Mountains. Lower alkalinity was also observed in the California Aqueduct in 2011, which was another wet year, and alkalinity has been higher in dry or drought years like 2015.

Table 6-7: Annual/Monthly Average Treated Water Alkalinity

Month\Year	Treated Water Alkalinity (mg/L as $CaCO_3$)					
	2012	2013	2014	2015	2016	2017
Jan	62.0	61.3	61.5			59.0
Feb	68.4	65.0	58.0	78.0		57.8
Mar	63.3	64.8		77.0	82.3	56.8
Apr	66.6	70.8	71.3	90.6	78.5	57.8
May	74.1	71.6	72.8	93.0	75.8	57.6
Jun	71.2	77.5	74.5	90.0	79.2	51.0
Jul	66.1	84.0	79.2	90.4	79.3	43.3
Aug	61.9	73.5	86.0	88.8	76.4	36.3
Sep	58.0	78.3	81.3	88.0	68.3	44.6
Oct	53.5	88.6	79.6	84.0	69.3	NA
Nov	56.0	86.8	80.8	85.3	61.5	NA
Dec	59.0	76.6	84.0			NA
Annual Average	**63.3**	**74.9**	**75.4**	**86.5**	**74.5**	**51.6**

6.3.5. Disinfection Byproducts (DBPs)

Monthly sampling data for total trihalomethane (TTHM) and five-haloacetic acid (HAA5) regulated disinfection byproducts was reviewed. Locational running annual average (LRAA) values were not provided, but TTHM and HAA5 measurements were typically less than 50 µg/L and 10 µg/L, respectively. Measured TTHM values exceeded 80 µg/L in 20 of the 472 samples collected from individual monitoring sites in the distribution system between 2012 and 2017. The number of TTHM values in excess of 80 µg/L has varied annually: 2.8 percent of samples in 2012, 1.0 percent in 2013, 4.2 percent in 2014, 5.2 percent in 2015, 9.1 percent in 2016, and 0 in the first 2 quarters of 2017. Table 6-8, Table 6-9 and Table 6-10 summarize the system-wide quarterly running average and annual average DBP concentrations, as well as quarterly and annual average bromide at the Palmdale WTP. Regulated DBP concentrations decreased markedly system-wide over the 2007 to 2012 testing period, consistent with decreased TOC levels in treated water, and coincident with installation of granular activated carbon treatment. Constituent concentrations have steadied between 2012 and 2017, as shown in Figure 6-8.

Table 6-8: TTHM Quarterly Running Annual Average

	TTHM (ug/L)					
Quarter\Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1st Quarter	28.25	41.05	32.43	33.00	39.50	42.03
2nd Quarter	30.95	38.60	29.48	34.68	43.90	41.13
3rd Quarter	35.40	38.43	30.18	36.43	38.93	NA
4th Quarter	39.08	34.75	33.70	39.10	35.55	NA
Year Average	**33.42**	**38.21**	**31.44**	**35.80**	**39.47**	**41.58**

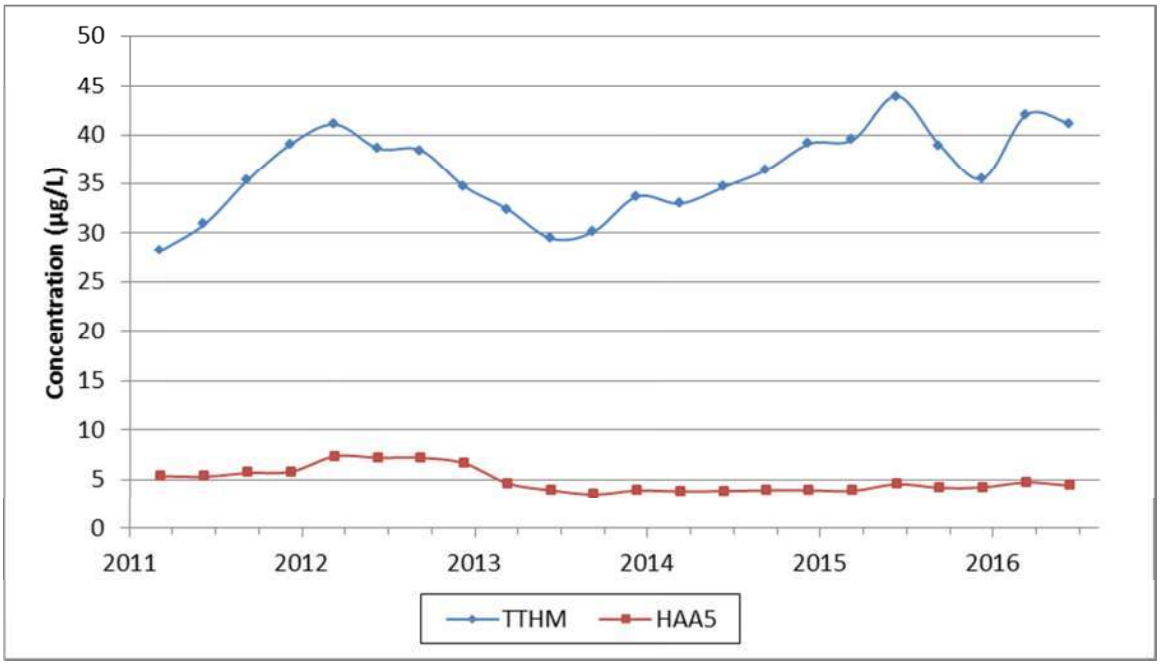
Table 6-9: HAA5 Quarterly Running Annual Average

	HAA5 (ug/L)					
Quarter\Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1st Quarter	5.35	7.35	4.63	3.80	3.88	4.73
2nd Quarter	5.30	7.20	3.93	3.85	4.55	4.40
3rd Quarter	5.68	7.20	3.50	3.93	4.18	NA
4th Quarter	5.80	6.65	3.90	3.93	4.23	NA
Year Average	**5.53**	**7.10**	**3.99**	**3.88**	**4.21**	**4.56**

Table 6-10: Quarterly and Annual Average Bromide at the Palmdale WTP

	Bromide (ug/L)					
Quarter\Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1st Quarter	22.87	15.80	15.30	NA	29.10	35.10
2nd Quarter	40.77	30.20	53.03	33.85	43.33	23.87
3rd Quarter	25.90	19.77	25.90	46.13	38.60	NA
4th Quarter	32.37	32.77	20.03	26.15	26.70	NA
Year Average	**30.48**	**24.63**	**28.57**	**35.38**	**34.43**	**29.48**

Figure 6-8: Disinfection Byproduct Quarterly Running Annual Average



6.3.6. Data from Weekly Lab Samples

Water quality data from daily lab samples collected from 2012 through 2017 are presented in Table 7-11. Color is presented in color units, which have a scale from 0 to 500 units with zero representative of distilled water. Odor is reported as a Threshold Odor Number (TON), which is the dilution ratio at which odor is just detectable. Average annual values for a variety of public opinion affecting constituents are presented. It should be noted that after treatment all color and odor issues have been mitigated.

Table 6-11: Treated and Raw Water Color, Odor and Hardness

Year	Raw Water			Treated Water		
	Color (color units)	Odor (TON)	Hardness (mg/L as $CaCO_3$)	Color (color units)	Odor (TON)	Hardness (mg/L as $CaCO_3$)
2012	8.0	11.2	111.8	<5	1	109.9
2013	7.0	11.3	122.4	<5	1	123.3
2014	7.7	11.6	127.6	<5	1	126.7
2015	12.2	11.4	135.8	<5	1	138.7
2016	11.8	10.4	138.4	<5	1	137.2
2017	6.1	9.6	106.6	<5	1	105.9

6.3.7. Contaminants with Primary MCLs

Finished water monitoring data for contaminants with enforceable primary MCLs provided by the District was reviewed and no exceedances were noted.

7.0 Regulatory Discussion

7.1. Overview

This section evaluates current, pending, and future drinking water regulations pertaining to the District's water system.

7.2. Water Quality Regulatory Requirements

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* are the part of the rule that specify the amount or concentration of a particular constituent that is legally allowed in drinking water. At the federal level, the U.S. Environmental Protection Agency (USEPA) is primarily responsible for developing and enforcing drinking-water regulations, whereas state health departments regulate drinking water quality at the state level. Any drinking-water regulations promulgated by a state are required to have standards that are at least as stringent as those required by similar federal regulations; however, states may implement regulations in addition to those mandated by federal statutes. Federal regulations specify requirements and the process by which states may assume major responsibility or *primacy* for implementing and enforcing drinking-water regulations. Although state drinking-water regulations generally follow the provisions of federal regulations there are some differences among the states; therefore, this review focuses on federal regulations.

Drinking water regulations and standards are designed to protect human health. Prior to 1974 there was no consistent set of enforceable drinking water regulations throughout the United States. Federal involvement in regulation of drinking water quality began with passage of the Interstate Quarantine Act by the U.S. Congress in 1893, which authorized the U.S. Public Health Service (USPHS) to set regulations designed to minimize the spread of communicable diseases from outside and within the U.S. In 1914, the USPHS developed standards for bacterial plate count and *Bacillus coli* for drinking water supplied to the public by any common carrier engaged in interstate commerce or transport. Additional limitations on the mineral, metal, synthetic organic chemical (SOC), and ultimately radionuclide content of drinking water were developed by the USPHS, with revised standards issued in 1925, 1942, 1946, and 1962. The two-tiered approach to drinking water standards encompassing legally enforceable health-related and aesthetically-recommended limits for individual constituents dates back to the USPHS standards of 1925 that introduced tolerance and recommended limits. Although the USPHS standards applied only to drinking water supplied to the public during interstate commerce, over time they were informally recognized as a source of water quality criteria and formed the basis of standards used by many state and local regulatory agencies engaged in regulating public water supplies.

In 1969, the USPHS conducted the Community Water Supply Survey (CWSS) to assess if public drinking water supplies met the USPHS standards and to what extent routine drinking water monitoring was practiced. The CWSS demonstrated that compliance with the USPHS standards was minimal and drinking water surveillance programs were generally ineffective and often completely absent. Other reviews of treatment practice by public drinking water suppliers indicated operations and maintenance were frequently inadequate, and that the level of personnel training was often insufficient to protect public health. These circumstances, in addition to

recognition of other important emerging environmental conditions, provided impetus for the formation of the U.S. Environmental Protection Agency in December, 1970.

7.3. Laws Governing Drinking Water Quality

7.3.1. Safe Drinking Water Act of 1974

The Safe Drinking Water Act (SDWA – Public Law 93-523) was enacted in December, 1974 because of congressional concern over organic chemical contamination of drinking water and uneven and often ineffective state supervision of public drinking water supplies. The SDWA outlined a series of procedures and timetables that USEPA was required to follow to develop drinking water quality regulations in two phases. National Interim Primary Drinking Water Regulations (NIPDWR) were required to be set immediately, based primarily on the USPHS 1962 guidelines, specifying enforceable health-related maximum contaminant levels (MCLs) for a number of chemical, physical, radioactivity, and bacteriological parameters. Following a comprehensive National Academy of Sciences assessment of the occurrence of contaminants in drinking water and the potential health effects of human exposure, revised National Primary Drinking Water Regulations (NPDWR) were required to be established. The revised NPDWR also required that non-enforceable health-related standards, termed maximum contaminant level goals (MCLGs), be set at a level at which, in the Administrator's judgment, there are no known or anticipated adverse effects on the health of persons and that allows an adequate margin of safety. The SDWA also mandated that USEPA develop National Secondary Drinking Water Regulations (NSDWR) that set non-enforceable federal guidelines for contaminants, or secondary maximum contaminant levels (SMCLs), that if present in excessive amounts may affect the palatability and aesthetic quality of drinking water. Other key provisions of the SDWA relate to the definition of public water supply, primacy, obtaining variances and exemptions, public notification, compliance monitoring, recordkeeping and reporting, and enforcement. Regulations and amendments implemented under the SDWA are listed in Table 7-1, and discussed below.

7.3.2. Safe Drinking Water Act Amendments of 1986

Comprehensive amendments were made to the SDWA when it was reauthorized in June, 1986 by Congress (Public Law 99-339), that affected the operation of virtually every public water system in the United States. These changes were driven by public and congressional concern over the prolonged process of establishing the revised NPDWR and the slow pace of setting standards for additional contaminants. The 1986 Amendments finalized the 23 MCLs set by the original NPDWR and subsequent minor amendments, and designated these standards the NPDWR. Furthermore, the 1986 Amendments required USEPA to set standards for 83 specified contaminants within 3 years, and an additional 25 contaminants from a prescribed list known as the Drinking Water Priorities List every 3 years thereafter. These amendments also required USEPA to develop criteria for filtration of surface water supplies and establish regulations that require all public water systems to practice disinfection. Other significant provisions of these amendments banned the use of lead pipe and solder in drinking water systems and required public education about the sources and health effects of lead in drinking water and steps to reduce exposure. The Amendments empowered USEPA to set enforceable standards for contaminants in drinking water based on the degree of removal that could be achieved using the best available technology (BAT). USEPA was also granted enforcement powers through the use of administrative orders to supplement its efforts to correct deficiencies in public water supplies

through the legal system. Existing regulations promulgated under the SDWA Amendments of 1986 are given in and are discussed below.

7.3.3. Safe Drinking Water Act Amendments of 1996

The Safe Drinking Water Act was further amended in 1996 (Public Law 104-182), to primarily increase public awareness and participation in the drinking water regulatory process. These amendments required USEPA to publish related material and seek public comment on the potential health risk reduction provided by a proposed regulation and conduct a cost analysis associated with implementing the proposed new standard or treatment technique. Analyses performed in support of the regulatory process must now consider contaminant effects on sensitive subpopulations including infants, children, pregnant women, the elderly, and individuals with a history of serious or chronic illness. Because the requirement to set NPDWR standards for 25 new contaminants every 3 years mandated by the 1986 SDWA Amendments proved impractical, the 1996 Amendments replaced this provision with a requirement to select and evaluate 5 contaminants for possible regulation from a published *contaminant candidate list* (CCL) within 5 years, and then every 5 years thereafter. The 1996 SDWA Amendments also increased the compliance deadline following final promulgation of new regulations from 18 to 36 months, with an additional 2 year extension if substantial capital improvements are required. Other provisions of these amendments established schedules for implementation of a revised arsenic standard and a new standard for radon, source water assessment and protection, operator certification programs, establishment of a State Drinking Water Revolving Fund to support infrastructure improvements, and a requirement for utilities to distribute Consumer Confidence reports to their customers.

A complete listing of all currently regulated contaminants along with their maximum contaminant levels (MCLs) can also be found in Table 7-2, Table 7-3 and Table 7-4. At the time of this report, regulations under the SDWA and Amendments govern the following:

- 7 microbiological contaminants
- 4 disinfection byproducts
- 3 disinfectants
- 16 inorganic chemicals
- 53 organic chemicals, and
- 4 radionuclides.

Table 7-1: Schedule for Promulgation of Pertinent SDWA Regulations

Regulation	Proposed	Final	Effective
Fluoride	11/85	4/86	10/87
Trihalomethanes (THMs)	2/78	11/79	11/83
8 Volatile Organic Compounds (VOCs) (Phase I)	11/85	7/87	1/89
Surface Water Treatment Rule (SWTR)	11/87	6/89	6/93
Coliform Rule *(revisions expected by August 2008)*[9]	11/87 *(06)*	6/89 *(08)*	12/90
Lead & Copper (LCR) Minor Revisions – *more revisions pending*	8/88 4/98	6/91 1/00	1/92 1/01
26 Synthetic Organic Contaminants (SOCs)[1], 7 Inorganic Contaminants (Phase II)	5/89	1/91[1]	7/92
MCLs for barium, pentachlorophenol (Phase II)	1/91	7/91	1/93
Phase V Organics, Inorganics	7/90	7/92	1/94
Radionuclides (Phase III) - except radon Radon – Delayed, no target date.	4/00 11/99	12/00 2008	12/07 2011
Sulfate	12/94	Not regulated. 7/03	
MCLs for aldicarb, aldicarb sulfoxide, aldicarb sulfone	8/04	8/05 *delayed*	8/08[2] *delayed*
Disinfectants/Disinfection Byproducts Stage 1 DBPR Stage 2 DBPR	7/94 8/03	12/98 1/06	1/02[4,5] 10/06[6,8]
Information Collection Rule	2/94	5/96	Completed
Interim ESWTR Stage 1 - Long Term Enhanced SWTR Stage 2 - Long Term Enhanced SWTR	7/94 4/00 8/03	12/98 1/02 1/06	1/02[4] 1/05[5] 10/06[8]
Filter Backwash Recycle Rule	4/00	6/01	12/03
Consumer Confidence Reports Rule	2/98	8/98	9/98
Ground Water Rule (GWR)	5/00	7/06	7/09
Operator Certification - State Guidance	3/98	2/99	2/01
Unregulated Contaminants, Monitoring Only[7] UCMR 2	2/99 8/05	9/99 2/06	1/01 2/07
Five New Contaminants – CCL1 Contaminant Candidate List 2 – CCL2	7/03 4/04	7/03 5/05	Completed 5/08
Chlorine Gas as Restricted Use	9/00	Final notice delayed.	
Source Water Protection Program -Guidance[3]	8/97	Completed	Completed
Effluent Guidelines for WTPs	9/06	9/07	9/10
Arsenic	6/00	2/02[10]	1/06

Notes: **1.** MCL, MCLG for atrazine to be reconsidered. **2**. Assumes regulation in effect 3 years after final promulgation. **3.** Program required as part of 1996 Amendments. **4.** For PWS serving > 10,000. **5.** Effective Jan. 2005 for PWS serving < 10,000. **6.** Running annual averages to be computed at each sampling location (LRAA) including sites with high DBPs. **7.** Tiered monitoring approach pending availability of analytical methods. **8.** Monitoring begins. **9.** Revised TC Rule may become Distribution System Rule **10.** Original As Rule final on Jan. 22, 2001 but delayed by administrative action until Feb. 22, 2002.

