

Solano Project – Watershed Sanitary Survey Below Monticello Dam FINAL REPORT October 2006

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LIST OF ABBREVIATIONS

AWWA - American Water Works Association

BLM – US Bureau of Land Management

BMP – best management practice

Caltrans – California Department of Transportation

CCR - Consumer Confidence Report

CDHS – California Department of Health Services

CUPA - Certified Unified Program Agency

CUWA – California Urban Water Agencies

D/DBP – Disinfectants/Disinfection By-Products

DBP – disinfection by-product

DOC – dissolved organic carbon

DPR - California Department of Pesticide Regulation

E. coli – Escherichia coli

GPS – global positioning system

HAA5 - haloacetic acids

IDSE – Initial Distribution System Evaluation
IESWTR – Interim Enhanced Surface Water Treatment Rule

IPM - Integrated Pest Management

KPRA – King-pin to rear-axle

LRAA – locational running annual average

LT2ESWTR - Long Term 2 Enhanced Surface Water Treatment Rule

MCL - maximum contaminant level

MEP - maximum extent practicable

mgd – million gallons per day

mg/L - milligrams per liter

MPN/100 mL - most probable number per 100 milliliters

MRP - Monitoring and Reporting Program Plan

NBA – North Bay Aqueduct

NBR – North Bay Regional

NPDES - National Pollution Discharge Elimination System

NIMS - National Incident Management System

NPS – Nonpoint Source

NTU – nephelometric turbidity unit

OES – California Office of Emergency Services

POE – Point of Entry

RAA - running annual average

Regional Board - San Francisco Bay Regional Water Quality Control Board

RIMS – Response Information Management System

RV - recreational vehicle

RWQMP - Rangeland Water Quality Management Program

SCWA – Solano County Water Agency

SDWA – Safe Drinking Water Act

SEMS - Standardized Emergency Management System

SFM - State Fire Marshall

SID – Solano Irrigation District

SOC - synthetic organic compound

STAA – Surface Transportation Assistance Act

State Board - State Water Resources Control Board

SUVA - Specific Ultraviolet Light Absorbance

SVWQC – Sacramento Valley Water Quality Coalition

SWTR - Surface Water Treatment Rule

TOC – total organic carbon

TT – Treatment Technique

TTHM - total trihalomethanes

UCCE – University of California Cooperative Extension

μg/L – micrograms per liter

URO - Urban Runoff

USEPA – US Environmental Protection Agency

WDR – waste discharge requirements

WER – Watershed Evaluation Report

WTP – water treatment plant

VOC – volatile organic compound

BACKGROUND

The Solano Project supplies agricultural water and municipal drinking water to Solano County. The major facilities of the project are Lake Berryessa, formed by Monticello Dam on Putah Creek, the Putah Diversion Dam, the Putah South Canal, and the Terminal Reservoir. The facilities are owned by the U.S. Bureau of Reclamation and maintained and operated by Solano County Water Agency (SCWA) through an operating agreement with Solano Irrigation District (SID). SCWA is a wholesale agency that provides untreated water to communities in Solano County, and is therefore responsible for preparing the watershed sanitary surveys on the Solano Project.

Two watershed sanitary surveys have been completed for the Solano Project. The initial watershed sanitary survey provided a detailed inventory of contaminant sources in both the Lake Berryessa and Putah South Canal watersheds (Brown and Caldwell, 1993). The First Update of the watershed sanitary survey focused mainly on the Lake Berryessa watershed and efforts to form the Lake Berryessa Watershed Partnership (Solano County Water Agency, 2001). Both of these watershed sanitary surveys concluded that water leaving Lake Berryessa, near the bottom of the dam, is high quality with few contaminants. The principle sources of contaminants to the Solano Project water are downstream of Monticello Dam. The water providers and the California Department of Health Services (CDHS) staff determined that this Second Update of the watershed sanitary survey should concentrate on the watershed downstream of Lake Berryessa (the Lake Solano watershed) and contaminant sources that enter the Putah South Canal. A separate sanitary survey update will be prepared, in coordination with Napa County, for the Lake Berryessa watershed.