Table 7-2: National Primary Drinking Water Standards (as of 11/2017)

Contaminant	Regulation	MCL, mg/L (unless noted)	MCLG, mg/L
Organic substances			
Acrylamide	Phase II	Treatment Technique	Zero
Alachlor	Phase II	0.002	Zero
Atrazine	Phase II	0.003	0.003
Benzene	Phase I	0.005	Zero
Benzo(a)pyrene	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
2,4-D	Phase II	0.07	0.07
Dalapon	Phase V	0.2	0.2
Di(2-ethylhexyl) adipate	Phase V	0.4	0.4
Di(2-ethylhexyl) phthalate	Phase V	0.006	Zero
Dibromochloropropane	Phase II	0.0002	Zero
p-dichlorobenzene	Phase I	0.075	0.075
o-dichlorobenzene	Phase II	0.6	0.6
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 (methylene chloride)	Phase V	0.005	Zero
1,2-dichloropropane	Phase II	0.005	Zero
Dinoseb	Phase V	0.007	0.007
Diquat	Phase V	0.02	0.02
Endothall	Phase V	0.1	0.1
Endrin	Phase V	0.002	0.002
Epichlorohydrin	Phase II	Treatment Technique	Zero
Ethylbenzene	Phase II	0.7	0.7
Ethylene dibromide	Phase II	0.00005	Zero
Glyphosate	Phase V	0.7	0.7
Haloacetic Acids (total)[1]	Stage 2 DBPR	0.060	-
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

Contaminant	Regulation	MCL, mg/L (unless noted)	MCLG, mg/L
Lindane	Phase II	0.0002	0.0002
Methoxychlor	Phase II	0.04	0.04
Monochlorobenzene	Phase II	0.1	0.1
Oxamyl (vydate)	Phase V	0.2	0.2
Pentachlorophenol	Phase II	0.001	Zero
Picloram	Phase V	0.5	0.5
Polychlorinated byphenyls	Phase II	0.0005	Zero
Simazine	Phase V	0.004	0.004
Styrene	Phase II	0.1	0.1
2,3,7,8-TCDD (dioxin)	Phase V	3×10^{-8}	Zero
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
Trichloroethylene	Phase I	0.005	Zero
Trihalomethanes (total)	Stage 2 DBPR	0.080	-
Vinyl chloride	Phase I	0.002	Zero
Chlorobenzene	Phase II	0.1	0.1
Xylenes (total)	Phase II	10	10
Inorganic Substances			
Antimony	Phase V	0.006	0.006
Arsenic	Arsenic	0.010	0
Asbestos (fibers/L > 10 um)	Phase II	7×10^{6}/L	7×10^{6}/L
Barium	Phase II	2	2
Beryllium	Phase V	0.004	0.004
Bromate	Stage 2 DBPR	0.010	Zero
Cadmium	Phase II	0.005	0.005
Chlorite	Stage 2 DBPR	1.0	0.8
Chromium (total)	Phase II	0.1	0.1
Copper	LCR	Treatment Technique	1.3
Cyanide	Phase V	0.2	0.2
Fluoride	-	4.0	4.0
Lead	LCR	Treatment Technique	Zero

Contaminant	Regulation	MCL, mg/L (unless noted)	MCLG, mg/L
Mercury (Inorganic)	Phase II	0.002	0.002
Nitrate (as N)	Phase II	10	10
Nitrite (as N)	Phase II	1	1
Nitrate + Nitrite (both as N)	Phase II	10	10
Perchlorate	CA MCL	0.006	
Selenium	Phase II	0.05	0.05
Thallium	Phase V	0.002	0.0005
Radionuclides			
Beta-particle and photon emitters	Radionuclides	4 mrem/yr	zero
Alpha emitters	Radionuclides	15 pCi/L	zero
Radium 226 + 228	Radionuclides	5 pCi/L	zero
Uranium	Radionuclides	30 µg/L	zero
Microorganisms			
Cryptosporidium	IESWTR, LT1ESWTR, LT2ESWTR	2-log Removal Source water[2]	Zero
Escherichia coli	TCR	Treatment Technique	Zero
Fecal coliform	TCR	Treatment Technique	Zero
Giardia lamblia	SWTR	Treatment Technique	Zero
Heterotrophic bacteria	SWTR	Treatment Technique	
Legionella	SWTR	Treatment Technique	Zero
Total coliforms	TCR	[3]	Zero
Turbidity	SWTR	0.3[4]	-
Viruses	SWTR	Treatment Technique	Zero

[1] Sum of concentrations of five haloacetic acid species (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, dibromoacetic acid).
[2] Depends on source water concentration.
[3] No more than 5 percent of monthly samples may be positive for presence of coliforms.
[4] Performance standard; no more than 95 percent of monthly samples may exceed 0.3 NTU.

DBPR = Disinfection By-Products Rule
IESWTR = Interim Enhanced Surface Water Treatment Rule
LCR = Lead and Copper Rule
SWTR = Surface Water Treatment Rule
TCR = Total Coliform Rule

Table 7-3: Current Secondary Drinking Water Standards

Contaminant	SMCL
Aluminum	0.05 - 0.2 mg/L
Chloride	250 mg/L
Color	15 Color Units
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 Threshold Odor Units
pH	6.5 – 8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

Table 7-4: Disinfectant Residuals

Contaminant	MRDL[1]	MRDLG[2]
Chloramines, mg/L Cl2	4.0	4
Chlorine, mg/L	4.0	4
Chlorine dioxide, mg/L	0.8	0.8
[1] Maximum Residual Disinfectant Level. [2] Maximum Residual Disinfectant Level Goal.		

7.4. Existing Drinking Water Rules and Regulations

7.4.1. Surface Water Treatment Rule

The SWTR pertains to utilities which use surface water sources or groundwater sources "under the direct influence of surface water". Major provisions of the SWTR are as follows:

- Filtered water turbidity is to be equal to or less than 0.3 NTU in 95 percent of the monthly samples collected. The maximum allowable interval between turbidity measurements is four hours.
- The disinfectant concentration in the water entering the distribution system must be at least 0.2 mg/L
- The disinfectant residual within the distribution system must be "detectable" in at least 95 percent of the monthly monitoring samples.
- Removal and/or inactivation of *Giardia* cysts must be at least 3.0 logs (99.9 percent), and removal and/or inactivation of enteric viruses must be at least 4.0 logs (99.99 percent).

- Conventional clarification/filtration plants receive 2.5 log *Giardia* and 2.0 log virus removal credit, whereas direct filtration plants receive 2.0 log *Giardia* and 1.0 log virus removal credit.

7.4.2. Lead and Copper Rule

The Lead and Copper Rule (LCR), promulgated during May 1991, establishes "Action Levels" for lead and copper. Based on first-draw samples collected at taps within the distribution system, lead and copper concentrations must be less than 0.015 mg/L and 1.3 mg/L, respectively, in ninety percent of the samples. Selected sample sites must consist of single-family residences which contain copper pipes with lead solder installed after 1982, which contain lead pipes, or which are served by a lead service line. Following implementation of state-specified "optimal" treatment to minimize lead and copper concentrations at consumer taps, annual follow-up monitoring is required. If the results of follow-up monitoring indicated that the system is consistently in compliance with the lead and copper Action Levels, the state may elect to reduce the annual monitoring requirements. Should follow-up monitoring indicate noncompliance, the utility is required to initiate a public education program, collect additional water quality samples, and possibly begin a program of replacing lead service lines.

On October 10, 2007 USEPA published final revisions to the LCR. The revisions apply only to lead and do not amend the portion of the LCR pertaining to copper. The revisions include the following major components:

- Public water systems must notify their State primacy agency in advance and must obtain its approval before implementing any long-term changes in treatment of introduction of a new source of supply that could result in increased corrosion of lead. These changes would include a new treatment process of modification of an existing process, such as a change in secondary disinfectant, switching coagulants or corrosion inhibitors and/or changes in finished water PH of the concentration of corrosion inhibitor residuals.
- Utilities must provide written notification of the results of tap water monitoring for lead to consumers served from the sites (taps) that are tested.
- The requirements pertaining to the number of samples to be collected annually and the number of sampling sites used are clarified. In addition, the requirements state that all samples must be collected within the same calendar year.
- A new reduced monitoring requirement is added that prevents systems with water exceeding the action level for lead from remaining reduced monitoring status.
- The process of compliance determination for systems required to collect fewer than five samples annually has been revised.
- Systems will be required to reevaluate their lead service lines classified as "replaced through testing" if they resume a lead service line replacement program. (The current regulation allows utilities to consider lead service lines that test below the action level as "replaced" for the purposes for compliance.)
- Changes in public education requirements are outlined, including how educational materials must be delivered to consumers and the timeframe for delivery. Utilities must also include educational statements about lead in drinking water in their annual Consumer Confidence Report. The primary purpose of these changes is to provide

consumers with additional information to help them make decisions about how to limit their exposure to lead in drinking water.

7.4.3. Phase II and Phase V SOC / IOC Regulations

The Phase II regulation for synthetic organic chemicals (SOCs) and inorganic chemicals (IOCs) lists MCLs and Maximum Contaminant Level Goals (MCLGs) for 30 SOCs and 9 IOCs. Establishment of limits for three Phase II SOCs (aldicarb, aldicarb sulfone, and aldicarb sulfoxide) has been delayed, but is expected before the end of the year. Some chemicals added to treat the raw water may introduce potential contaminants and under the Phase II Rule, treatment techniques for two of these contaminants (acrylamide and epichlorohydrin) were established. Polymers containing acrylamide and/or epichlorohydrin are sometimes used to treat water supplies to remove particulate contaminants. When polymers containing acrylamide or epichlorohydrin are used in the treatment process, the utility must certify in writing to the state primacy agency (using third-party or manufacturer's certification) that the combination (or product) of dosage and monomer level does not exceed the following:

- Acrylamide: 0.05 percent dosed at 1 mg/L (or equivalent)
- Epichlorohydrin: 0.01 percent dosed at 20 mg/L (or equivalent)

The Phase V regulation lists MCLs and MCLGs for an additional 23 contaminants (18 SOCs and 5 IOCs). The MCL and MCLG for nickel included in the Phase V regulation were remanded by the US District Court during February 1995. Therefore, while utilities must continue to monitor for nickel in their treated water supplies, there currently is no USEPA legal limit on the amount of nickel in drinking water supplies. Contaminants regulated under the Phase II and Phase V regulations are primarily volatile organic compounds and pesticides/herbicides.

7.4.4. Total Coliform Rule

During June 1989, USEPA promulgated revisions to the 1995 regulation governing total coliform levels in water distribution systems. The 1989 rule expanded coliform monitoring requirements and specified new MCLs. Compliance with the monthly MCL under the Coliform Rule (TCR) is determined based on the presence or absence of coliform organisms. The Coliform Rule allows for up to 5 percent of the monthly water quality samples collected within the distribution system to test positive for coliforms. Fecal or *Escherichia* coliform levels are to be monitored for each sample where the presence of total coliforms is indicated. Public notification by electronic media (TV or radio) is required within 72 hours if a positive result indicates the presence of either fecal or *Escherichia* coliforms. The USEPA also modified the Total Coliform Rule to allow states to use a variance procedure for utilities encountering nonfecal biofilm problems in their distribution systems. Some coliform species, which are not classified as fecal, produce positive analytical results in total coliform and *E. coli* tests. States are allowed to disregard any coliform-positive analytical results that are speciated and not found to be of fecal origin.

7.4.5. Revised Total Coliform Rule

EPA published the Revised Total Coliform Rule (RTCR) in the Federal Register on February 13, 2013 and minor corrections on February 26, 2014. The intent of the RTCR is to increase public health protection through the reduction of potential pathways of entry for fecal contamination into the distribution system. The RTCR establishes a MCL for *E. coli* and uses *E. coli* and total coliforms to initiate a "find and fix" approach to address fecal contamination that could enter into the distribution system. *E. coli* is considered to be a more specific indicator of fecal

contamination and the potential presence of harmful pathogens than total coliform bacteria, the RTCR reflects a shift in compliance requirements that focuses more on the presence/absence of *E. coli* in the distribution system. Monitoring requirements remained the same, but under the RTCR, a system was required to test any total coliform-positive sample for *E. coli*. Any *E. coli*-positive sample must be reported to the state no later than the end of the next business day. Systems with violations are required to conduct assessments to find and fix the source of contamination. All public water systems (PWSs), except aircraft PWSs subject to the Aircraft Drinking Water Rule, must comply with the RTCR starting April 1, 2016.

7.4.6. Stage 1 Disinfection By-Products Rule

Stage 1 of the Disinfection By-Products Rule (DBPR) was finalized during late November 1998, and became effective during January 2002 for systems treating surface water supplies (or groundwater under direct surface water influence) serving 10,000 or more consumers. (Smaller surface water systems and systems treating groundwater not under direct surface water influence had until January 2004 to achieve compliance.) The primary objective of this rule is to protect human health by reducing the concentrations of disinfection by-products (DBPs) in drinking water. Major provisions of the Stage 1 DBPR are as follows:

- The MCL for total trihalomethanes has been reduced to 0.080 mg/L.
- New MCLs have been established for total haloacetic acids, bromate (a by-product of disinfection using ozone), and chlorite ion (a by-product of disinfection using chlorine dioxide).
- Maximum Residual Disinfectant Levels (MRDLs) and MRDL Goals (MRDLGs) have been established for free chlorine, chloramine, and chlorine dioxide.
- A treatment technique has been established which requires that surface water systems (or groundwater systems under direct surface water influence) operate in either an enhanced coagulation or enhanced softening mode to achieve specified removals of total organic carbon (TOC).

As stated above, under the Stage 1 DBPR, the MCL for total trihalomethanes has been reduced to 0.080 mg/L. In addition, a new MCL of 0.060 mg/L has been established for total haloacetic acids (referred to as HAA5, as 5 of the 9 known haloacetic acid compounds are regulated under the Stage 1 rule). New MCLs for bromate and chlorite ion of 0.010 mg/L and 1.0 mg/L, respectively, have also been established. Compliance with these MCLs is assessed based on the "running annual average" of quarterly monitoring data.

Under the Stage 1 DBPR, the maximum allowable disinfectant residual in the water leaving the treatment facility, based on a running annual average of monthly monitoring data, is 4.0 mg/L for free chlorine and chloramines, and 0.8 mg/L for chlorine dioxide. (Higher residuals are permissible on a short-term basis if necessary to address specific water quality problems, providing that running annual average concentrations do not exceed the MRDLs.)

A primary goal of the DBPR is to reduce the levels of organic/humic compounds (collectively referred to as DBP precursors) which react with chlorine-based disinfectants to form DBPs. This is to be accomplished through operation of treatment facilities in an "enhanced coagulation" or "enhanced softening" mode, which will typically involve increases in coagulant dosages and/or adjustment of operating pH to optimize the removal of the precursor compounds. Precursor removal is to be quantified by measuring the removal of TOC across the treatment process. In

general, for systems with average source water TOC concentrations exceeding 2.0 mg/L, enhanced coagulation/enhanced softening treatment will be required. Minimum TOC removal levels are summarized in Table 7-5. TOC removals must be determined monthly, and compliance is assessed quarterly based on a running annual average of monthly TOC removals.

Table 7-5: Step 1 TOC Removal Requirements for Enhanced Coagulation/Enhanced Softening

Source Water TOC, mg/L	Percent TOC Removal Required at Indicated Source Water Alkalinity		
	0 – 60 mg/L	>60 – 120 mg/L	>120 mg/L*
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%
*Systems practicing softening must meet the TOC removals shown in this column.			

The Stage 1 DBPR also provides alternative compliance criteria that are independent of the criteria discussed above. Systems can be exempted from the enhanced coagulation/enhanced softening requirements if any of the following conditions are met:

- The system's source water TOC is less than 2.0 mg/L (calculated quarterly as a running annual average of monthly monitoring data).
- The system's treated water TOC is less than 2.0 mg/L (calculated quarterly as a running annual average of monthly monitoring data).
- The system's source water TOC is less than 4.0 mg/L, the source water alkalinity is greater than 60 mg/L (as CaCO3), and the system is achieving TTHM concentrations less than 0.040 mg/L and HAA5 concentrations less than 0.030 mg/L.
- The system's running annual average TTHM concentration is less than 0.040 mg/L, and annual average HAA5 concentration is less than 0.030 mg/L, when only free chlorine is used for disinfection and maintenance of a residual in the distribution system. (Systems using chloramines would not comply with these conditions.)
- The system's source water specific UV absorbance (SUVA, defined as the ratio of the water's ultraviolet absorbance at 254 nm (UV254) to its dissolved organic carbon (DOC) concentration) prior to any treatment is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average of monthly monitoring data.
- The system's finished water SUVA is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average of monthly monitoring data. (This measurement must be made prior to the addition of a chemical oxidant, which will likely be problematic for most utilities).

Systems that elect to utilize one of these alternative criteria must still conduct monthly monitoring of source water TOC and alkalinity concentrations, and treated water TOC concentrations. Systems practicing lime softening may demonstrate compliance if they meet any of the six alternative compliance criteria listed above, or one of the following criteria:

- Softening that results in a reduction in the alkalinity of the treated water to less than 60 mg/L (as CaCO3), measured monthly and calculated quarterly as a running annual average.

- Softening that results in removal of at least 10 mg/L of magnesium hardness (as CaCO3), measured monthly and calculated quarterly as a running annual average.

If a system determines that it cannot achieve the TOC removals specified in Table 7-2 on a running annual average basis, and it does not meet any of the alternative compliance criteria listed above, it will be required to perform bench-scale or pilot-scale testing to set an alternative TOC removal requirement. (This is referred to as Step 2 testing.) Results of this testing must be reported to the state within three months of failing to achieve the TOC removal percentages presented in Table 7-5.

Under the Stage 1 DBPR, utilities serving more than 10,000 consumers must collect four DBP samples per quarter per treatment plant, and at least 25 percent of these samples must be collected at locations which reflect maximum system residence time. The Stage 1 rule also includes provisions for reduced monitoring if the following conditions are met:

- Source water TOC concentration (prior to any treatment) is less than or equal to 4.0 mg/L (based on a running annual average of monthly TOC data).
- The system annual average TTHM and HAA5 concentrations are less than or equal to 0.040 mg/L and 0.030 mg/L, respectively.

Systems that meet these requirements will be required to collect only one TTHM/HAA5 sample per quarter per plant at a distribution system location considered to reflect maximum residence time. Systems on a reduced monitoring schedule may remain on that schedule as long as running annual TTHM and HAA5 concentrations remain at 0.060 mg/L and 0.045 mg/L, respectively, and the annual average source water TOC concentration remains at 4.0 mg/L or less.

7.4.7. Interim Enhanced Surface Water Treatment Rule

The Interim Enhanced Surface Water Treatment Rule (IESWTR) was finalized during late November 1998, and became effective during January 2002 for systems serving 10,000 or more consumers. The rule applies to systems using surface water, or groundwater supplies under the direct influence of surface water. The primary objectives of this rule are to improve the control of microbial pathogens in drinking water (particularly *Cryptosporidium*), and to guard against significant increases in microbial risk that might occur when systems implement the Stage 1 DBPR. Primary requirements of the IESWTR are as follows:

- Systems with DBP levels exceeding or approaching the Stage 1 MCLs for trihalomethanes and haloacetic acids (0.080 mg/L and 0.060 mg/L, as discussed above) may consider changing their disinfection practices in order to comply with the new limits. However, in an effort to avoid increasing the risk from microbial contaminants while attempting to lower DBPs, USEPA will require systems which have annual average DBP concentrations within 80 percent of the new MCLs (i.e., >0.064 mg/L for TTHMs or 0.048 mg/L for HAA5) for the most recent 12-month monitoring period to prepare a "disinfection profile" for state review prior to altering disinfection practices. The disinfection profile is a compilation of daily criteria that affect the overall efficacy of the disinfection process, collected over a minimum of one year. The average level of microbial inactivation for each month is developed from the disinfection profile, and the lowest monthly average inactivation becomes the disinfection benchmark. A minimum of one year and a maximum of three years of daily disinfection performance data must be used to develop the disinfection profile. If the State does not approve changes in

disinfection, systems must develop alternate ways of reducing DBPs to meet the new MCLs.

- For those systems that do not have four quarters of distribution system HAA5 monitoring data available, HAA5 monitoring had to be conducted for four consecutive quarters and completed by March 2000.
- Allowable finished water turbidity is reduced from the present 0.5 NTU allowed under the SWTR to 0.3 NTU. This standard applies to the combined filtered water, and a minimum of 95 percent of the monthly turbidity measurements must meet the revised turbidity criteria. The turbidity of the combined filter effluent cannot exceed 1 NTU at any time. (The SWTR allowed for a maximum filter effluent turbidity of 5 NTU.)
- Continuous turbidity monitoring is required for each filter, and specific performance criteria will apply to each filter. Systems must record the results of individual filter turbidity monitoring at 15-minute intervals, and must maintain records of individual filter performance for a minimum of three years.
- Systems treating surface water (or groundwater under direct surface water influence) and serving more than 10,000 consumers must achieve at least a 2-log (99 percent) removal of *Cryptosporidium*. (The regulation states that systems that comply with the revised turbidity requirement of 0.3 NTU are assumed to be achieving compliance with the 2-log *Cryptosporidium* removal requirement.)
- States will be required to conduct sanitary surveys for all public water systems (regardless of size) no less frequently than every 3 years.

Under the IESWTR, systems are required to provide "an exceptions report to the State on a monthly basis". Exceptions to be reported consist of the following:

- Any individual filter with a turbidity level greater than 1.0 NTU based on 2 consecutive measurements 15 minutes apart.
- Any individual filter with a turbidity level greater than 0.5 NTU at the end of the first 4 hours of operation, based on 2 consecutive measurements 15 minutes apart.

A "filter profile" is to be produced if "no obvious reason for the abnormal filter performance can be identified". Other requirements are as follows:

- If an individual filter has turbidity levels greater than 1.0 NTU, based on 2 consecutive measurements 15 minutes apart at any time in each of three consecutive months, the water system is required to conduct a self-assessment of the filter utilizing "relevant portions" of guidance issued by USEPA under its Comprehensive Performance Evaluation (CPE) program.
- If an individual filter has turbidity levels greater than 2.0 NTU based on 2 consecutive measurements 15 minutes apart at any time in each of two consecutive months, the water system must arrange for a CPE to be conducted by the State or a third party approved by the State. The State will ensure that the recommendations resulting from the CPE are implemented.

7.4.8. Consumer Confidence Reports Rule

As directed by the 1996 SDWA Amendments, all Public Water Systems serving more than 500 consumers are required to prepare annual reports to advise their customers of the quality of the distributed water. The reports must contain a specific list of material such as information on the source water, an explanation of terms such as MCLs and MCLGs, data on levels of currently-regulated contaminants in the treated water, and information regarding potential health effects of the contaminants. Water wholesalers are not obliged to prepare annual reports for this purpose as the requirement falls to the distributors.

7.4.9. Radionuclides

Radionuclides normally present problems for systems that treat groundwater from deep wells or that are located downstream from an industrial source of radiation. A proposed rule for several radionuclides (radon, radium, alpha, beta, and photon emitters, and radium) was released in 1991, but not finalized until December 2000. This rule established a new MCL for uranium of 30 ug/L; however, USEPA elected to retain the MCLs for radium and alpha, beta, and photon emitters established under the original SDWA in 1976 with no modifications. The new regulation does include separate monitoring requirements for radium-228 under the combined MCL for radium-226 and radium-228.

7.4.10. Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was proposed concurrently with the LT1ESWTR during April 2000, but promulgated as a separate regulation during June 2001. Provisions of the FBRR addressing in-plant recycling of waste streams apply to all systems. In addition to filter backwash flows, recycle streams covered under this regulation consist of sludge thickener supernatant, and flows associated with sludge dewatering processes. Plants practicing recycle of these streams within the treatment plant must return them to a location such that all unit processes of a system's conventional or direct filtration process are employed in the treatment of the recycle flow or to a location approved by the State.

All systems that recycle these flows should have submitted a plant process schematic to the state regulatory agency for review by December 2003 showing the recycle return location and the proposed return location that will be used to establish compliance. Data on typical recycle flow rates, maximum recycle flow rates, and the plant design capacity and state-approved maximum operating capacity must also be submitted to the State. Systems must also collect and maintain additional information on filter operating data, recycle flow treatment provided, physical dimensions of recycle flow equalization and/or treatment units, and recycle flow rate and frequency data for review and evaluation by the state regulatory agency beginning June 2004.

Systems needed to comply with the recycle return provisions of the FBRR by June 2004. If the system required capital improvements to modify the location of the recycle return, these improvements must be in place and operational by June 2006.

The regulation does not address recycle of filter-to-waste flows. Process solids recycle flows from lime softening and contact clarification units are also not covered by the FBRR. However, softening systems may not return spent filter backwash, thickener supernatant, or liquids from solids dewatering processes to a location that does not incorporate all unit treatment processes unless approved by the State.

7.4.11. Stage 2 Disinfectants and Disinfection By-Products Rule

As part of the 1996 amendments to the SDWA, Congress established deadlines for promulgation of new regulations governing both DBPs and microbial contaminants. USEPA was required to promulgate a Stage 2 regulation for the DBPR (Stage 2 DBPR), and a Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). These two rules are closely related and were referred to collectively as the Stage 2 MDBP Rules. Like their predecessors, these rules were developed simultaneously to balance trade-offs in risk between the control of pathogens and the desire to limit exposure to disinfection by-products.

The final Stage 2 DBPR was promulgated on January 4, 2006 and contains MCLGs for several THM species; NPDWRs that set MCLs, monitoring, reporting, and public notification requirements for total THMs and HAA5; and revisions to the reduced monitoring requirements for bromate. This rule also specifies the BAT for compliance with the final MCLs, and approves additional analytical methods for measurement of disinfectants and DBPs in drinking water.

Stage 2 DBPR requirements will apply to all *community water systems* (CWSs) and *non-transient non-community water systems* (NTNCWS) that add a disinfectant other than UV light or deliver water that has been disinfected by a primary or residual disinfectant other than UV light. This rule utilizes a risk-targeted approach to reduce health risks from exposure to DBPs in drinking water. The rule focuses on identifying those locations within a distribution system that have the highest DBP levels, and mitigates exposure by using a new method for monitoring and reporting, which is called the *locational running annual average* at each DBP monitoring site. The State 2 DBPR also defines *operational evaluation levels* and regulates *consecutive systems*. In the Stage 2 DBPR, MCLs for TTHMs and HAAs will remain at the levels established under the Stage 1 DBPR, i.e., 0.080 mg/L and 0.060 mg/L, respectively.

All DBP monitoring required by the Stage 2 DBPR is based on the *population served* by a water system. This approach was selected to streamline implementation for both water systems and primacy agencies, and specifically addresses monitoring requirements for *consecutive systems* that are part of a *combined distribution system*. Consecutive systems are defined in the final rule as PWSs that receive some or all of their finished water from one or more wholesale systems. Each State agency groups individual water systems into combined distribution systems as appropriate, which are reported to USEPA. For the purpose of defining combined distribution systems, States use their expertise and extensive knowledge of local operational practices to determine the nature of interconnections between systems. For example, at the discretion of the state, two systems interconnected only by an emergency connection may be considered not to constitute a combined distribution system. *Consecutive systems within a combined distribution system must comply with the requirements of the Stage 2 DBPR on the same schedule as required for the largest system in their combined distribution system.* The compliance schedule for all Stage 2 DBPR requirements is based on the population of the largest system in a combined distribution system as shown in Table 7-6. The implementation schedule for groups 1, 2, 3, and 4, is shown in Figure 7-1. Under Stage 2 DBPR/LT2ESWTR, Source Water Monitoring Round 2 is also required. Round 2 sampling must being no later than:

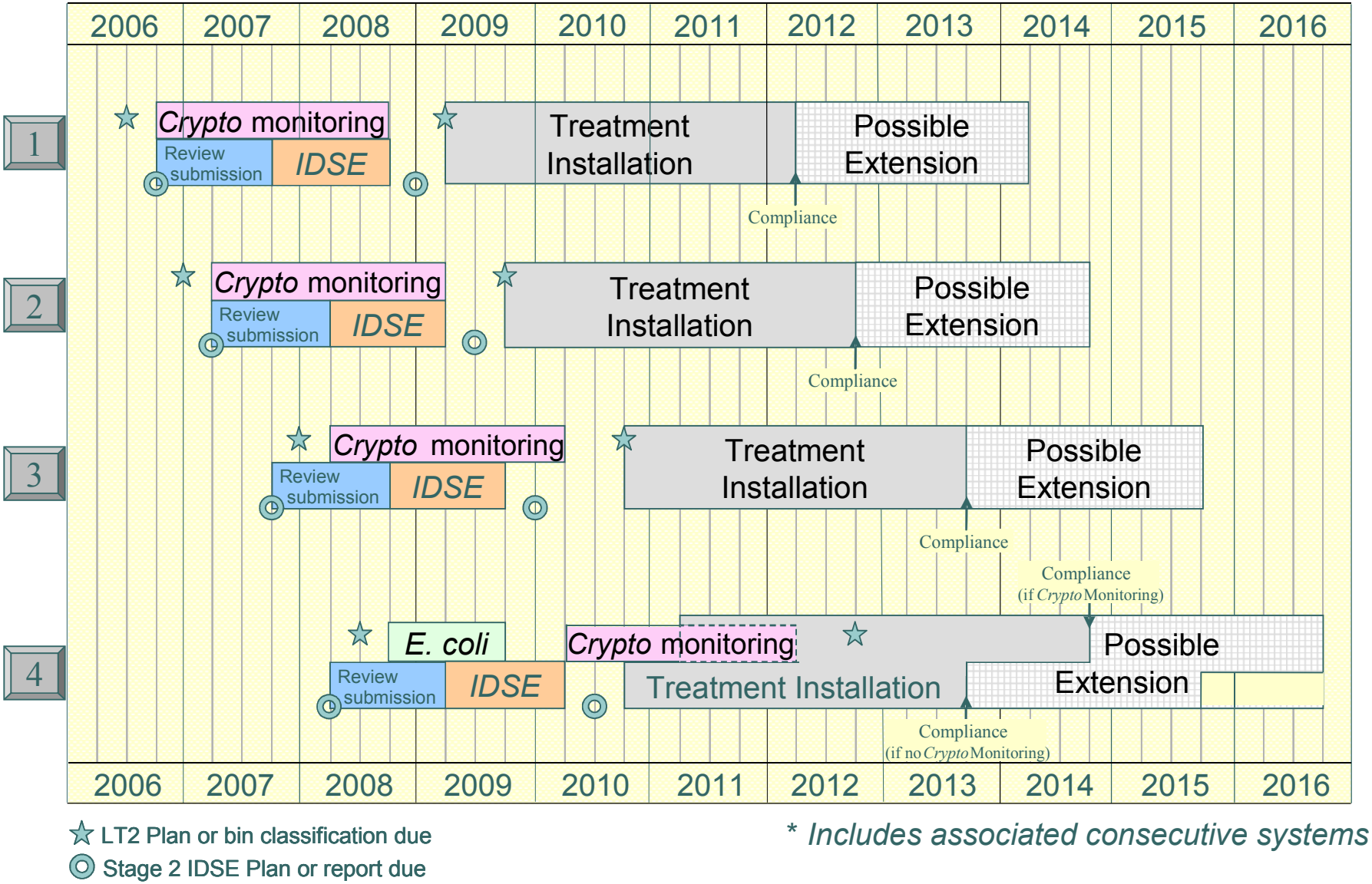
- April 2015 (Compliance Schedule 1);
- October 2015 (Compliance Schedule 2);
- October 2016 (Compliance Schedule 3);

- October 2017 (Schedule 4 monitor for *E. coli*);
- April 2019 (Compliance Schedule 4 monitor for *Crypto*).

Table 7-6: Population-Based Compliance Schedule for Stage 2 DBPR

System Size	Compliance Schedule
Systems serving 100,000 or more people or part of a combined distribution system in which the largest system serves 100,000 or more people	1
Systems serving 50,000 to 99,999 people or part of a combined distribution system in which the largest system serves 50,000 to 99,999 people	2
Systems serving 10,000 to 49,9999 people or part of a combined distribution system in which the largest system serves 10,000 to 49,999 people	3
Systems serving fewer than 10,000 people and not connected to a system that serves more than 10,000 people	4

Figure 7-1: Implementation Schedule for the Stage 2 DBPR and LT2ESWTR



7.4.11.1. Initial Distribution System Evaluation

The Initial Distribution System Evaluation (IDSE) provision of the Stage 2 DBPR is designed to identify monitoring sites that have the highest DBP levels. Identifying compliance monitoring sites with the highest DBP concentrations in a water provider's distribution system offers increased assurance that MCLs are met across the distribution system, and that customers are receiving more equitable public health protection.

IDSE requirements apply to *all* CWSs and NTNCWSs *serving at least* 10,000 people that use a primary or residual disinfectant other than UV light or that deliver water that has been treated with a primary or residual disinfectant other than UV light. With the exception of the exemptions discussed below, each system must develop an *IDSE plan*, collect data on DBP occurrence in its distribution system, analyze these data to determine sampling locations that have consistently high DBP levels, and submit this information in a report to the State.

7.4.11.2. IDSE Compliance Options

There are four ways in which a water system may meet the requirements of the IDSE provision of the Stage 2 DBPR. These options require either: 1) collection of new DBP data on a specified schedule in addition to Stage 1 DBPR monitoring requirements (*Standard Monitoring Plan*), 2) use of qualifying existing DBP monitoring or hydraulic modeling data (*System Specific Study*), 3) certification that all existing DBP monitoring data is less than half of TTHM and HAA5 MCLs with no monitoring violations (*40/30 Certification*), or 4) exemption from IDSE monitoring requirements for systems that serve less than 500 people and that have DBP data collected under the Stage 1 DBPR (*Very Small System Waiver*).

(1) *Standard Monitoring Plan.* Systems that select the Standard Monitoring Plan (SMP) option must conduct DBP monitoring throughout their distribution system for one year, on a schedule that is based on the population served and the type of water source. All systems that conduct IDSE standard monitoring must include the *peak historical month* for DBP levels or water temperature in their sample plan. Prior to beginning IDSE standard monitoring, systems must prepare a study plan and submit it to the primacy agency for approval. Table 7-7 lists monitoring frequencies and location which are based on the system size and the type of water source.

Table 7-7: IDSE Standard Monitoring Plan Sampling Frequencies and Locations

Sampling Requirements for IDSE Standard Monitoring Plan							
Source Water Type	CWS Population	Sampling Frequency	Distribution System Monitoring Locations[1]				
			Total per Monitoring Period	Near Entry Point	Average Residence Time	High TTHM Locations	High HAA_5 Locations
Surface Water	<500 consecutive systems	Once during peak historical month[2]	2	1	-	1	-
	<500 non-consecutive systems		2	-	-	1	1
	500 - 3,300 consecutive systems	Every 90 days	2	1	-	1	-
	500 - 3,300 non-consecutive systems		2	-	-	1	1
	3,301 – 9,999		4	-	1	2	1
	10,000 – 49,999	Every 60 days	8	1	2	3	2
	50,000 – 249,999		16	3	4	5	4
	250,000 – 999,999		24	4	6	8	6
	1,000,000 – 4,999,999		32	6	8	10	8
	≥5,000,000		40	8	10	12	10
Ground Water	<500 consecutive systems	Once during peak historical month[2]	2	1	-	1	-
	<500 non-consecutive systems		2	-	-	1	1
	500 – 9,999	Every 90 days	2	-	-	1	1
	10,000 – 99,999		6	1	1	2	2
	100,000 – 499,999		8	1	1	3	3
	≥500,000		12	2	2	4	4

[1]A dual sample set (i.e. a TTHM and an HAA5 sample) must be taken at each monitoring location during each monitoring period.
[2]The peak historical month is the month with the highest TTHM or HAA5 levels or the warmest temperature.

(2) *System Specific Study.* Under this approach, public water providers may choose to perform a system specific study (SSS) based on earlier monitoring studies or distribution system hydraulic models in lieu of standard monitoring. The two options for system specific studies are (1) historical or new TTHM and HAA monitoring data that encompass a wide range of sample sites representative of the entire distribution system, including those judged to represent high TTHM and HAA concentrations, and (2) *extended period simulation* hydraulic models that simulate water age in the distribution system, in conjunction with one round of TTHM and HAA sampling. Prior to beginning a SSS, systems must prepare a study plan and submit it to the

primacy agency for approval. Table 7-8 lists the number of sampling locations and frequency associated with using existing monitoring data in a SSS. Table 7-9 lists the number of sampling locations and frequency associated with using modeled data in a SSS. To qualify for inclusion in a SSS, existing data must have been collected within 5 years of the study plan submission date and include samples at each location during the month of peak TTHM and HAA levels or the month of warmest water temperature. Furthermore, data collected for IDSE SSSs are in addition to Stage 1 DBPR compliance monitoring data.

Table 7-8: IDSE System Specific Study - Existing Monitoring Data Sample Requirements

System Type	Population	Number of Monitoring Locations	Number of Samples	
			TTHM	HAA_5
Surface Water	<500	3	3	3
	500 – 3,300	3	9	9
	3,301 – 9,999	6	36	36
	10,000 – 49,999	12	72	72
	50,000 – 249,999	24	144	144
	250,000 – 999,999	36	216	216
	1,000,000 – 4,999,999	48	288	288
	≥5,000,000	60	360	360
Ground Water	<500	3	3	3
	500 – 9,999	3	9	9
	10,000 – 99,999	12	48	48
	100,000 – 499,999	18	72	72
	≥500,000	24	96	96

Table 7-9: IDSE Requirements for Modeling SSS Sampling

Source Water Type	Population Size Catergory[1]	Distribution System Monitoring Locations[2]				
		Total Number of Samples	Near Entry Points	Average Residence Time	High TTHM Locations	High HAA% Locations
Subpart H	<500 consecutive systems	2	1	---	1	---
	<500 non-consecutive systems	2	---	---	1	1
	500 – 3,300 consecutive systems	2	1	---	1	---
	500 – 3,300 nonconsecutive systems	2	---	---	1	1
	3,301 – 9,999	4	---	1	2	1
	10,000 – 49,999	8	1	2	3	2
	50,000 – 249,999	16	3	4	5	4
	250,000 – 999,999	24	4	6	8	6
	1,000,000 – 4,999,999	32	6	8	10	8
	≥5,000,000	40	8	10	12	10

Source Water Type	Population Size Catergory[1]	Distribution System Monitoring Locations[2]				
		Total Number of Samples	Near Entry Points	Average Residence Time	High TTHM Locations	High HAA% Locations
Ground Water	<500 consecutive systems	2	1	---	1	---
	<500 non-consecutive systems	2	---	---	1	1
	500 – 9,999	2	---	---	1	1
	10,000 – 99,999	6	1	1	2	2
	100,000 – 499,999	8	1	1	3	3
	≥500,000	12	2	2	4	4

Extended period simulation hydraulic models must conform to extensive requirements to qualify for use in IDSE SSSs. Models must simulate 24-hour demand variation and show a consistently repeating 24-hour pattern of residence time. At a minimum, models must represent 75 percent of distribution system pipe volume, 50 percent of pipe length, all 12-inch or larger pipes, many 8- and 6-inch pipes, all storage facilities with standard operations represented, all active pump stations with controls represented, and all control valves. The model must also be calibrated for the current distribution system configuration during the period of high TTHM formation potential within 12 months of plan submission. In addition, at least one round of TTHM and HAA monitoring at a number of locations equal to or greater than required for standard monitoring must be performed during the month of historical peak TTHM.