SOLANO PROJECT FACILITIES

The Solano Project facilities are described in great detail in the initial watershed sanitary survey. This section provides information on the facilities to assist with understanding of this report. **Figure 1-1** shows the major facilities of the Solano Project.

Lake Berryessa and Monticello Dam

Lake Berryessa is located in eastern Napa County and has a watershed of 576 square miles and a storage capacity of 1.6 million acre-feet. Monticello Dam is 304 feet high. Water is released near the bottom of the dam and used to generate electricity. Water is released through the uncontrolled glory hole spillway when the lake reaches capacity.

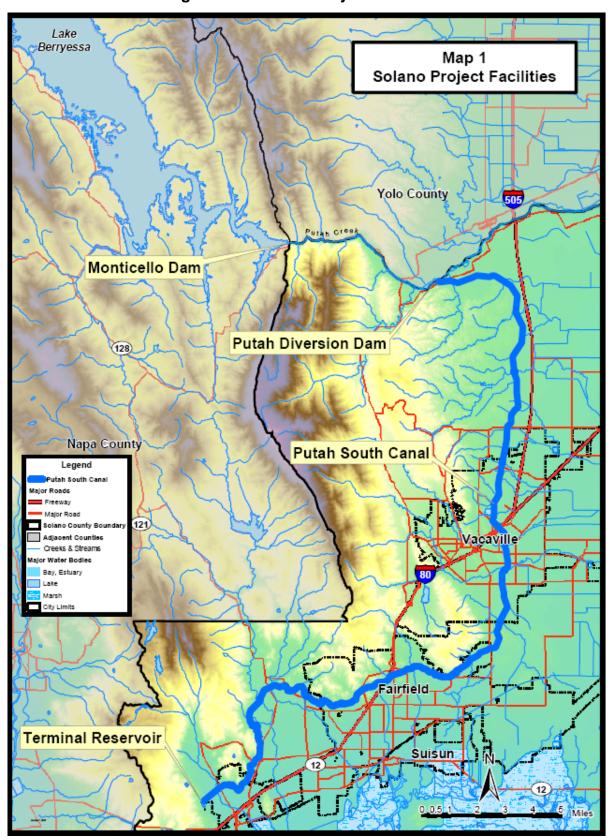


Figure 1-1. Solano Project Facilities

Putah Creek, Lake Solano, and the Putah Diversion Dam

Putah Creek, which forms the approximate border between Solano and Yolo counties, is the only outlet from Lake Berryessa. As noted in the initial watershed sanitary survey, the watershed between Monticello Dam and the Putah Diversion Dam is approximately 30 square miles. The region below Monticello Dam is a well-established riparian habitat that has become known for its coldwater fisheries. The sub watershed for this reach of Putah Creek, shown in **Figure 1-2**, includes a small contributory area north of the creek in Yolo County and a larger contributory area south of the creek in Solano County, primarily in Pleasants Valley. The major tributaries include Thompson, Cold, and Bray Canyon Creeks and Pleasants Creek. All of these are seasonal streams that largely provide flows during the winter and spring rains.

This is a largely uninhabited area that consists of native vegetation. The United States Bureau of Land Management (BLM) owns a substantial amount of land in the Vaca Mountains along Blue Ridge in Pleasants Valley. Land is also owned by the California Department of Fish and Game and the University of California Natural Reserve System in Cold Canyon. The soils in the watershed are highly erodable.

Putah Diversion Dam is located on Putah Creek approximately six miles below Monticello Dam. The principal function of the dam is to divert water into Putah South Canal. The dam creates Lake Solano, which is about 1.5 miles long with a capacity of 750 acre-feet. The lake provides recreation in an area already popular for picnicking, non-motorized boating, swimming, and fishing.