(3) *40/30 Certification*. Systems with consistently low DBP levels may apply for 40/30 certification and exemption from the IDSE provisions of the Stage 2 DBPR. Systems must certify to the State that every individual compliance sample collected during a specified period of Stage 1 DBPR monitoring was less than or equal to 0.040 mg/L for TTHM and less than or equal to 0.030 mg/L for HAAs, and that the system had no monitoring violations during the same period. Stage 1 DBPR monitoring results, a distribution system schematic, or recommended Stage 2 DBPR monitoring sites may also be required at the State's discretion. The schedule for 40/30 certification data collection is listed in Table 7-10.

Table 7-10: 40/30 Certification Eligibility Dates

If your 40/30 Certification is Due	Eligibility for 40/30 certification is based on 8 consecutive calendar quarters of Stage 1 DBPR compliance monitoring results beginning no earlier than:
October 1, 2006	January, 2004
April 1, 2007	January, 2004
October 1, 2007	January, 2005
April 1, 2008	January, 2005

(4) *Very Small Water System Waiver*. Systems serving fewer than 500 people are covered by the very small system provisions of the Stage 2 DBPR and are not required to complete an IDSE if they have collected TTHM and HAA compliance data under the Stage 1 DBPR. However, states

can require a very small system to complete an IDSE if the system has a complex or extended distribution system that the State feels should be studied further.

7.4.11.3. IDSE Reporting Requirements

After monitoring for one year, a final summary report is due to the primacy agency. The reports must include the following information:

- The original SMP plan and an explanation of any deviations from the plan
- All analytical results
- All analytical results from the Stage 1 DBPR monitoring locations collected during the one-year IDSE sampling period
- A schematic of the distribution system that indicates the location, sampling date, and results of all IDSE and Stage 1 DBPR samples
- Information and data used to select the IDSE sampling sites
- A list of the Stage 2 DBPR sampling locations selected for compliance monitoring along with a rationale for their selection
- A sampling schedule (with proposed months) for collection of the compliance monitoring samples

7.4.11.4. Stage 2 DBPR Compliance Monitoring

For all systems conducting either a SMP or a SSS, initial Stage 2 DBPR compliance monitoring locations are based on the system's IDSE data, as well as analysis of the system's Stage 1 DBPR compliance monitoring results. System's receiving 40/30 certification or a very small system waiver, and NTNCWSs serving <10,000 people not required to conduct an IDSE, select initial Stage 2 compliance monitoring sites based on Stage 1 compliance monitoring results. The monitoring frequencies are shown in Table 7-11.

Table 7-11: Routine Compliance Monitoring Frequencies for Stage 2 DBPR Sites

System Type	Population	Monitoring Frequency	Number of Sample Locations per Monitoring Period[(1)]
Surface Water	<500	per year	2
	500 – 3,300	per quarter	2
	3,301 – 9,999	per quarter	2
	10,000 – 49,999	per quarter	4
	50,000 – 249,999	per quarter	8
	250,000 – 999,999	per quarter	12
	1,000,000 – 4,999,999	per quarter	16
	≥5,000,000	per quarter	20
Ground Water	<500	per year	2
	500 – 9,999	per year	2
	10,000 – 99,999	per quarter	4
	100,000 – 499,999	per quarter	6
	≥500,000	per quarter	8

[(1)]CWSs that are required to sample quarterly must take dual samples (TTHM andHAA_5) at each location, except for systems that serve 500 – 3,300 people.

Should an MCL be exceeded at one or more system monitoring points (based on annual running average DBP concentrations), the system would be considered to be in violation of the Stage 2 regulation, regardless of results for the remaining monitoring sites. This represents a major change from current TTHM and Stage 1 DBP regulations, as the "system averaging" concept would be eliminated under the Stage 2 regulation.

7.4.11.5. Reduced monitoring

Systems that have completed one year of routine monitoring at IDSE sites, and that exhibit TTHM and HAA5 locational running annual average concentrations of no more than 0.040 mg/L and 0.030 mg/L, respectively, at all sites, and annual average source water TOC levels of 4.0 mg/L or less will be allowed to reduce the number of dual DBP samples collected to two per quarter per treatment plant. (For each quarterly sample pair, one sample would need to be collected at a location reflecting maximum TTHM levels, while the remaining sample would need to be collected at a location reflecting maximum HAA5 levels.)

7.4.11.6. Operational Evaluation Levels

The Stage 2 M-DBP Advisory Committee also recommended that systems document peaks in TTHM and HAA5 concentrations that may occur in their distribution systems as part of the sanitary survey process, and USEPA has adopted this recommendation in the Stage 2 DBPR. USEPA has prepared guidance for systems and State primacy agencies on how to conduct peak excursion evaluations and how to reduce peaks. Utilities experiencing these peaks would be required to (1) evaluate system operational practices to identify opportunities to reduce DBP levels, (2) prepare a written report of the evaluation, and (3) review the evaluation with the State regulatory agency.

7.4.11.7. Best Available Technology

Best available technologies (BATs) for compliance with the LRAA MCLs:

- GAC adsorbers with at least 10 minutes of empty bed contact time and an annual average carbon reactivation/replacement frequency no greater than 120 days plus enhanced coagulation / enhanced softening.
- GAC adsorbers with at least 20 minutes of empty bed contact time and an annual average carbon reactivation/replacement frequency no greater than 240 days.
- Nanofiltration using a membrane with a molecular weight cutoff of 1000 Daltons or less.

For consecutive systems the Stage 2 DBPR specifies that BAT is chloramination with management of system hydraulic flow and storage to minimize residence time in the distribution system.

7.4.11.8. Bromate

Considerable pressure to reduce the Stage 1 MCL for bromate to 0.005 mg/L or less currently exists, as ongoing research suggests that this contaminant may be more carcinogenic than originally believed. This change would primarily impact utilities practicing ozonation for primary disinfection. The Stage 2 DBPR retains the MCL for bromate at the previous value of 0.010 mg/L. As recommended by the Stage 2 M-DBP Advisory Committee, USEPA will review the bromate MCL as part of the Six-Year National Primary Drinking Water Regulations (NPDWR) review process required under the SDWA to determine whether the MCL should

remain at 0.010 mg/L or be reduced. The results of the latest Six-Year NPDWRs review (prepublication date 12/20/2016) available at the time of this document concluded the current MCL for bromate remains appropriate.

7.4.12. Long-Term 2 Enhanced Surface Water Treatment Rule

The Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESTWR) was finalized on January 5, 2006. This rule applies to all public water systems that use surface water or groundwater under the direct influence of surface water (Subpart H systems). The primary purpose of this rule is to improve control of microbial pathogens, specifically *Cryptosporidium*. The final rule includes an initial period of raw water microbial monitoring, with treatment requirements based on microbial contaminant levels in the supply. The results from the initial round of monitoring will be used to determine the appropriate *bin classification* for each CWS. The bin classifications determine the amount of additional treatment required beyond the removal credit awarded for complying with the IESWTR (i.e., 0.3 NTU for combined filter effluent turbidity for conventional treatment).

(1) Source Water Monitoring. The LT2ESWTR includes an initial period of raw water microbial monitoring, with any additional treatment requirements subsequently established based on microbial contaminant levels present in the supply. Filtered water systems serving at least 10,000 consumers must sample their source water for *Cryptosporidium*, *E. coli*, and turbidity at least monthly over a 2-year period. Specific regulatory compliance requirements will then be established based on the following:

- If monthly samples are collected, classification is to be based on the highest 12-month running annual average.
- If the system conducts monitoring twice per month, classification is to be based on a 2-year mean value of all monitoring data. (This increased monitoring must be conducted at evenly distributed time intervals over the 2-year period.)

Filtered systems serving fewer than 10,000 consumers must sample their source water for *E. coli* at least once every two weeks for 12 months. These systems must also sample their source water for *Cryptosporidium* at least twice per month for 12 months or at least monthly for 24 months if any of the following apply:

- For systems using lake/reservoir sources, the annual mean *E. coli* concentration is greater than 10 *E. coli* per 100 mL.
- For systems using flowing stream sources, the annual mean *E. coli* concentration is greater than 50 *E. coli* per 100 mL.
- The system fails to conduct the required 12 months of source water monitoring for *E. coli*.

Systems serving fewer than 10,000 consumers using ground water under direct influence of surface water influence (GWUDI) must comply with these requirements based on the *E. coli* level that applies to the nearest surface water body. If no surface water body is nearby, the system must comply with the requirements that apply to systems using lake/reservoir sources.

Schedules for initiation of source water monitoring are staggered based on the number of consumers served. Wholesale systems (systems that treat source water as necessary to produce finished water and then deliver some or all of that finished water to another public water system) must comply with the schedule of the largest system in the combined distribution system. (The

combined distribution system is the interconnected system consisting of the distribution system of wholesale systems and consecutive systems that receive finished water.)

Samples are to be collected from the raw water supply prior to any treatment/chemical addition. Treatment bin classification under the LT2ESWTR, based on average raw water *Cryptosporidium* oocyst concentrations, are summarized in Table 7-12 and additional *Cryptosporidium* treatment required as a function of bin classification and existing filtration treatment provided is summarized in Table 7-13.

Table 7-12: Bin Classification for Filtered Systems Under LT2ESWTR

Bin Classification for Filtered Systems Under LT2ESWTR	
Raw Water *Cryptosporidium* Concentration, oocysts per Liter[1]	Bin Classification[2]
Cryptosporidium < 0.075/L	Bin 1
0.075/L ≤ Cryptosporidium <1.0/L	Bin 2
1.0/L ≤ Cryptosporidium <3.0/L	Bin 3
Cryptosporidium ≥ 3.0/L	Bin 4

[1]Based on maximum value for 12-month running annual average, or 2-year arithmetic mean if twice-monthly monitoring is conducted.
[2]Systems serving fewer than 10,000 consumers and NOT required to monitor for Cryptosporidium are classified as Bin 1.

Table 7-13: Additional *Cryptosporidium* Treatment Requirements

Additional *Cryptosporidium* Treatment Requirements				
Bin Classification	Average Raw Water *Cryptosporidium* Concentration, oocysts per Liter	Additional *Cryptosporidium* Inactivation/Removal Requirements		
		Conventional Filtration (including softening), Slow Sand, Diatomaceous Earth Filtration	Direct Filtration	Alternative Filtration Technology
1	< 0.075	None	None	None
2	0.075 to <1.0	1-log	1.5-log	(1)
3	1.0 to < 3.0	2-log[2]	2.5-log	(3)
4	≥ 3.0	2.5-log[2]	3-log	(4)

[1]As determined by the State such that total *Cryptosporidium* removal/inactivation is at least 4.0-log.
[2]At least 1-log additional treatment must be provided by bag filters, bank filtration, cartridge filters, chlorine dioxide, membranes, ozone, and/or UV.
[3]As determined by the State such that total *Cryptosporidium* removal/inactivation is at least 5.0-log.
[4]As determined by the State such that total *Cryptosporidium* removal/inactivation is at least 5.5-log.

Systems will choose technologies to comply with additional treatment requirements from a "toolbox" of options, including improved watershed control, improved treatment system and/or disinfection performance, and additional treatment barriers. Specific "tools" identified, and the associated log treatment credits, are summarized in Table 7-14.

Table 7-14: Microbial Toolbox Options, Log Credits, and Design/Implementation Criteria

Toolbox Option	*Cryptosporidium* Log Credit
Source Protection and Management Toolbox Options	
Watershed Control Program	0.5 log credit for State-approved program comprising required elements, annual program status report to State, and regular watershed survey. Does not apply to unfiltered systems.
Alternative Source / Intake Management	No prescribed credit. Systems may conduct simultaneous monitoring for treatment bin classification at alternative intake locations or under alternative intake management strategies.
Prefiltration Toolbox Options	
Pre-sedimentation Basin with Coagulation	0.5 log credit during any month the pre-sedimentation basins achieve a monthly mean turbidity reduction of 0.5-log (68.4%) or greater or alternative State-approved performance criteria. Basins must be operated continuously with coagulant addition, and all plant flow must pass through the basins.
Two-Stage Lime Softening	0.5 log credit for two-stage softening where chemical addition and hardness precipitation occur in both stages. All plant flow must pass through both stages. Single-stage softening is credited as equivalent to conventional treatment.
Bank Filtration	0.5 log credit for 25 ft. setback; 1.0 log credit for 50 ft. setback; aquifer must be unconsolidated sand containing at least 10% fines; average turbidity in wells must be < 1 NTU. Systems using wells followed by filtration when conducting source water monitoring must sample the well to determine bin classification and are not eligible for additional credit.
Treatment Performance Toolbox Options	
Combined Filter Performance	0.5 log credit for combined filter effluent ≤ 0.15 NTU in at least 95% of measurements each month.
Individual Filter Performance	0.5-log credit (in addition to 0.5-log combined filter performance credit) if individual filter effluent turbidity ≤ 0.15 NTU in at least 95 percent of samples each month in each filter and is never greater than 0.3 NTU in two consecutive measurements in any filter.
Demonstration of Performance	Credit awarded to unit process or treatment train based on demonstration to the State, with State-approved protocol.
Additional Filtration Toolbox Options	
Bag or Cartridge Filters (individual filters)	Up to 2-log credit based on the removal efficiency demonstrated during challenge testing with a 1.0-log factor of safety.
Bag or Cartridge Filters (in series)	Up to 2.5-log credit based on the removal efficiency demonstrated during challenge testing with a 0.5-log factor of safety.
Membrane Filtration	Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing.
Second Stage Filtration	0.5 log credit for second separate stage of granular media filtration if treatment train includes coagulation prior to first filter.
Slow Sand Filters	2.5 log credit as a secondary filtration step; 3.0 log credit as a primary filtration process. No prior chlorination for either option.
Inactivation Toolbox Options	
Chlorine Dioxide	Log credit based on CT in relation to CT table.
Ozone	Log credit based on CT in relation to CT table.
UV	Log credit based on validated UV dose table in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions.

Six years after completion of initial system classification, systems will be required to initiate a second round of source water monitoring. This process could result in system reclassification (to determine additional treatment requirements for *Cryptosporidium*) under the current regulatory structure, or in promulgation of a revised regulation.

(2) Use of Existing Source Monitoring Data. With primacy agency approval, systems with at least two years of historical source water *Cryptosporidium* monitoring data that is equivalent in sample number, frequency, and quality to the data required under the LT2ESWTR may use those data to determine bin placement in lieu of conducting additional monitoring. (These monitoring results are referred to in the LT2ESWTR as "grandfathered" data.) Samples must have been collected at least each calendar month on a regular schedule, started not earlier than January 1999, and the laboratory that conducted the analyses must certify that all applicable quality assurance/quality control requirements have been met. Systems that elect to use historical data in lieu of conducting new monitoring must certify that the samples are representative of the source water and that all results are included in the submittal.

(3) Uncovered Finished Water Storage Facilities. Systems using uncovered finished water storage facilities must notify the primacy agency of the use of these facilities not later than April 1st 2008, and must meet one of the following conditions (or be in compliance with an approved schedule to meet these conditions) not later than April 1st 2009:

Systems must cover any uncovered finished water storage facility.

Systems must treat the discharge from the uncovered finished water storage facility to the distribution system to achieve inactivation and/or removal of at least 4-log virus, 3-log *Giardia lamblia*, and 2-log *Cryptosporidium* using a protocol approved by the State.

(4) Disinfection Profiling / Benchmarking. Following completion of the initial round of source water monitoring, systems that will need to make significant changes in disinfection practices in order to maintain compliance with the LT2ESWTR and/or the Stage 2 DBPR will be required to develop disinfection profiles and calculate disinfection benchmarks for *Giardia lamblia* and viruses. Prior to modifying the disinfection process, systems must notify the State, and must submit the following information:

- A completed disinfection profile and benchmark for *Giardia lamblia* and viruses.
- A description of the proposed change(s) in disinfection practice.
- An analysis of how the proposed changes will affect the current level of disinfection.

Significant changes to disinfection practice are defined in the LT2ESWTR as the following:

- Changes to the point of disinfection;
- Changes to the disinfectant(s) used in the treatment plant;
- Changes to the disinfection process;
- Any other modification identified by the State as a significant change to disinfection practice.

In preparing the disinfection profile and benchmark, systems must monitor disinfection conditions at least weekly for a period of 12 consecutive months to assess total log *Giardia* and virus inactivation levels. Systems must determine log *Giardia* inactivation through the entire plant based on published CT values, and log virus inactivation through the entire plant based on a State-approved protocol. Systems that have at least one year of existing disinfection monitoring data may utilize that information in preparing the disinfection profiles, and up to three years of existing data may be used in preparing the profiles (assuming that no changes in disinfection practices or source water were made during the period that the existing data were collected). The disinfection benchmark is the lowest mean value (for systems with one year of profiling data) or the mean of the lowest monthly mean values (for systems with more than one year of profiling data) of *Giardia* and virus log inactivation in each year of profiling data.

(5) Compliance Assistance / Guidance Documents. EPA issues guidance documents to assist systems and primacy agencies implement and comply with new regulations. For the LT2ESWTR, EPA has announced that it will publish the following 8 guidance manuals:

- Source Water Monitoring Guidance for Public Water Systems
- Microbial Laboratory Guidance
- Small Entity Compliance Guidance
- Microbial Toolbox Guidance Manual
- Ultraviolet Disinfection Guidance Manual
- Membrane Filtration Guidance Manual
- Simultaneous Compliance Guidance Manual for Stage 2 Rules
- Low-Pressure Membrane Filtration for Pathogen Removal: Application, Implementation, and Regulatory Issues

(6) Compliance Schedule. A summary of key compliance dates under the LT2ESWTR is presented in Table 7-15.

Table 7-15: Key Dates for LT2ESWTR Compliance

Activity	Compliance Date vs. Population Served			
	≥100,000	50,000-99,999	10,000-49,999	<10,000
Source Water Monitoring Plan Submittal Deadline[1]	07/01/2006	01/01/2007	01/01/2008	07/01/2008[2] 01/01/2010[3]
Deadline for Initiating Source Water Monitoring Program	10/01/2006[4]	04/01/2007[3]	04/01/2008[3]	10/01/2008[5] 04/01/2010[6]
Deadline for Submittal of Grandfathered *Cryptosporidium* Monitoring Data	12/01/2006	06/01/2007	06/01/2008	12/01/2008
Deadline for Completion of Source Water Monitoring Program	09/30/2008	03/31/2009	03/31/2010	09/30/2009[5] 03/31/2011[7] 03/31/2012[8]
Submit Source Water Monitoring Report with Bin Placement	04/01/2009	10/01/2009	10/01/2010	10/01/2011[7] 10/01/2012[8]
Deadline for Compliance with Additional Treatment Requirements	04/01/2012	10/01/2012	10/01/2013	10/01/2014
Initiate Second Round of Source Water Monitoring	04/01/2015	10/01/2015	10/01/2016	10/01/2017[5] 04/01/2019[6]

[1]Including notice of intent to submit previously-collected ("grandfathered") monitoring data
[2]Monitoring plan for *E. coli.*
[3]Monitoring plan for *Cryptosporidium*, if monitoring required.
[4]Monitor *Cryptosporidium*, *E. coli*, and turbidity; minimum of once per month for 2 years.
[5]Monitor source water *E. coli* biweekly for 1 year
[6]Monitor source water for *Cryptosporidium* (if req'd) twice per month for 1 year or monthly for 2 years.
[7]If *Cryptosporidium* monitoring required and conducted over 1 year.
[8]If *Cryptosporidium* monitoring required and conducted over 2 years.
[9]2-year compliance extension available (with State approval) if capital improvements required.