Putah South Canal

The Putah South Canal originates at the Putah Diversion Dam and runs easterly for about 4 miles. It then turns south, then southwest, to follow the edge of the foothills for about 30 miles and terminates in Cordelia. The canal is concrete lined, except for a one-mile segment beginning at the Green Valley Siphon that is pre-cast reinforced concrete pipe and designated as the Putah South Pipeline. The canal from the Diversion Dam through Allendale is surrounded by high earthen berms. The canal has a diversion capacity of 956 cubic feet per second (cfs) with a terminal capacity of 116 cfs.

The Putah South Canal is almost completely fenced and patrolled by SID three times per week. SCWA has an on-going fencing program as part of the Solano Project Rehabilitation and Betterment Program. The purpose of the fencing program is to improve security of the Putah South Canal. There are approximately 7.5 miles of the canal that are currently not fenced. The program is primarily concentrated on rural stretches of the canal that have no fence and on replacing inadequate field fences. Approximately 1 mile of fencing is completed per year. SCWA expects to address the majority of these areas within the next 4 years. However, areas that are anticipated to be developed adjacent to the canal within the near future (approximately 3.5 miles of the 7.5 miles) will likely be postponed for completion by developers.

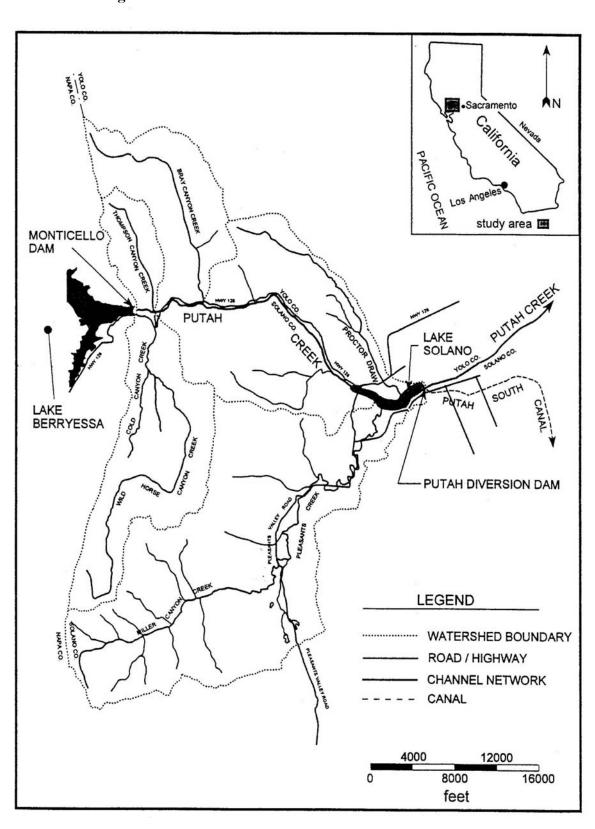


Figure 1-2. Putah Creek and Lake Solano Sub Watershed

Steep banks are vegetated with grasses to reduce erosion and engineered with catchment troughs to reduce direct runoff. There is little direct runoff directly into the canal. The initial sanitary survey estimated that the watershed that drained to the canal was 10 square miles. There are over 100 pipe crossings, including overchutes and buried pipelines. These are largely storm water runoff, but also include water, wastewater, and other utilities. There are also 62 bridge crossings, including both farm roads and urban roads.

Terminal Dam and Reservoir

The Terminal Dam is a 119 acre-foot reservoir located at the end of Putah South Canal and serves as a Terminal Reservoir for the canal and a forebay from which water is delivered to the cities of Vallejo and Benicia. This reservoir regulates the terminal flows in the canal and provides a small carryover supply in case of an interruption in flow.

WATER TREATMENT PLANTS

A number of agencies rely on Putah South Canal water for all or a portion of their drinking water supply. **Figure 1-3** is a schematic showing the relative location of the water treatment plants (WTPs) and other facilities on the Putah South Canal. The facilities are identified by milepost along the Putah South Canal. The headworks of the canal is milepost 0.0.

Gibson Canyon Water Treatment Plant

The Gibson Canyon Water Treatment Plant (WTP) receives water from the Putah South Canal at milepost 11.8. Water is pumped from the canal by the Eldridge Pumping Plant to the 21 acre-feet Bascherini Reservoir. SID owns and operates the 1.3 million gallons per day (mgd) membrane microfiltration plant that serves 157 service connections.

City of Vacaville

The Vacaville WTP receives water from the Putah South Canal at milepost 12.84. This WTP treats Solano Project water on a seasonal basis. The WTP has a capacity of 11.8 mgd but the typical production rate is 5 mgd. The plant is a diatomaceous earth filter plant with two sides that can produce 6 mgd each. Chlorine is used for disinfection. There is no adjustment of pH for corrosion control in the distribution system.

High turbidity and algal blooms create treatment challenges for the Vacaville WTP. The plant had to be shut down in August and September of 2005 due to blooms of the alga, *Tetraspora gelatinosa*. When the Vacaville WTP is shut down, the city relies on water from the North Bay Regional WTP and from groundwater.

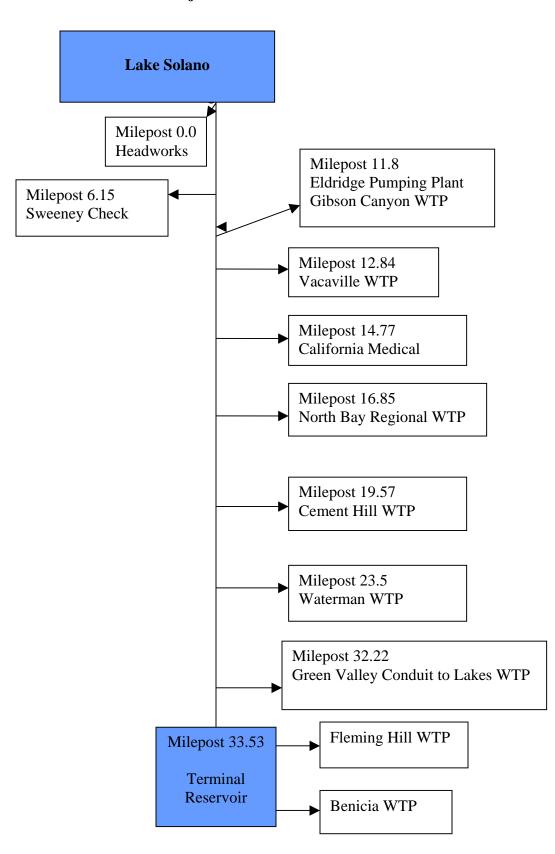


Figure 1-3. Schematic of Solano Project Facilities and Water Treatment Plants

California Medical Facility

The California Medical Facility/California State Prison-Solano takes water from the Putah South Canal at milepost 14.77. The WTP uses two parallel micro-flocculation package plants rated at 780 gallons per minute with post chlorination. The facility has the capability of blending water from the City of Vacaville.

North Bay Regional WTP

The North Bay Regional (NBR) WTP is a regional facility jointly owned by the cities of Fairfield and Vacaville. Water from both the Putah South Canal and the State Water Project's North Bay Aqueduct (NBA) are treated at this plant. The NBR WTP takes water from the Putah South Canal at milepost 16.85. Water from the NBA is controlled by the State Department of Water Resources and is delivered, via pipeline, from Barker Slough. Water from both sources can be blended. The NBR WTP has a design capacity of 40 mgd but the typical production rate is 20 mgd, with 10 mgd going to each of the two cities. The plant is a conventional water treatment plant consisting of preozonation, coagulation/flocculation with cationic and non-ionic polymers, sedimentation, and filtration. The filters are dual media, granular activated carbon/sand gravel. Free chorine is used for secondary disinfection and for maintaining a residual in the distribution systems. Caustic soda is used for pH adjustment of the finished water to prevent corrosion in the distribution system. Fluoride is applied to reduce the potential for dental carries.