7.4.13. Arsenic Rule

USEPA proposed revisions to the current drinking water standard for arsenic during May 2000, and promulgated a new MCL of 0.010 mg/L during January 2001. The new MCL became effective January 2006.

7.4.14. Ground Water Rule

EPA issued the Ground Water Rule (GWR) in October 2006 to improve drinking water quality and provide additional protection from disease-causing microorganisms. Communities that use ground water as a source of drinking water (either for their entire supply or a portion of their supply) are covered under this regulation. (Public water systems that use ground water under the influence of surface water, or that blend ground water with surface water prior to treatment are not affected by this regulation.)

A key aspect of the GWR is whether shallow ground water supplies are susceptible to microbial contamination. These supplies will be termed "vulnerable," and disinfection will be required. State-led sanitary surveys will determine if disinfection is necessary.

The targeted, risk-based strategy addresses risks through an approach that relies on four major components:

- Periodic sanitary surveys of systems to be conducted by the State every 3 years that require the evaluation of eight critical elements of a public water system and the

identification of significant deficiencies (e.g., a well located near a leaking septic system);

- Hydrogeologic Sensitivity Assessment; will apply only to those systems that do not provide disinfection/treatment to achieve at least 4-log removal/inactivation.
- Triggered source water monitoring when a system (that does not already treat drinking water to remove 99.99 percent (4-log) of viruses) identifies a positive sample during its Total Coliform Rule monitoring and assessment monitoring (at the option of the state) targeted at high-risk systems;
- Corrective action is required for any system with a significant deficiency or source water fecal contamination; and
- Compliance monitoring to ensure that treatment technology installed to treat drinking water reliably achieves 99.99 percent (4-log) inactivation or removal of viruses.

Systems were subject to the triggered source water monitoring requirements beginning December 1, 2009. States were required to complete initial sanitary surveys of individual systems by December 31, 2012, for most community water systems (CWSs), and by December 31, 2014, for CWSs with outstanding performance and for all non-community water systems. Systems determined to have deficiencies during their sanitary survey had up to 120 days to correct all deficiencies, eliminate the contamination source, switch to a different source, or provide treatment that will reliably achieve at least 4-log removal/inactivation of viruses. Neither general variances nor exemptions from the regulatory requirements are granted. As with most recent USEPA regulations, requirements are complex and site-specific.

7.5. Potential Future Drinking Water Regulations

The Safe Drinking Water Act (SDWA) 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. The purpose of the review, termed the Six-Year Review, is to identify those National Primary Drinking Water Regulations for which current health effects assessments, changes in technology, and/or other factors provide a health or technical basis to support a regulatory revision that will maintain or strengthen public health protection.

Additional regulations have been proposed by EPA and are in various stages of development, review, and approval. These rules will be promulgated under the procedures established by the 1996 Amendments to the SDWA, meaning that EPA will no longer establish an MCL for a contaminant based solely on projected health related issues. The 1996 Amendments require the use of sound science, and allow for consideration of other factors such as cost, benefits, and competing risks.

7.5.1. Drinking Water Contaminants Candidate List

The SDWA requires EPA to publish a Contaminant Candidate List (CCL) every five years identifying contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, but that are known or anticipated to occur in public water systems. EPA is required to determine whether to regulate at least five contaminants on the CCL every five years, a process termed regulatory determination. The regulatory determination process considers available health effects and drinking water occurrence data, as well as

availability of suitable analytical protocols. Contaminants for which sufficient data or methods are not available to support a regulatory determination may be carried forward from the current CCL to the next. CCLs are used to set regulatory, research, and occurrence-investigation priorities within EPA.

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; and
- 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 EPA makes a determination that regulation of a contaminant in the CCL is warranted, the Agency has 24 months to publish a proposed Maximum Contaminant Level Goal (MCLG) and a proposed National Primary Drinking Water Rule (NPDWR). After proposal, the Agency has 18 months to publish a final MCLG and promulgate a final NPDWR. The requirements of an NPDWR take effect three years after promulgation, unless the primacy agency determines that an earlier date is practicable. The compliance date of an NPDWR may be extended by up to two additional years if capital improvements are required.

The first Contaminant Candidate List (CCL1) was published in draft form in March 1998, and consisted of 50 chemical contaminants and 10 microbial contaminants. EPA subsequently narrowed this list to include 19 chemicals and one microbial contaminant the Agency considered as "high priority" with respect to determination of the need to regulate, and ultimately reduced the list to a total of nine. In June 2003, the Agency announced its decision that no regulatory action was needed for these nine contaminants, as they were determined not to present a significant public health risk.

Contaminants from the CCL1 for which regulatory determinations not to regulate were issued include:

- Acanthamoeba (guidance for contact lens wearers)
- Naphthalene
- Hexachlorobutadiene
- Aldrin
- Dieldrin
- Metribuzin
- Sodium (guidance)
- Manganese
- Sulfate

The second Contaminant Candidate List (CCL2) was finalized in February 2005. CCL2 contained the 51 contaminants (42 chemical and 9 microbial) from CCL1 for which regulatory determinations were not issued. Regulatory determinations indicating no regulatory action was appropriate for 11 of the contaminants listed in CCL2 were published in the Federal Register in July 2008.

Contaminants from the CCL2 for which regulatory determinations not to regulate were issued include:

- Boron
- Dacthal Mono- and Di-Acid Degradates
- 1,1-Dichloro-2,2-bis(p-chlorophenyl)ethylene
- 1,3-Dichloropropene
- 2,4-Dinitrotoluene and 2,6-Dinitrotoluene
- s-Ethyl dipropylthiocarbamate
- Fonofos

EPA implemented a different CCL process after CCL 2. This new process considers evaluations from previous CCLs and includes substantial expert input and recommendations from various groups, including the National Academy of Science's National Research Council, the National Drinking Water Advisory Council, and the Science Advisory Board. Contaminants of emerging concern contained in CCL 3 (September, 2009) included 116 microbial pathogens, inorganic compounds, synthetic organic chemicals, disinfection byproducts, hormones, and pharmaceuticals. On January 4, 2016 EPA announced final determinations not to regulate four of the 116 CCL3 contaminants (i.e. dimethoate, 1,3-dinitrobenzene, terbufos, and terbufos sulfone). EPA delayed final regulatory determination on strontium to consider additional data prior to deciding if there is a significant opportunity for health risk reduction by regulation strontium in drinking water. The EPA announced the Final CCL 4 in November 2017, which includes 97 chemical or chemical groups and 12 microbial contaminants.

7.5.2. Unregulated Contaminant Monitoring

The Unregulated Contaminants Monitoring Regulation (UCMR) program was developed in coordination with the Contaminant Candidate List (CCL) regulations. The data collected by the UCMR process is used to support analysis and review of contaminant occurrence, to guide the CCL process, and to support determination of whether to regulate a contaminant to protect public health. The Safe Drinking Water Act Amendments of 1996 required EPA to establish criteria for a program to monitor unregulated contaminants and to identify not more than 30 contaminants to be monitored every 5 years. EPA published a list of unregulated contaminants for the first UCMR cycle (UCMR1) in September 1999. UCMR1 established a tiered monitoring approach, and required all large public water systems and some systems serving fewer than 10,000 consumers to monitor for unregulated contaminants from 2001 to 2005.

Monitoring under the second cycle of unregulated contaminants monitoring (UCMR2), as outlined in the January 2007 Final Rule, was conducted between 2007 and 2010. UCMR2 included 25 contaminants and five associated analytical methods. All systems serving more than 10,000 consumers (based on retail population directly served plus the population served by any

consecutive system(s)), and 800 selected systems serving 10,000 or fewer consumers were required to conduct first tier assessment monitoring for 10 contaminants (List 1 contaminants). A second tier screening survey of 15 additional contaminants (List 2 contaminants) was conducted by 400 systems serving more than 100,000 consumers, 320 systems serving between 10,001 and 100,000 consumers, and 480 systems serving 10,000 or fewer consumers. Consecutive systems that purchase all of their water from another system were not subject to the UCMR2 monitoring requirements.

Samples were collected during one continuous 12-month period beginning no earlier than January 2008 and concluding no later than December 2010. For systems with surface water sources, monitoring was required at 3-month intervals for 4 consecutive quarters, while groundwater systems monitored twice at 6-month monitoring intervals. Monitoring for most contaminants was conducted at the entry point to the distribution system; however, monitoring for the six List 2 nitrosamine compounds was conducted at both the system entry point and at a point that reflects maximum system residence time. Monitoring requirements for systems with blended surface and groundwater sources, or with multiple groundwater wells, were more complex.

EPA published the final UCMR3 in May 2012. The structure of UCMR3 is similar to previous UCMRs. UCMR3 required all systems serving greater than 10,000 people to monitor for 21 List 1 contaminants (seven VOCS, 1,4 Dioxane, six metals, and six perfluorinated compounds, and chlorate) and systems serving greater than 100,000 people to monitor for the seven List 2 contaminants (seven hormones). Also, EPA selected 800 representative PWSs that serve 1,000 or fewer people, do not disinfect, and have wells located in areas of karst or fractured bedrock to monitor for enteroviruses and noroviruses. One notable difference between UCMR3 and previous rules is that consecutive systems are required to conduct monitoring. Participating systems will conduct UCMR3 monitoring during one consecutive 12-month period between 2013 and 2015.

A fourth UCMR (UCMR4) was published December 2016. UCMR4 requires systems serving greater than 10,000 people to monitor for 10 List 1 Cyanotoxins (Surface Water (SW) or Groundwater Under the Influence (GWUDI) systems) and 20 additional List 1 chemicals (all SW, GWUDI and GW (Groundwater) systems). Participating systems will conduct UCMR4 monitoring between 2018 and 2020 using analytical methods developed by EPA consensus organizations.

7.5.3. Proposed Rules

7.5.3.1. Radon

EPA proposed new regulations for radon during October 1999. Two alternative compliance approaches were included in the proposed radon rule:

- States can elect to develop programs to address the health risks from radon in indoor air through adoption and implementation of a multimedia mitigation program. Under this approach, individual water systems would be required to reduce radon levels in the treated water to 4,000 pCi/L or lower. EPA will encourage states to adopt this approach, as it considered the most cost-effective way to achieve the greatest reduction in radon exposure risk.

- If the State elects not to develop a multimedia radon mitigation program, individual water systems will be required to reduce radon levels in their system's treated water to 300 pCi/L, or to develop local multimedia mitigation programs and to reduce radon levels in drinking water to 4,000 pCi/L.

Systems with radon levels at or below 300 pCi/L would not be required to treat their water to remove radon. States will likely be granted fairly wide latitude in developing and implementing the multimedia programs, and it is expected that the programs will differ significantly from state to state. The need for radon treatment will be based on results of quarterly monitoring. If the state regulatory agency commits to the multimedia mitigation and alternative MCL compliance approach within 90 days of final promulgation of the rule, it will be granted an additional 18 months to achieve compliance. Considerable controversy currently surrounds the regulation of radon in drinking water supplies, and modification of this regulation as currently proposed could significantly alter the requirements contained in the final rule. There is no recent information on the status of this proposed regulation, and no revised timeline for its implementation has been issued by EPA.

7.5.3.2. Long-Term Lead and Copper Rule

Revision of the Lead and Copper Rule is currently in progress to address several long-term issues including partial lead service line replacement, sample site selection, tap sampling, measures to ensure optimal corrosion control, and public education for lead and copper. EPA has convened a Work Group under guidance of the National Drinking Water Advisory Council (NDWAC) to review and make recommendations on some of the more complex issues related to the Lead and Copper Rule Long Term Revisions (LCR-LTR) under consideration. In December of 2015, EPA received comprehensive recommendations from the NDWAC and other concerned stakeholders on potential steps to strengthen the LCR. In October of 2016, the EPA released a LCR white paper that detailed key potential elements under consideration for the proposed revisions to the LCR. EPA expects to convene a peer-review panel in June, 2017. A proposed LCR-LTR rule may be expected sometime in 2017. On January 5, 2017, EPA proposed a rule to implement the 2011 Reduction of Lead in Drinking Water Act as modified by the Community Fire Safety Act of 2013, which further amended the SDWA Section 1417 to include fire hydrants in the list of exempted plumbing devices that did not have to meet the more stringent levels of lead in the wetted surfaces of plumbing used for potable sources.

7.5.4. Contaminants on the Regulatory Horizon

7.5.4.1. Cyanotoxins

A chemically diverse group of over 100 cyanobacterial metabolites have been identified as cyanotoxins, which have been variously classified as neurotoxins, hepatoxins, and contact irritants. Assuming EPA waits until the UCMR 4 monitoring is complete in 2020, the Agency could either make a positive regulatory determination or simply move directly to a proposed rule. A cyanotoxin rule would typically involve a two-year development period (2022) and a final rule could follow in approximately another two years (2024). If the Agency elects to make a positive regulatory determination prior to developing a proposed rule, then the timing of the regulatory determination rulemaking would figure into this timeline and delay the proposed rule by two to seven years. There is also increasing focus at the state level on harmful algal blooms and recreational water use.

7.5.4.2. Nitrosamines

Five organic nitrogen-containing compounds (4 nitrosamines and nitrosopyrrolidine) that have been detected in treated drinking water are listed on CCL 4. Formation of these compounds is associated with disinfection with free chlorine in the presence of naturally occurring ammonia in the source water or ammonia added to treated water to form a combined-chlorine residual. Formation of these nitroso-compounds requires a nitrogenous organic precursor. Dimethylamine has been shown to be particularly reactive in formation of N-nitrosodimethylamine (NDMA) in drinking water, with formation from several other less reactive precursors possible.

Regulation of nitrosamines in drinking water remains controversial for several reasons. Recent research on human exposure to nitrosamines indicates that drinking water contributes a very small percentage (less than 0.01 percent) of total exposure compared with natural formation in the body and consumption in certain foods. Therefore, it is unclear whether or not a regulation for nitrosamines would meet the SDWA criteria for "a meaningful opportunity for health risk reduction for persons served by public water systems". Likely strategies for reducing nitrosamine formation in drinking water, such as limiting or discontinuing use of polyDADMAC polymers or chloramine disinfectant residual, would also present simultaneous compliance issues with other currently regulated contaminants.

MCLs for individual nitrosamines or as a chemically similar group of several compounds would be established during the rulemaking process. The body of research on animal and human responses to nitrosamine exposure indicates the MCLs for nitrosamines in drinking water would be at the nanogram per liter (ng/L) level. NDMA and other nitrosamines have been classified as either probable or known human carcinogens by several public health organizations, with a relatively wide range of non-enforceable guidelines or enforceable standards. The World Health Organization has set a guideline for NDMA in drinking water of 100 ng/L, whereas Health Canada has established a Maximum Allowable Concentration for NDMA in drinking water of 40 ng/L. Massachusetts has set a guideline level of 10 ng/L for NDMA in drinking water, and Arizona requires monitoring for NDMA as part of its state administered National Pollution Discharge Elimination System permit program and has set a water quality criterion of 30 ng/L. The State of California has set a notification level of 10 ng/L for NDMA in drinking water and a public health goal of 3 ng/L. EPA Regions 3 and 6 have calculated 0.42 ng/L as the nonenforceable screening level for NDMA in drinking water based on a 1 in 10-6 lifetime excess cancer risk.

The American Water Works Association Governmental Affairs Office recommends that a utility consider sampling for nitrosamines if it did not participate in UCMR 2, to develop an understanding of nitrosamine occurrence and formation patterns within its system (AWWA, 2012). Potential sampling points the City should consider include the raw water influent to the Topeka WTP, finished water at the point of entry to the distribution system, and several locations in the distribution system. One location should be representative of the highest likely residence time in the distribution system. All samples should be analyzed using EPA Method 521.

A decision not to regulate nitrosamines as part of the preliminary regulatory determinations for contaminants on CCL 3 was published in the Federal Register on October 20, 2014. However, EPA evaluated existing MDBP regulations and unregulated DBPs including nitrosamines as part of Six-Year Review 3. Because nitrosamines are DBPs that may be introduced or formed in public water systems related to disinfection practices, EPA believes it is important to evaluate

these DBPs in the context of the review of existing MDBP regulations. Nitrosamines are included in the CCL 4.

7.5.4.3. Strontium

Strontium occurs in drinking water supplies due to dissolution of naturally-occurring mineral deposits, and due to its commercial and industrial uses in pyrotechnics, steel production, as a catalyst, and as a lead scavenger. EPA delayed the final CCL 3 regulatory determination on strontium to consider additional data and decide whether there is a meaningful opportunity for health risk reduction by strontium in drinking water. A final rule on strontium would be expected in 2019 or 2020.

7.5.4.4. Chlorate

Chlorate compounds are used in agriculture as defoliants or desiccants and may occur in drinking water related to use of disinfectants such as chlorine dioxide. A decision not to regulate chlorate as part of the preliminary regulatory determinations for contaminants on CCL 3 was published in the Federal Register on October 20, 2014. However, EPA evaluated existing MDBP regulations and unregulated DBPs including chlorate as part of Six-Year Review 3. Because chlorate is a DBP that may be introduced or formed in public water systems related to disinfection practices, EPA believes it is important to evaluate this DBP in the context of the review of existing MDBP regulations. Chlorate is included in the CCL 4.

7.5.4.5. Perchlorate

On February 11th 2011, EPA published its decision to move forward with the development of a regulation for perchlorate, a contaminant evaluated under CCL 2. Under the current regulatory schedule, a proposed MCL for perchlorate would have been expected sometime in 2014, and a final MCL no later than 2016, with compliance required by 2019. However, EPA is still finalizing its peer review of the modeling research recommended by a Science Advisory Board in conjunction with the Food and Drug Administration. A panel meeting of the peer reviewers was held on January 10 and 11, 2017, and a subsequent peer review will be scheduled to evaluate methods to develop a MCLG for perchlorate in drinking water.

7.5.4.6. Fluoride

In January 2011, the United States Department of Health and Human Services (HHS) announced a proposed recommendation that fluoride levels in drinking water be set at an optimal level of 0.7 mg/L. Concurrent with the HHS announcement, EPA announced plans to initiate a review of the current MCL and maximum contaminant level goal (MCLG) for fluoride. HHS's proposed recommendation would replace the 1962 US Public Health Standard of 0.7 to 1.2 mg/L, under which the optimal fluoride level is determined based upon the ambient air temperature of the geographic region. HHS believes that this revised optimal concentration will provide the best balance of public protection from dental caries (tooth decay) and the desire to limit the risk of dental fluorosis (spotting/pitting damage to tooth enamel), particularly in children.

Starting in 2015, the HHS's recommended optimal fluoridation level of drinking water is 0.7 mg/L. While the HHS guidance is advisory rather than regulatory, EPA could elect to modify current regulations governing maximum fluoride levels in response to HSS recommendations and to the agency's review of recent research results.

On January 7, 2011, EPA announced its intent to review the national primary and secondary drinking water regulations for fluoride. This review follows up on a commitment made in the second Six-Year Review to reevaluate fluoride after the Office of Water completed its updates of health and exposure assessments, and that when the Agency finalized these studies it would review the existing drinking water regulation to determine whether revisions are appropriate.