High turbidity associated with runoff into Putah Creek and the canal during storm events results in the need for additional chemical treatment, reduction in the amount of water taken into the plant, increasing the NBA blend, and occasionally the plant shuts down for short periods of time until water quality improves. Other than during storm events, the Solano Project water is considered by NBR WTP staff to be a high quality source.

Cement Hill WTP

The Cement Hill WTP, owned and operated by the Suisun-Solano Water Authority, provides water to Suisun City. Water is diverted from the Putah South Canal at milepost 19.57. Solano Project water is the only source of water for this WTP. The WTP has a design capacity of 10 mgd but the typical production rate is 4.5 mgd. The plant is a conventional water treatment plant consisting of coagulation/flocculation with polyaluminum chloride, sedimentation, and filtration in multi-media pressure filters. Free chorine is used for disinfection.

High turbidities caused by runoff into Putah Creek and the canal during storm events results in the Cement Hill WTP being shut down occasionally to avoid taking the highly turbid water into the plant. The Suisun-Solano Water Authority is currently evaluating options for complying with the requirements of the Stage 2 Disinfectants/Disinfection

Byproducts Rule to calculate running quarterly averages of disinfection byproducts at various locations in the distribution system.

Waterman WTP

The Waterman WTP, owned and operated by the City of Fairfield, receives water from the Putah South Canal at milepost 23.5. This plant only treats Solano Project water. The WTP has a design capacity of 22.5 mgd and average daily production is 9 mgd. During the summer months there is a demand for 15 to 16 mgd but some treatment processes are overloaded if more than 15 mgd is treated. The plant is currently a conventional water treatment plant consisting of pre-ozonation, coagulation/flocculation, sedimentation, and filtration in anthracite over sand filters. Free chlorine is used for secondary disinfection. The plant is undergoing an expansion to increase the capacity to 30 mgd. As part of the expansion, the Acti-Flow process will be replacing the coagulation/flocculation and sedimentation processes. Acti-Flow is a high-rate, sand-ballasted process that combines these processes into one structure that requires less physical space at the plant site. Ozone will be injected into the water after clarification. Four additional filters are being added and the media in the existing filters is being replaced. Free chlorine will continue to be used for secondary disinfection.

Turbidity during storm events and occasional low alkalinity create treatment challenges. When SID alerts the plant operators that turbidity is increasing in the Putah South Canal, the operators shut the plant down until the slug of higher turbidity water has passed the intake. The plant can be shut down for up to 24 hours but that is rarely needed.

Green Valley WTP

Solano Project water can be diverted at the end of the open canal (milepost 32.33) to the City of Vallejo's Green Valley WTP. Solano Project water is blended with water from Vallejo's Lakes System at this plant. The Green Valley WTP is a 1 mgd conventional plant consisting of flocculation/coagulation, sedimentation, filtration, MIEX ion exchange, and chlorination.

High total organic carbon (TOC) concentrations in the Lakes System resulted in difficulties meeting the disinfection byproduct (DBP) standards of 80 micrograms per liter (μ g/L) for total trihalomethanes (TTHMs) and 60 μ g/L for haloacetic acids (HAA5). As a result, MIEX was added to the plant to increase TOC removal prior to chlorination. The WTP has no difficulties treating Solano Project water.

Fleming Hill WTP

Water is pumped from the Solano Project's Terminal Reservoir to the City of Vallejo's Fleming Hill WTP. This WTP treats water from the Solano Project and from the NBA. The sources can be treated individually or blended. The WTP has a rated hydraulic capacity of 42 mgd but the typical production rates range between 14 and 25 mgd. The

plant is a conventional water treatment plant consisting of pre-ozonation, alum/cationic polymer coagulation/flocculation, sedimentation, ozonation, and filtration. The filters are dual media; granular activated carbon over sand and gravel. Free chorine is used for secondary disinfection and for maintaining a residual in the distribution system. Caustic soda is used for pH adjustment of the finished water to prevent corrosion in the distribution system. Fluoride is applied to reduce the potential for dental carries.