In December 2016, EPA announced the review results for the third Six-Year Review, and it was determined that a revision to the NPDWR for fluoride is not appropriate at this time. EPA determined that the potential revision of the fluoride NPDWR is a lower priority that would divert significant resources from the higher priority rulemakings that the Agency intends to undertake, but the Agency will continue to monitor the evolving science, and, when appropriate, will reconsider the fluoride NPDWR's relative priority for revision.

7.5.4.7. Hexavalent Chromium

The existing regulation for total chromium in drinking water was reevaluated by EPA as part of Six-Year Review 2, the results of which were announced in March 2010. The Agency noted that it had initiated a reassessment of the health risks associated with chromium exposure and that it did not believe it was appropriate to revise the national primary drinking water regulation while that effort was in process. EPA began a rigorous and comprehensive review of hexavalent chromium health effects following the release of the toxicity studies by the National Toxicology Program in 2008. In September, 2010, EPA released a draft scientific assessment for public comment and external peer review.

Hexavalent chromium (Cr6+) has come under increased scrutiny recently with the release of an Environmental Working Group study in December 2010 that found levels of hexavalent chromium exceeding the non-enforceable public health goal set by the California Department of Health in the tap water of 25 of 35 US cities tested. Based on additional recent research, the schedule for the hexavalent chromium human health assessment was revised by EPA in Feb 2012, with the final version now expected to be approved and posted in the near future. When this human health assessment is finalized, EPA will carefully review the conclusions and consider all relevant information to determine if a new standard needs to be set. Hexavalent chromium levels in public drinking water supplies are currently being monitored as part of UCMR 3. EPA Six-Year Review 3 determined that a revision to the existing regulation for total chromium was not appropriate for revision at this time as the health effects assessment is still ongoing (as of December 2015).

7.5.4.8. Volatile Organic Compounds

In January 2011 the EPA Administrator announced that Carcinogenic Organic Compounds (cVOCs) will be the first contaminants regulated as a group rather than as individual compounds under the Agency's new Drinking Water Strategy. Eight currently regulated cVOCs and eight currently unregulated cVOCs have been proposed for regulation as a group. In December 2016, EPA announced the review results for the Six-Year Review 3. The reviews of eight cVOCs were included but were not given detailed consideration because of other recent or ongoing regulatory actions. The eight cVOCs mentioned in the Six-Year Review 3 include 1,2-Dichloroethane (Ethylene dichloride), 1,2-Dichloropropane, Benzene, Carbon Tetrachloride, Dichloromethane (Methylene chloride), Tetrachloroethylene (PCE), Trichloroethylene (TCE), and Vinyl chloride. The ultimate form of this regulation remains to be determined.

7.5.4.9. Methyl Tertiary Butyl Ether

Methyl tertiary butyl ether (MTBE) is an oxygenate additive used in gasoline to increase the octane number. It has been used widely used in gasoline in the United States as a replacement for lead; however, its use has declined in recent years due incorporation of ethanol in fuels. MTBE is very soluble and has been detected in numerous water supplies but is most commonly found in ground water supplies.

In 1997, EPA issue a drinking water advisory for MTBE of 20 to 40 µg/L based on taste and odor. MTBE was included in CCL 1 and CCL 2 for evaluation, with negative regulatory determinations because its regulation would not present a meaningful opportunity for health risk reduction for persons served by public water systems. Because of several prominent cases of drinking water contamination with MTBE in the past, public interest related to MTBE regulation remains active. Therefore, MTBE was carried over to CCL 3 and CCL 4 for further evaluation; however, no schedule for revision of the health risk assessment for MTBE has been set. However, MTBE is regulated in drinking water in the State of California, with a primary MCL of 13 µg/L and secondary MCL of 5 µg/L.

7.5.4.10. Legionella

Legionella bacteria can cause a serious type of pneumonia called Legionnaires' disease, and also a less serious infection called Pontiac fever that has symptoms similar to a mild case of the flu. The bacterium grows best in warm water conditions including large plumbing systems, cooling towers (air-conditioning units for large buildings), and hot water tanks and heaters. EPA's third six-year review notice (January 11, 2017) highlights an opportunity to further reduce the risk posed by Legionella. The notice suggests a linkage being drawn between maintaining a secondary disinfectant residual and reducing the risk posed by Legionella.

7.6. California Regulated Drinking Water Contaminants Water Regulations

7.6.1. Primary Regulated Drinking Water Contaminants

The DDW regulates contaminants in drinking water with the goal of protecting public health. A current listing of MCLs, DLRs, and PHGs (Public Health Goals) for primary regulated drinking water contaminants is provided in Table 7-16. PHGs for NDMA and 1,2,3 – Trichloropropane (not regulated at the time this review was performed) are also included. DDW has established MCL's for several contaminants that are not currently regulated under the EPA's National Primary Drinking Water Standards. This includes: aluminum, nickel, nitrate + nitrite, perchlorate, strontium-90, tritium, 1,1-Dichloroethane (1,1-DCA), 1,3-Dichloropropene, MTBE, Trichlorofluoromethane (Freon 11), 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113), Bentazon, Molinate, and Thiobencarb.

Table 7-16: DDW Regulated Primary Drinking Water Contaminants (as of 9/29/2017)

Contaminant	MCL[1]	DLR[1]	PHG[1]	Date of PHG
Chemicals with MCLs in 22 CCR §64431—Inorganic Chemicals				
Aluminum	1	0.05	0.6	2001
Antimony	0.006	0.006	0.001	2016
Arsenic	0.010	0.002	0.000004	2004

Contaminant	MCL[1]	DLR[1]	PHG[1]	Date of PHG
Asbestos (MFL = million fibers per liter; for fibers >10 microns long)	7 MFL	0.2 MFL	7 MFL	2003
Barium	1	0.1	2	2003
Beryllium	0.004	0.001	0.001	2003
Cadmium	0.005	0.001	0.00004	2006
Chromium, Total - OEHHA withdrew the 0.0025-mg/L PHG	0.05	0.01	withdrawn Nov. 2001	1999
Chromium, Hexavalent - 0.01-mg/L MCL & 0.001-mg/L DLR repealed September 2017	--	--	0.00002	2011
Cyanide	0.15	0.1	0.15	1997
Fluoride	2	0.1	1	1997
Mercury (inorganic)	0.002	0.001	0.0012	1999 (rev2005)[2]
Nickel	0.1	0.01	0.012	2001
Nitrate (as nitrogen, N)	10 as N	0.4	45 as NO3 (=10 as N)	1997
Nitrite (as N)	1 as N	0.4	1 as N	1997
Nitrate + Nitrite (as N)	10 as N	--	10 as N	1997
Perchlorate	0.006	0.004	0.001	2015
Selenium	0.05	0.005	0.03	2010
Thallium	0.002	0.001	0.0001	1999 (rev2004)
Copper and Lead, 22 CCR §64672.3				
Values referred to as MCLs for lead and copper are not actually MCLs; instead, they are called "Action Levels" under the lead and copper rule				
Copper	1.3	0.05	0.3	2008
Lead	0.015	0.005	0.0002	2009
Radionuclides with MCLs in 22 CCR §64441 and §64443—Radioactivity				
[units are picocuries per liter (pCi/L), unless otherwise stated; n/a = not applicable]				
Gross alpha particle activity - OEHHA concluded in 2003 that a PHG was not practical	15	3	none	n/a
Gross beta particle activity - OEHHA concluded in 2003 that a PHG was not practical	4 mrem/yr	4	none	n/a
Radium-226	--	1	0.05	2006
Radium-228	--	1	0.019	2006
Radium-226 + Radium-228	5	--	--	--
Strontium-90	8	2	0.35	2006
Tritium	20,000	1,000	400	2006
Uranium	20	1	0.43	2001
Chemicals with MCLs in 22 CCR §64444—Organic Chemicals				
(a) Volatile Organic Chemicals (VOCs)				
Benzene	0.001	0.0005	0.00015	2001

Contaminant	MCL[1]	DLR[1]	PHG[1]	Date of PHG
Carbon tetrachloride	0.0005	0.0005	0.0001	2000
1,2-Dichlorobenzene	0.6	0.0005	0.6	1997 (rev2009)
1,4-Dichlorobenzene (p-DCB)	0.005	0.0005	0.006	1997
1,1-Dichloroethane (1,1-DCA)	0.005	0.0005	0.003	2003
1,2-Dichloroethane (1,2-DCA)	0.0005	0.0005	0.0004	1999 (rev2005)
1,1-Dichloroethylene (1,1-DCE)	0.006	0.0005	0.01	1999
cis-1,2-Dichloroethylene	0.006	0.0005	0.1	2006
cis-1,2-Dichloroethylene	--	--	0.013	2017 draft
trans-1,2-Dichloroethylene	0.01	0.0005	0.06	2006
trans-1,2-Dichloroethylene	--	--	0.05	2017 draft
Dichloromethane (Methylene chloride)	0.005	0.0005	0.004	2000
1,2-Dichloropropane	0.005	0.0005	0.0005	1999
1,3-Dichloropropene	0.0005	0.0005	0.0002	1999 (rev2006)
Ethylbenzene	0.3	0.0005	0.3	1997
Methyl tertiary butyl ether (MTBE)	0.013	0.003	0.013	1999
Monochlorobenzene	0.07	0.0005	0.07	2014
Styrene	0.1	0.0005	0.0005	2010
1,1,2,2-Tetrachloroethane	0.001	0.0005	0.0001	2003
Tetrachloroethylene (PCE)	0.005	0.0005	0.00006	2001
Toluene	0.15	0.0005	0.15	1999
1,2,4-Trichlorobenzene	0.005	0.0005	0.005	1999
1,1,1-Trichloroethane (1,1,1-TCA)	0.2	0.0005	1	2006
1,1,2-Trichloroethane (1,1,2-TCA)	0.005	0.0005	0.0003	2006
Trichloroethylene (TCE)	0.005	0.0005	0.0017	2009
Trichlorofluoromethane (Freon 11)	0.15	0.005	1.3	2014
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1.2	0.01	4	1997 (rev2011)
Vinyl chloride	0.0005	0.0005	0.00005	2000
Xylenes	1.75	0.0005	1.8	1997
(b) Non-Volatile Synthetic Organic Chemicals (SOCs)				
Alachlor	0.002	0.001	0.004	1997
Atrazine	0.001	0.0005	0.00015	1999
Bentazon	0.018	0.002	0.2	1999 (rev2009)
Benzo(a)pyrene	0.0002	0.0001	0.000007	2010
Carbofuran	0.018	0.005	0.0007	2016
Chlordane	0.0001	0.0001	0.00003	1997 (rev2006)
Dalapon	0.2	0.01	0.79	1997 (rev2009)
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	0.00001	0.0000017	1999

Contaminant	MCL[1]	DLR[1]	PHG[1]	Date of PHG
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07	0.01	0.02	2009
Di(2-ethylhexyl)adipate	0.4	0.005	0.2	2003
Di(2-ethylhexyl)phthalate (DEHP)	0.004	0.003	0.012	1997
Dinoseb	0.007	0.002	0.014	1997 (rev2010)
Diquat	0.02	0.004	0.006	2016
Endothal	0.1	0.045	0.094	2014
Endrin	0.002	0.0001	0.0003	2016
Ethylene dibromide (EDB)	0.00005	0.00002	0.00001	2003
Glyphosate	0.7	0.025	0.9	2007
Heptachlor	0.00001	0.00001	0.000008	1999
Heptachlor epoxide	0.00001	0.00001	0.000006	1999
Hexachlorobenzene	0.001	0.0005	0.00003	2003
Hexachlorocyclopentadiene	0.05	0.001	0.002	2014
Lindane	0.0002	0.0002	0.000032	1999 (rev2005)
Methoxychlor	0.03	0.01	0.00009	2010
Molinate	0.02	0.002	0.001	2008
Oxamyl	0.05	0.02	0.026	2009
Pentachlorophenol	0.001	0.0002	0.0003	2009
Picloram	0.5	0.001	0.166	2016
Polychlorinated biphenyls (PCBs)	0.0005	0.0005	0.00009	2007
Simazine	0.004	0.001	0.004	2001
2,4,5-TP (Silvex)	0.05	0.001	0.003	2014
2,3,7,8-TCDD (dioxin)	$3x10^{-8}$	$5x10^{-9}$	$5x10^{-11}$	2010
Thiobencarb	0.07	0.001	0.042	2016
Toxaphene	0.003	0.001	0.00003	2003
Chemicals with MCLs in 22 CCR §64533—Disinfection Byproducts				
Total Trihalomethanes	0.080	--	0.0008	2010 draft
Bromodichloromethane	--	0.0010	--	--
Bromoform	--	0.0010	--	--
Chloroform	--	0.0010	--	--
Dibromochloromethane	--	0.0010	--	--
Haloacetic Acids (five) (HAA5)	0.060	--	--	--
Monochloroacetic Acid	--	0.0020	--	--
Dichloroacetic Adic	--	0.0010	--	--
Trichloroacetic Acid	--	0.0010	--	--
Monobromoacetic Acid	--	0.0010	--	--
Dibromoacetic Acid	--	0.0010	--	--
Bromate	0.010	0.0050[3]	0.0001	2009
Chlorite	1.0	0.020	0.05	2009

Contaminant	MCL[1]	DLR[1]	PHG[1]	Date of PHG
Chemicals with PHGs established in response to DDW requests. These are not currently regulated drinking water contaminants.				
N-Nitrosodimethylamine (NDMA)	--	--	0.000003	2006
1,2,3-Trichloropropane	--	--	0.0000007	2009
[1] Units are in mg/L, unless otherwise noted. [2]OEHHA's review of this chemical during the year indicated (rev20XX) resulted in no change in the PHG.				
[3]The DLR for Bromate is 0.0010 mg/L for analysis performed using EPA Method 317.0 Revision 2.0, 321.8, or 326.0.				

7.6.2. Secondary Drinking Water Standards

Table 7-17 lists those constituents regulated under the DDWs secondary drinking water standards.

Table 7-17: DDW Secondary MCLs (effective 9/27/2006)

Chemical	Secondary MCL	
Aluminum	0.2 mg/L	
Color	15 Units	
Copper	1.0 mg/L	
Foaming Agents (MBAS)	0.5 mg/L	
Iron	0.3 mg/L	
Manganese	0.05 mg/L	
Methyl-*tert*-butyl ether (MTBE)	0.005 mg/L	
Odor-Threshold	3 Units	
Silver	0.1 mg/L	
Thiobencarb	0.001 mg/L	
Turbidity	5 Units	
Zinc	5.0 mg/L	
	Recommended	*Upper/Short Term*
Total Dissolved Solids or Specific Conductance	500 mg/L 900 µS/cm	1000 mg/L/1,500 mg/L 1600 µS/cm/ 2,200 µS/cm
Chloride	250 mg/L	500 mg/L/600 mg/L
Sulfate	250 mg/L	500 mg/L/600 mg/L

7.6.3. *Cryptosporidium* Action Plan

In April, 1995, the DDW issued the *Cryptosporidium* Action Plan (CAP). This plan requires utilities to provide sanitary surveys of the water shed to the State every five years to highlight risks of pathogen contamination. Utilities should also optimize treatment to achieve less than 2 NTU during pre-treatment to filtration and to consistently achieve an effluent turbidity of 0.1 NTU. The CAP also promotes the use of (1) particle counters and turbidimeters on settled and filtered waters; (2) filter-to-waste capabilities after filter backwashing; and, (3) operating filters without sudden increases in flow. Any recycled backwash water or sludge treatment decant/ supernatant should have less than 2 NTU and should be chemically treated (e.g., coagulation) to maintain less than 2 NTU, if necessary. Although limiting the quantity of recycle flow to less

than 10 percent of the main process flow is not specifically mentioned in the CAP, it is a common practice for most utilities.

7.6.4. Drinking Water Notification Levels

The DDW maintains a list of notification levels for contaminants that do not have a maximum contaminant level (MCL). Notification levels are used for guidance to utilities, but are typically used as operating goals for utilities in California. A current listing of notification levels is shown in Table 7-18.

Table 7-18: California DDW Drinking Water Notification Levels (as of 2/04/2015)

Notes*	Chemical	Notification Level (milligrams per liter)
1	Boron	1
2	n-Butylbenzene	0.26
3	sec-Butylbenzene	0.26
4	tert-Butylbenzene	0.26
5	Carbon disulfide	0.16
6	Chlorate	0.8
7	2-Chlorotolune	0.14
8	4-Chlorotolune	0.14
9	Diazinon	0.0012
10	Dichlorodifluoromethane (Freon 12)	1
11	1,4-Dioxane	0.001
12	Ethylene glycol	14
13	Formaldehyde	0.1
14	HMX	0.35
15	Isopropylbenzene	0.77
16	Manganese	0.5
17	Methyl isobutyl ketone (MIBK)	0.12
18	Naphthalene	0.017
19	N-Nitrosodiethyamine (NDEA)	0.00001
20	N-Nitrosodimethylamine (NDMA)	0.00001
21	N-Nitrosodi-n-propylamine (NDPA)	0.00001
22	Propachlor**	0.09
23	n-Propylbenzene	0.26
24	RDX	0.0003
25	Tertiary butyl alcohol (TBA)	0.012
26	1,2,3-Trichloropropane (1,2,3-TCP)	0.000005
27	1,2,4-Trimethylbenzene	0.33
28	1.3.5-Trimethylbenzene	0.33
29	2,4,6-Trinitrotoluene (TNT)	0.001
30	Vanadium	0.05
* Notes include toxicological endpoint, references, history, and other information		

The DDW recommends removal of a supply source if these contaminants reach certain levels. If the supply is not removed from service, DDW recommends additional notifications to the public. The response levels and their toxicological endpoints are presented in Table 7-19.

Table 7-19: Response Levels

Chemical	Toxicological Endpoint	Response Level (Multiples of Notification Level)
RDX	Cancer risk	100 times the NL
TBA	Cancer risk	100 times the NL
1,2,3-TCP	Cancer risk	100 times the NL
TNT	Cancer risk	100 times the NL
NDPA	Cancer risk	50 times the NL
1,4-Dioxane	Cancer risk	35 times the NL
NDMA	Cancer risk	30 times the NL
NDEA	Cancer risk	10 times the NL
All others	Non-cancer	10 times the NL

7.6.5. Upcoming Regulations in Drinking Water

DDW has several relevant drinking water regulations in process or at the planning stages as summarized below.

7.6.5.1. 1,2, 3-trichloropropane (TCP)

1,2,3- TCP is a chlorinated hydrocarbon with high chemical stability. It is a manmade chemical found at industrial or hazardous waste sites. It has been used as a cleaning and degreasing solvent and also is associated with pesticide products. Over the past several years, the Division of Drinking Water has received input from affected water systems, local community groups, and environmental justice groups expressing concerns about the need for a drinking water standard for 1,2,3-TCP. The State Water Board set the development of an MCL for 1,2,3-TCP as one of its highest priorities. On February 21, 2017 the State Water Board submitted a Notice of Proposed Rulemaking for 1,2,3,-TCP drinking water standard and associated regulations. The proposed MCL for 1,2, 3- TCP is 0.000005 mg/L.

7.6.5.2. Hexavalent Chromium

The California Office of Environmental Health Hazard Assessment (OEHHA) finalized a public health goal for hexavalent chromium of 0.02 µg/L on July 27, 2011. DDW adopted a drinking water MCL for hexavalent chromium of 10 µg/L, which became effective July 1, 2014. The regulations adopted by DDW specify initial monitoring requirements, approved analytical methods and detection limits, and best available technologies for treatment (coagulation/filtration, ion exchange, and reverse osmosis). Compliance with the MCL is based on a running annual average of hexavalent chromium measurements averaged quarterly. However, on May 31, 2017 the Superior Court of Sacramento County invalidated the MCL for hexavalent chromium citing the state "failed to properly consider the economic feasibility of complying with the MCL". At the time of this document the DDW was in the process of establishing a new MCL for hexavalent chromium.

7.6.5.3. N-Nitrosodimethylamine and Other Nitrosamines

N-nitrosodimethylamine (NDMA) and related nitrosamine compounds can be released directly from industrial sources as a contaminant of products such as liquid rocket fuel, or they can be formed in solution by chemical reactions between an inorganic nitrogen-containing species such as NH2Cl and an organic nitrogen compound, particularly dimethylamine. Formation of nitrosamines has been associated with disinfection of drinking water and treated wastewater with free chlorine in the presence of naturally occurring ammonia in the source water or ammonia added to treated water to form a combined-chlorine residual. NDMA and other nitrosamines are among the chemicals known to the State to cause cancer (Title 27, California Code of Regulations, Section 27001). In 2006, OEHHA established a public health goal of 3 ng/L for NDMA in drinking water. An MCL for NDMA will likely not be established for several years, so the 10 ng/L notification level will continue to be used to provide information to local governing agencies and consumers.

7.6.5.4. Revised Total Coliform Rule (RTCR)

In lieu of the Federal Revised Total Coliform Rule, DDW will be revising the Total Coliform Rule in Title 22; however, the draft regulations will not be adopted in time to correspond with the Federal rule requirements. Beginning April 1, 2016, all public water systems will need to comply with California's existing Total Coliform Rule and the new requirements in the federal RTCR, until California can complete the regulatory adoption process for the RTCR.

7.6.5.5. Lead and Copper Rule

The DDW will update the State Lead and Copper Rule in 2018 to reflect the recent changes to the federal rule.

7.6.5.6. Perchlorate MCL Review

In July 2017, the DDW presented to the State Water Board findings and recommendations regarding the DDW's review of the perchlorate MCL. DDW recommended to first establish a lower DLR to gather additional occurrence data and then revise the MCL if the new data support development of a new standard.

7.6.5.7. MCL Review

The State Water Board reported on February 22, 2017 that it had reviewed the California MCLs to determine whether any of the current MCL's should be revised to protect public health. Two contaminants (perchlorate and antimony), OEHHA issued revised PHGs since 2015 that have prompted additional review of these MCLs. In 2016, the State Water Board initiated further review of the MCL for perchlorate to determine whether a formal revision of the MCL may provide benefits to public health. The PHG for perchlorate was reduced from 6 ppb to 1 ppb by OEHHA in 2015. The review of the MCL for perchlorate is underway but is not yet complete.

In 2016, the PHG for antimony was lowered from 6 ppb to 1 ppb. The current MCL for antimony is 6 ppb, but the current laboratory methods limit the reliable detection of antimony to 6 ppb. In addition, there are five wells in the state with antimony levels greater than the MCL. Based on the low number of detections, DDW does not plan on further review of the antimony MCL.

7.6.6. Interim Enhanced Surface Water Treatment Rule

The DDW has adopted a State Interim Enhanced Surface Water Treatment Rule which establishes treatment techniques for microbial contaminants (i.e., *Giardia lamblia* cysts, viruses,

heterotrophic plate count bacteria, Legionella, and *Cryptosporidium*; from Title 22. Social Security, Division 4. Environmental Health, Chapter 17. Surface Water Treatment, effective January 12, 2008). Emphasis is placed on utilizing multiple treatment barriers for treatment, and in general, the requirements for turbidity removal and disinfection follow those of the Federal Surface Water Treatment Rule and Interim Enhanced Surface Water Treatment Rule. There are microbial removal requirements for conventional filtration, direct filtration, and alternative filtration technologies. For conventional and direct filtration plants, filtration and disinfection barriers must achieve at least 99.9 (or 3 log) *Giardia lamblia* and 99.99 (or 4 log) virus removal. The requirements for alternative filtration technologies are 99 percent inactivation or removal of *Giardia*, 99 percent inactivation or removal of *Cryptosporidium*, and 90 percent virus inactivation or removal. This regulation also requires that the turbidity and flow of a recycled stream be monitored at least one a day or once per recycle event.

7.6.7. Recycle Stream Guidance

The DDW established a guideline for recycle flows at surface water treatment plants in Appendix K (October 1994) of the State's Surface Water Treatment Rule. It states that the 'percent of recycled water in the plant flow during recycle should not exceed 10 percent of the total plant flow. The guidelines also indicate that 80 percent of the solids should be removed prior to recycling, and that recycling should occur during the middle of a filter run. DDW requires additional disinfection beyond that of the SWTR when elevated total coliforms counts are detected in the source water. The requirements are shown in Table 7-20. For a conventional plant that is granted a removal/inactivation credit of 2.5 log *Giardia* removal, an additional 1.5 log inactivation or removal is required if source water total coliforms are between 1,000 and 10,000 per 100 mL.

7.6.8. Point-of-Use and Point-of-Entry Treatment

The DDW adopted resolution 2016-0015 on March 15, 2016, which approves emergency regulations pertaining to point-of-use and point-of-entry treatment. A public water system may be permitted to use point-of-use (POUs) or point-of-entry (POEs) treatment devices in lieu of centralized treatment for compliance with one or more maximum contaminant levels of treatment technique requirements other than for microbial contaminants, volatile organic chemicals, or radon. Use of these devices may be approved no longer than three years, or until funding for the total construction cost of centralized treatment or access to an alternative water source is available. The provisions of this regulation stipulate that the system must serve fewer than 200 service connections, and centralized treatment is not economically feasible. Equipment, recordkeeping, reporting, and compliance requirements are also specified. At the time this document was updated the State Board was in the process of developing permanent POE and POU regulations.

7.6.9. Disinfectant Residuals, Disinfection Byproducts and Disinfection Byproduct Precursors

Provisions of the Stage 2 Disinfectants and Disinfection Byproducts Rule (S2DDBPR) that were initially adopted in compliance with the Permit Reform Act of 1981, which was repealed in 2003 by California Assembly Bill 1757, were repealed. This rule includes the remaining public notification and consumer confidence report requirements from the federal Public Notification Rule that relate to the federal S1DDBPR. The rule also includes, for clarity, a provision from the federal S1DDBPR on monitoring violations.

Table 7-20: Additional *Giardia* and Virus Disinfection Requirements

Median Monthly Raw Water Total Coliform Concentration	*Giardia* Cyst Treatment Requirement	Monitoring Frequency
(Counts/100 mL)	(Log Removal)	(--)
< 1,000	3	2/month
>1,000 – 10,000	4	1/week
>10,000 – 100,000	5	1/day
Median Monthly Raw Water Total Coliform Concentration	**Virus Treatment Requirement**	**Monitoring Frequency**
(Counts/100 mL)	(Log Removal)	(--)
< 1,000	4	Not specified
>1,000 – 10,000	5	Not specified
>10,000 – 100,000	6	Not specified
Taken From: Guidelines for Determining When Surface Waters Will Require More Than Minimum Levels of Treatment Defined in the Surface Water Treatment Regulations, May 15, 1991. Disinfection Requirements of the DDW for Surface or Groundwater under the Direct Influence of a Surface Water Systems.		

7.6.10. Recreation at Domestic Water Supply Reservoirs

The CCR prohibits recreational use of a domestic water supply reservoir unless it is specifically authorized in a water supply permit. The CCR also establishes minimum data requirements to accompany an application for recreational use. State law requires DDW to issue permits for recreation activities on drinking water reservoirs.

In November 2000 DDW issued a draft version of its "Guidelines for Evaluating Applications for Recreational Use Permits at Domestic Water Supply Reservoirs." The purpose of the guidelines is to help ensure the safety of California's potable water supply by controlling sources of contamination on reservoirs used by public water systems. The document has not been finalized. The following is a summary of the recommendations from the guidelines.

7.6.10.1. Reservoir and Watershed Information

DDW recommends that a map showing the reservoir and its surrounding areas be developed that includes the following information:

- Location of water works facilities (i.e., reservoir inlets or tributaries, reservoir outlets, controls, any treatment works, etc.).
- Topography of the reservoir (including subsurface) and its immediate watershed (i.e., within approximately 1 mile of shoreline).
- Location of the shoreline at anticipated high and low water levels.
- Prevailing currents in the lake.
- Areas to be open for different types of recreational use.
- Locations of any intakes used to supply water for recreational use areas.

- Locations of activities and/or facilities that have the potential to contaminate the water supply (e.g., horse stables).
- Location of wastewater collection, treatment, or disposal facilities in the proximity of the reservoir, including information on the degree of treatment provided and any reliability features.
- Locations of toilets to be provided for the public.
- Information on the quality of the water in the reservoir (i.e., results of any microbiological, chemical, turbidity, and radiological monitoring).

The following data on the reservoir should also be known:

- Physical dimensions of the reservoir.
- Range of water level fluctuations.
- Storage capacity and shoreline length at anticipated high and low water levels.
- Residence time for water stored in the reservoir at anticipated high and low water levels,
- Topography of the reservoir site.
- Occurrence of wind-induced currents, natural or man-induced turbulence, thermal gradients, a thermocline, or other factors that may affect the quality of the stored water and movement of possible contaminants to the water intake from various points in the reservoir.

7.6.10.2. Protection of the Reservoir Outlet

A protective zone must be established around the intake to the treatment plant intake. The zone is an area around the inlet in which all recreational use is prohibited. The zone should be marked with buoys and a cable line and patrolled to prevent boats from entering. The area should be a minimum of 500 feet from the reservoir inlet. A site specific study of flow dynamics may be undertaken to determine whether the 500-foot setback is adequate or necessary.

7.6.10.3. Recreational Activities

A detailed inventory of the recreational activities allowed on and around the reservoir should be completed.

7.6.10.4. Control Program

The control program is based on appropriate measures centered on the following activities: boating, swimming, toilets, trailer sanitation stations, onsite sewage disposal systems, sewerage systems, refuse disposal, equestrian activities, visitor limitation, water quality monitoring, reservoir area closure, reservoir patrol, emergency plan, public health surveillance, and public notification. The following subsections provide specifics regarding these activities.

(1) Boating Activities

If boating is allowed, a program to control boating activities should be implemented. Key requirements include the following.

- Watercraft Program to Prevent Quagga Mussel & Invasive Species Contamination.

- Vessels with any form of portable toilet capable of being emptied into the reservoir must be prohibited. In some cases, all boats with any form of toilet or sink can be excluded from the reservoir.
- Boat-washing facilities should be provided for rental and private boats. All waste from such facilities must be removed to an on-shore disposal system.
- A responsible person must be on duty at all times at the launching ramps when the ramps are in operation to inspect all boats being launched to ensure compliance with applicable regulations.
- A safety inspection program must be implemented to ensure that boats are equipped with a life preserver for each passenger and to regulate the number of personals that can be carried by each boat.
- Containment features must be provided at all fuel-loading facilities to prevent fuel spillage into the reservoir. Storing fuel in containers over the water must be prohibited.
- Floating restaurants, snack bars, or other similar types of facilities that require disposal of sewage or other waste should be prohibited.
- Fish cleaning facilities with adequate water supply and waste disposal systems must be provided.
- The reservoir must be open to boating only when the operating agency can maintain an adequate patrol.
- Patrol personnel must enforce the provisions of all applicable regulations.

(2) Swimming

Swimming areas should be located as far as possible from drinking water inlets. In order to reduce the introduction of fecal matter into the reservoir, diaper wearing infants, dogs and other domestic animals should be prohibited from water contact.

(3) Toilets

Toilets must be sufficient in number, conveniently located, readily accessible to the public, and maintained in a clean, sanitary fashion at all times. DDW recommends either conducting a study to determine the appropriate number of toilets or assume 50 persons per toilet at picnic areas, playgrounds, beaches, and other general use areas and 70 persons per toilet for designated shore-fishing areas. The following additional requirements should also be met:

- Toilet facilities must be convenient and available to the boating public in all areas of the reservoir open to recreation. Only parts of the shoreline where toilet facilities are available within a 5-minute walk (or, alternatively, within 500 feet) should be open for recreation.
- Toilet facilities must be available within two miles of any point of the reservoir and provided with a dock for easy access.
- Toilets must be emptied and cleaned daily in developed areas during the recreation season. At other times, and in remote areas, toilets must be emptied and cleaned at least once a week.

(4) Trailer Sanitation Stations

Camping areas that allow van conversions, trailers, or recreational vehicles mush provide sanitation stations to receive the discharge of sewage holding tanks.

(5) Individual, Onsite Sewage Disposal Systems

Where residential or commercial sewage disposal is by means of individual septic tanks and leaching systems, the following is required:

- Onsite sewage disposal systems must be designed by a registered Civil Engineer.
- An alternative disposal system must be available if the regular system fails.
- An overflow tank at the terminus of the leaching system must be provided and inspected at least weekly to warn if the system is failing.
- Onsite sewage must be set back from the reservoir high water line at least 200 feet, and must be at least 10 feet above the high water line.
- Plans for onsite sewage disposal systems must be submitted to the local health department for review and approval

(6) Sewerage Systems

A variety of controls are recommended for areas using integrated collection and disposal systems including:

- Sewers and appurtenances must be at least 10 feet above and over 200 feet away from the high water line of the reservoir.
- Sewerage facilities must be designed and built to prevent overflow or leakage.
- Sewage pumping stations and force mains must be designed on a fail-safe basis.
- All failure alarms on the various portions of the sewerage system must have an independent power source.
- All portions of the sewerage system must be outside the closed zone at the reservoir outlet.

(7) Refuse Disposal

Dumping of refuse must be prohibited. Conveniently located, covered, and anchored refuse containers must be provided in all areas open for recreation. A sufficient number of such containers must be provided to accommodate refuse generated during peak use periods. An approved waste collection and disposal entity must transport refuse off the watershed for disposal.

(8) Equestrian Activities

Horse activity in the area around the reservoir must be carefully regulated. In general, horses must be prohibited from entering the reservoir or any tributary stream within 200 feet of the reservoir shoreline. All trails must be set back 100 feet from the reservoir high water level.

(9) Visitor Limitation

In order to prevent overuse of the area and creation of health or safety hazards, the number of persons, boats and trailers that are allowed to use a recreation area must be limited to avoid exceeding the capacity of sanitation and other support facilities.

(10) Water Quality Monitoring

The reservoir should be monitored for microbial quality. At a minimum, samples should be collected for total and *E. coli* bacteria. Samples for *E. coli*, enterococcus bacteria, *Giardia* and *Cryptosporidium* are also recommended. Bacteriological samples should be collected at least weekly during peak usage periods. Protozoa samples should be collected at least monthly. At least one sample should be collected for bacteriological analysis from each swimming or dock area and from the reservoir inlet(s) and outlet(s). Protozoa samples should be collected from the reservoir outlet.

(11) Reservoir Area Closure

The recreation administrator or manager must be authorized to close a reservoir to recreation. DDW recommends that a recreation area be posted (or closed) when water quality monitoring indicated that levels of indicator organisms exceed any of the values listed in Table 7-21.

Table 7-21: Reservoir Closure Cutoff Values

Parameter	Single Sample	30-day Average
Total coliform	10,000/100 ml	1,000/100 ml
Fecal coliform	400/100 ml	200/100 ml
E. coli	235/100 ml	126/100 ml
Enterococcus	61/100 ml	33/100 ml

(12) Reservoir Patrol

Full-time patrol personnel must be provided. Table 7-22 identifies the necessary number of patrol personnel.

Table 7-22: Reservoir Patrol Personnel Requirements

Body Contact Recreation Prohibited	Body Contact Recreation Allowed
1 per 500 persons or less	1 per 200 persons or less
2 per 1,500	2 per 1,000
3 per 2,500	3 per 1,500
4 per 4,000	4 per 2,000
5 per 5,000	5 per 2,500
-	6 per 3,000

Additional personnel should be provided for larger crowds. Boat patrols must also be provided where boating is permitted. The number of patrols should be sufficient to police the entire reservoir at least twice daily.

(13) Emergency Plan

An emergency plan should be developed if there is an actual or threatened water contamination incident.

(14) Public Health Surveillance

At least monthly, a registered Environmental Health Specialist should inspect the reservoir and provide recommendations for future reservoir protection.

(15) Public Notification

Visitors must be effectively informed that the reservoir is used for drinking water. The information program should have the following elements:

- Indicate on all informational bulletins that the reservoir is a source of domestic water supply and shall not be polluted.
- Provide all persons entering the recreation area with copies of ordinances or similar informational material relating to the protection of the water supply.
- Locate large permanent signs throughout the recreation area indicating that the reservoir is a source of domestic water supply. Signs in swimming areas should also indicate that domestic animals are not allowed and that diaper-wearing infants must be kept out of the water.
- Provide decals for posting inside all rental and all private boats indicating the need for protection of the stored water supply.

(16) Biological Risk Assessment

In cases where the annual number of visitors exceeds recommended guidelines, a numerical estimate of the anticipated densities of critical pathogenic organisms at the reservoir outlet, and how these concentrations vary with recreational use patterns, reservoir levels, and flow conditions must be completed.

8.0 Discussion of Regulatory Compliance

8.1. Overview

The raw and treated water quality at the Palmdale WTP is presented in Section 6.0, while a review of drinking water regulations is provided in Section 7.0. This section summarizes the compliance issues for current and pending regulations, only as they apply to PWD surface water supplies.

8.2. Impact of Current and Pending Regulations on PWD Compliance

Current treatment process at the Palmdale WTP include coagulation, flocculation, sedimentation, granular media filtration, granular activated carbon (GAC) adsorption, and chlorination for primary and residual disinfection. A summary of compliance and related issues is provided in Table 8-1.

Table 8-1: Impact of Current Regulations on PWD

Regulation	Conclusion
Surface Water Treatment Rule (SWTR)	Continued compliance with the disinfection and turbidity removal requirements of this regulation is anticipated.
Lead and Copper Rule	Revisions to the Federal Lead and Copper Rule were in progress at the time of this update. DDW to make revisions to the State Lead and Cooper Rule in 2018 to reflect changes made to the Federal Rule. Impacts to Palmdale WTP should be evaluated when more information is available.
Phase II, Phase V SOC/IOC Regulations	Continued compliance is anticipated.
Total Coliform Rule	Continued compliance is anticipated.
Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 DBP Rule)	Continued compliance is anticipated. Installation of GAC treatment has increased TOC removal.
Interim Enhanced Surface Water Treatment Rule (IESWTR)	Continued compliance with the turbidity removal and filter performance requirements of this regulation is anticipated.
California Interim Enhanced Surface Water Treatment Rule	Continued compliance is anticipated.
Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)	Continued compliance is anticipated.
Consumer Confidence Reports Rule	Continued compliance is anticipated.
Radionuclides	Continued compliance is anticipated.
Filter Backwash Recycling Rule	Continued compliance is anticipated.
Stage 2 Disinfectants/Disinfection Byproducts Rule (Stage 2 DBP Rule)	Continued compliance is anticipated. Installation of GAC treatment has lowered regulated DBP levels in the treated water.
Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)	Continued compliance is anticipated.
Arsenic Rule	Continued compliance is anticipated.
Radon	An MCL has not yet been promulgated. Compliance is anticipated for the Palmdale surface water supply.
California MTBE Standard	Continued compliance is anticipated.
Ground Water Rule (GWR)	Compliance not evaluated here.
Unregulated Contaminant Monitoring Rules	Continued compliance is anticipated.
Public Notification Rule	Continued compliance is anticipated.

Regulation	Conclusion
California *Cryptosporidium* Action Plan	Continued compliance is anticipated.
Perchlorate	Continued compliance is anticipated. At the time of this review, CA was reviewing lowering the MCL. As of January 2017, EPA was in the process of developing a MCLG for perchlorate in drinking water.
Hexavalent Chromium	DDW is currently establishing a new MCL for hexavalent chromium. A Federal MCL has not yet been promulgated. Potential treatment requirements are not currently known. The impact on Palmdale WTP treatment requirements should be evaluated when more information is available.
Nitrosamines	An MCL has not yet been promulgated. Potential treatment requirements are not currently known.
Cyanotoxins	EPA is evaluating a possible cyanotoxin rule based on UCMR 4 monitoring results which are scheduled to be completed in 2020.
Strontium	A Federal MCL has not been established however a final rule is expected in 2019-2020. Continued compliance is anticipated for the State MCL.
Chlorate	A Federal MCL has not been promulgated; however, the EPA recognizes chlorate may be introduced or formed in public water systems and disinfection practices and therefore it is important to evaluate chlorate in the context of reviewing existing Microbial and Disinfection Byproduct Regulations. Chlorate is also part of CCL 4.
VOCs	EPA is currently evaluating the regulation of Carcinogenic VOCs as a group rather than individual compounds. The ultimate form of the potential future regulation was undetermined at the time of this review.
Legionella	EPA's third year review (January 2017) highlights an opportunity to reduce risk posed by Legionella and links secondary disinfectant results to reduce the risk posed by Legionella.
1,2,3-TCP	At the time of this review, DDW had promulgated a proposed MCL of 0.00005 mg/L.

Both total and fecal coliform concentrations in Lake Palmdale have historically been relatively low. It is recommended that the District continues to monitor total and fecal coliform concentrations, and to follow best management practices.

Algal concentrations in Lake Palmdale were consistently low during periods when copper sulfate was added. A sharp spike in algal cell counts was observed in October of 2016. It is recommended that the District investigate potential cause of the increase algae cell counts and evaluate mitigation strategies to prevent reoccurrence of elevated algal cell counts.

9.0 Management Activities Review

9.1. Overview

This section presents a summary of the activities that PWD has participated in since the 2012 Sanitary Survey Update, as well as possible control measures for those sources of contamination that pose a significant risk to water quality. PWD is active in promoting watershed protection by a variety of different means, including education, regulatory review, participation in BMP implementation and improvements to their facilities to limit PCA impacts.

9.2. Local Watershed Management Programs

The degree of direct control that any water agency has over a watershed depends largely on the amount of watershed land that is owned by the agency.

9.2.1. Palmdale Water District

PWD does not have direct regulatory or enforcement authority over its watershed. They rely on the regulatory powers of other agencies and through them are active in promoting watershed protection by means of a variety of different venues including: education, regulatory review, and participation in Best Management Practice (BMP) implementation.

The District has taken an active role in protecting its sources of water supply from contamination, and in preparing to deal with accidents should they occur. Management activities completed since the 2012 report are detailed below.

- PWD staff inspect the Palmdale Ditch twice daily when it is in use and twice weekly during the off-season.
- PWD has enclosed a portion of the Palmdale Ditch from the Sierra Highway to Lake Palmdale. The segment is approximately 1 mile long and prevents direct dumping into the canal as well as drainage into the canal from an area that has been a common source of pollution.
- In an effort to discourage dumping in the area around the Palmdale Ditch, the District has blocked access to three common dumping areas and posted no trespassing signs.
- The District produces a seasonal newsletter, 'Water News' to update users on water quality, use restrictions and activities taking place in the watershed.

9.2.2. Fin and Feather Club

As part of their lease contract with the District the Fin and Feather Club provides security for the Lake Palmdale premises including posting signs against trespassing, and maintains the premises using volunteers, community service workers, and/or other personnel as required. Maintenance activities include upkeep of facilities constructed and operated by the Club, reasonable trimming of trees and other landscaping, trash and litter collection, and the clearing of vegetation from the road.

9.3. Other Existing Programs

Numerous existing federal and state programs are aimed at protecting water supplies and the regulation, inventory, and cleanup of contaminant sources and spills. Guidelines are in place for siting new sources of supply, and any newly proposed developments must undergo environmental review. The District does, when possible, rely on existing regulations and

processes to help make decisions and enforce requirements for the protection of the source water supply.

9.3.1. Federal Programs

There are six primary federal laws designed to help protect source water quality by setting standards or permitting uses and activities. The laws, their key elements, and the agencies responsible for implementing them are identified in

Table 9-1.

Table 9-1: Federal Laws Designed To Protect Source Water Quality

Act	Key Elements	Responsible Regulatory Agencies
Safe Drinking Water Act (SDWA)	Sets Maximum Contaminant Levels (MCLs) in drinking water and establishes flexible protection programs	EPA Region 9, Calif. Department of Public Health
Clean Water Act/Program (CWA)	Sets standards for allowable pollutant discharges to surface water or groundwater.	EPA Region 9, Central Valley Regional Water Quality Control Board
The Resource Conservation and Recovery Act (RCRA)	Regulates the transport, storage, treatment and disposal of hazardous wastes. Establishes the Federal Underground Storage Tank Program.	EPA Region 9, Central Valley RWQCB, County Health Department, Fire Districts and Depts., State Dept. of Toxic Substances Control (DTSC)
The Comprehensive Environmental Response and Liability Act (CERCLA or Superfund)	Regulates cleanup of contamination from hazardous wastes.	Department of Toxic Substances Control
The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)	Regulates pesticide sale and use and promotes alternative pest control strategies.	Department of Pesticide Regulation
The Toxic Substances Control Act (TSCA)	Regulates manufactured chemicals. Protects public health and the environment from risks from the improper handling, storage, transport, and disposal of hazardous substances.	Department of Toxic Substances Control

9.3.2. U.S. Department of Agriculture

The U. S. Department of Agriculture (USDA) through the USFS maintains and implements BMPs as needed for Forest Management within the Angeles National Forest. Additionally, they are responsible for coordinating the efforts of various agencies and encouraging implementation of BMPs immediately following fires. All projects within the forest must comply with Forest Plan Direction including timber cutting and pesticide or herbicide use and storage. Some of these practices that affect water quality are:

- Fire Management: Includes preparing for, administering, and managing fire protection activities including fire prevention, detection, wildfire suppression, and fuel management.
- Fish and Wildlife Habitat Administration: Includes activities that maintain the conditions of the wildlife habitat as needed to promoted growth and survival such as improving habitat areas.
- Forest Pests: Includes pest management without the use of pesticides.

- Recreation: Includes wild and scenic river inventories, environmental reports, and review development.

9.3.3. State Programs

Existing source water protection programs and related programs within the state of California are listed below. Activities undertaken by state agencies in support of federal and local programs include:

- Basin Planning
- NPDES and Waste Discharge Requirements
- Waste Discharges to Land
- Hazardous Waste Facility Monitoring
- Underground Storage Tanks
- Non-Point Source Pollution
- Resource Conservation and Recovery Act (RCRA)
- California Superfund Program
- Pesticide Use and Management
- Integrated Waste Management
- Porter-Cologne Act
- Water Quality Control Act

Table 9-2 summarizes involved state agencies and their roles in the protection of source water supplies.

Table 9-2: State Agencies and Their Roles in the Protection of Source Water

Agency	Departments/ Boards	Responsibility
Health and Welfare	DDW-Division of Drinking Water and Environmental Management	Promotes public health through the regulation and monitoring of public water systems. It implements the SDWA regulations.
California EPA	State Water Resources Control Board	Formulates and controls, the State's policy for water quality control, oversees the RWQCB's and administers California's system of water rights.

Agency	Departments/ Boards	Responsibility
	RWQCBs	Adopts, and implements water quality control policies and plans. They adopt Basin Plans and, under the authority of the CWA and the Porter – Cologne Act, they regulate point source discharges. They regulate any discharge of waste that may affect water quality in California. They also regulate waste discharge to land, carry out groundwater monitoring and surveillance programs and develop regulations, standards and guidelines pursuant to RCRA. They are also responsible for the enforcement of: UST Tank regulations, Non-Point Source Pollution control measures, Remediation of surface or groundwater pollution problems, and Implementation of the Coastal Zone Act Reauthorization Amendment (CZARA)
	Department of Toxic Substances Control (DTSC)	Protects public health from the improper handling, storage, transport and disposal of hazardous substances. Primary activities related to drinking water source protection are included in two programs mandated by federal law: RCRA and the California Superfund Program.
	Department of Pesticide Regulation	Regulates the use and management of pesticides to prevent pollution of surface water bodies and groundwater aquifers. It relies on authorities in the: California Food and Agricultural Code, and California Pesticide Contamination Prevention Act
	Waste Management Board	Oversees the treatment, storage, recycling, and disposal of solid waste by local agencies
	OEHHA	Provides information to environmental regulators and the public about adverse health effects that result from environmental exposures to noninfectious agents. It is responsible for implementing the Safe Drinking Water and Toxic Enforcement Acts of 1986 (Proposition 65)
Resources Agency	Department of Water Resources	Develops, conserves and manages the water resources of the state. Its mission is to manage water resources in cooperation with other agencies to benefit the people of the state and to protect, restore and enhance the natural and human environments.
	Department of Conservation	Among other responsibilities, it acts to prevent groundwater contamination due to the drilling, operation, maintenance, and abandonment of oil, gas and geothermal wells.
	Department of Forestry and Fire Protection	Protects against fires, responds to emergencies, and protects and enhances forest, range and watershed values.
	State Fire Marshal, Pipeline Safety Division	Regulates and enforces the safety of all intrastate hazardous liquid pipelines.
	Department of Food and Agriculture	Inventories agricultural operations, dairies, and animal feedlots. It also investigates water quality issues involving the accumulation of nitrates in groundwater basins.

10.0 Source Protection Opportunities

10.1. Overview

A comprehensive source water protection program can prevent contaminants from entering the public water supply, reduce treatment costs, and increase public confidence in the quality, reliability and safety of its drinking water. Protection of the source to reduce the risk of contamination is an important element of a multi-barrier approach and helps increase public confidence in the water supply. Protection of source water is an ongoing process. The PCAs of key concern to PWD's surface water supplies are recreation, illegal dumping and open access of the Palmdale Ditch. The following section outlines strategies to guide PWD in future source water protection decisions. Some of these strategies are ongoing and were recommended in the previous Sanitary Survey Updates.

10.2. Recreation Activities

10.2.1. Littlerock Reservoir

Historic monitoring data for fecal coliform, total coliform, *Giardia* and *Cryptosporidium* indicate that the Palmdale WTP has been well protected from the impacts of recreation on Littlerock Reservoir. Recreational access to Littlerock Reservoir is currently prohibited due to detection of mercury in some fish populations. The source of the mercury is unknown. The facilities will remain closed until the USFS and PWD choose to reopen the facilities to the public.

With the closure of Littlerock Reservoir to the public, the Lake has been well protected from bacteria and protozoa from human contact, and these constituents are likely to remain a low concern as long as the reservoir remains closed. Access will be restricted for an estimated 60 days per year for the next seven to 12 years as the LRSR dredging project is implemented.

When the facilities are re-opened, signage and educational materials regarding source water protection should be revisited and the DDW sampling and monitoring guidelines should be implemented. The facilities should be staffed at recommended levels, and maintained such that refuse and waste are removed daily to limit the potential for contamination. Recreational use is likely to increase the potential for contamination from human waste disposal and body contact, and will require staffing and outreach to limit negative impacts.

10.2.2. Lake Palmdale

Recreational activities at Lake Palmdale are limited, and overseen by the Palmdale Fin & Feather Club. No body contact is allowed, however dogs can be used for retrieving fowl from the Lake. Signage and staff should request that contact between dogs and the water be minimized. A diversion ditch reduces local runoff into Lake Palmdale. Additionally, lead ammunition is not permitted according to California State law, and compliance should be monitored by Fin & Feather staff.

Historic data collected in the timeframe surrounding peak weekend use indicate that the impact of recreation is mitigated by either the assimilative capacity of the reservoir or the relative dilution of contaminants in this secondary source with SWP water. To date, the impact on water quality from recreation has been negligible for supplies in Lake Palmdale at the WTP intake.

10.2.3. Access Control at Littlerock Reservoir

The Reservoir entrance gate is locked and signage indicates that the facilities are closed, however there are potential access points for trespassers. The area should be patrolled for signs of trespassing and the perimeter fencing inspected.

Figure 10-1: Littlerock Reservoir Gated Entry

10.2.4. Access/Illegal Use of Palmdale Ditch

Access and illegal use to the Ditch upstream of the enclosed section is still a potential source for contaminants entering into the system. PWD currently does have a program in place to increase public awareness or to alert the public to the dangers of using the Ditch for recreational activities and dumping.

Increased maintenance of "No Trespassing" and other water awareness signage to mitigate vandalism may be beneficial. In addition the District may want to investigate the feasibility for additional piping of the Ditch in other areas where dumping is an issue or where wildlife are more active.

PWD could consider creating a buffer zone on either side of the Ditch that would be cleaned regularly to prevent debris from entering the Ditch during storm events.

10.2.5. Equestrian Activities

Equestrian trails were identified adjacent to Palmdale Ditch, potential BMPs include requiring that trails be set back from the high water line by more 100 feet per DDW regulatory guidelines.

Additionally, consider coordinating with the company that runs the trail to require that the owner of each horse retrieves fecal matter and properly disposes of it in sanitary facilities, signage and plastic bag dispensers could be installed at each end of the trail to encourage compliance.

10.3. Public Education and Outreach Efforts

Public education and outreach efforts by PWD go a long way towards informing the public of the implications of their actions. Some efforts will need to be coordinated with other controlling agencies.

- Continue an open discussion with the counties to get their support in the effort of protecting the source.
- Coordinate with the USFS to establish educational information postings on lands under their control.
- Install signage indicating that Littlerock Reservoir and Lake Palmdale are drinking water sources.
- Communications to the membership of the Fin & Feather members, possibly via email, regarding any continued issues or best source protection practices.

10.4. Monitoring

Strong monitoring programs are the key to establishing baseline data and a broad understanding of the effects of activities in the watershed on the water supply source. PWD should consider the following monitoring recommendations.

- Develop electronic databases for all their water quality data and prepare an annual review for trends and unusual data outliers. Data in electronic form could provide operators with nearly immediate understanding of trends in the quality of water in their system.
- Special monitoring for fire events, spills and storm events.

10.5. Sewage and Storm Runoff

To protect the watershed from human/animal waste, there are various points of entry that must be considered and controlled. PWD should be proactive in communicating concerns to the local RWQCB and groups with recreation and agricultural activities in the watershed.

- Oppose the issuance of permits for discharges to surface water and provide discharge alternatives to the appropriate RWQCB to aid in their decision-making.
- Install and maintain fencing along the Palmdale Ditch right-of-way to prevent access.
- Limit access at Ditch locations currently designated for livestock and equipment crossing by installing gates.
- Grade Ditch right-of-way to minimize runoff.
- PWD may want to investigate the feasibility for additional piping of the Ditch in reaches where stormwater runoff into the Ditch is prevalent.
- Consider adding a third debris cleanup of the Palmdale Ditch in late April or May when the Palmdale Ditch is on average providing the most supply.

10.6. Other

Additionally, some other approaches presented below are recommended as a means of addressing impacts from other activities on the reservoir.

- Following wildfire incidents water quality monitoring should be initiated to assess impacts on water quality.
- Monitor fire activities and encourage rapid post fire BMP implementation.
- Work with stakeholders, including the County, to determine implementation schedule for source protection activities, maintenance of outreach materials and informational signage.
- Upgrade vehicle entry points to prevent trespassing (Figure 10-1).
- Patrol Littlerock Reservoir facilities to prevent trespassing.

11.0 Works Cited

Black & Veatch. "Sanitary Survey and Drinking Water Source Assessment for Littlerock Reservoir and Lake Palmdale Watersheds." June 2002.

Black & Veatch. "Sanitary Survey and Drinking Water Source Assessment Update for Littlerock Reservoir and Lake Palmdale Watersheds." January 2008.

Black & Veatch. "Sanitary Survey and Drinking Water Source Assessment Update for Littlerock Reservoir and Lake Palmdale Watersheds." December, 2012.

Bureau of Transportation Statistics. "Hazardous Material Incident Reporting System (HMIRS)." 2012. https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/

California Department of Public Health. "Draft Guidance for Fresh Water Beaches." July 2000. http://www.cDDW.ca.gov/healthinfo/environhealth/water/Documents/Beaches/DraftGuidanceforFreshWaterBeaches.pdf

California Department of Forestry and Fire Protection - Fire and Resource Assessment Program. "Maps". http://frap.cdf.ca.gov/data/frapgismaps/select.asp

California Fire Alliance. "Fire Planning and Mapping Tools." http://wildfire.cr.usgs.gov/fireplanning

California Governor's Office of Emergency Services. "Hazardous Materials Spill Reports 2008, 2009, 2010, 2011, and 2012". http://rimsinland.oes.ca.gov/operational/malhaz.nsf/$defaultview

HDR. "Sanitary Survey of the Littlerock Reservoir and Lake Palmdale Watershed." June 1993.

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

MWH, "2016 Water System Master Plan: Final Report," December, 2016.

Palmdale Water District and Aspen Environmental Group, "Littlerock Reservoir Sediment Removal Project Environmental Impact Report" (SCH # 2005061171), March 2017.

Northwest Hydraulic Consultants Inc., "Littlerock Reservoir Sediment Removal Project: Grade Control Structure Design Development Memorandum." Prepared for Palmdale Water District on Behalf of Aspen Environmental Group. September, 2017

Standish-Lee Consultants. "Updated Sanitary Survey for Littlerock Reservoir and Lake Palmdale Watersheds." March 1997.

State of California – California Data Exchange Center. http://cdec.water.ca.gov

State of California Department of Forestry & Fire Protection. "CDF Fact Sheets." http://www.fire.ca.gov/about_factsheets.php

State of California Fire and Resource Assessment Program. "Information and Data Center." http://frap.cdf.ca.gov/infocenter.html

Tchobanoglous, G., and E. Schroeder. "Water Quality Management: Water Quality." Reading MA: Addison-Wesley Publishing Co., 1987.

United States Census Bureau. "State and County Quick Facts." http://quickfacts.census.gov/qfd/states/06/0655156.html

United States Environmental Protection Agency (EPA2004). "BASINS: Better Assessment Science Integrating Point & Non-point Sources." November 2004. http://www.epa.gov/waterscience/basins/index.html

---"National Pollutant Discharge Elimination System (NPDES): Overview". December 2003. http://cfpub2.epa.gov/npdes/

---"Phases of the NPDES Stormwater Program." http://cfpub.epa.gov/npdes/stormwater/swphases.cfm

United States Environmental Protection Agency - Office of Solid Waste. "Human Health and Environmental Damages from Mining and Mineral Processing Wastes". 1995.