Ozone was added to the plant as the disinfectant to address issues associated with DBP formation with chlorine when NBA water is treated at the plant. The Fleming Hill WTP operators report that they do not have any routine difficulties in treating Solano Project water. Due to settling in the Terminal Reservoir, high turbidity during storm events does not adversely affect operations at Fleming Hill.

City of Benicia

The City of Benicia WTP receives water from the Solano Project via a Terminal Reservoir pump and pipeline. This is a secondary supply to the City's NBA entitlement. The majority of the time, Solano Project water is bended with NBA water to reduce the influent TOC concentrations in the NBA water. The WTP has a rated hydraulic capacity of 12 mgd but the typical production rates range between 3 and 10 mgd. The plant is a convention water treatment plant consisting of alum/cationic polymer coagulation-flocculation, dual granular activated carbon/sand gravel media filtration, and free chorine disinfection.

Point of Entry Devices

The Second Update to the Watershed Sanitary Survey, conducted in 2001, reported that a number of rural areas in Solano County used Point of Entry (POE) water treatment systems to treat Putah South Canal water at the place of use. The status of each of these areas is summarized in **Table 1-1**.

REPORT OUTLINE

An evaluation of potential contaminating activities is presented in **Section 2**, which focuses on agricultural pesticide use, erosion, grazing, recreation, spills/illegal dumping, urban runoff, wildfires, and source water protection programs. **Section 3** presents an evaluation of available water quality data for selected water quality constituents, including turbidity, microbiological contaminants, disinfection byproduct precursors, algal blooms, and pesticides. Finally, **Section 4** presents the key findings of the evaluations as well as a discussion on the recommendations for the water providers over the next five years related to water quality and potential contaminating activities.

Table 1-1. POE System Status

Area	Canal Milepost	Number of POE Systems	Status
Gibson Canyon	11.8	None	SID has installed a 1.3 mgd centralized package microfiltration plant to replace 200 POEs.
Moose Lodge	11.8	1	POE will continue to be used to treat water at the site. The Moose Lodge is classified as a non-transient non-community water system.
Pleasant Hills Ranch	11.8	22	Pleasant Hills Ranch is still operating with non-State approved POEs. This system is a public water system. There are currently 22 connections and there will be 39 connections at full build out. SID is conducting a pilot study on State approved POEs and is evaluating the costs and benefits of POEs and a centralized package water treatment plant.
Peabody Lateral	16.91	None	12 POEs are no longer used. Putah South Canal water is used for outside irrigation only. Treated water is supplied through a connection to the City of Fairfield's distribution system. This is a consecutive water system and SID is responsible for meeting all drinking water standards.
Blue Ridge Oaks	20.56	None	15 POEs are no longer used. Putah South Canal water is used for outside irrigation only. Treated water is supplied through a connection to the City of Fairfield's distribution system. This is a consecutive water system and SID is responsible for meeting all drinking water standards.
Rural areas of County	Various	Approximately 109	POEs still in use in rural areas of the County. Homes are required to be on a Bottled Water Program until an approved POE system is installed, a private well is installed, or a connection is made to a centralized treatment system. The rural areas are classified as non-public water systems.

Introduction

The Solano Project includes Lake Berryessa, Monticello Dam, Putah Diversion Dam at Lake Solano on Putah Creek, Putah South Canal, and the Terminal Reservoir. The Project furnishes municipal and industrial water to the principal cities of Solano County.

This Second Update focuses on the watershed below Monticello Dam, including Putah Creek, the tributaries to Putah Creek, Lake Solano, Putah South Canal, and the Terminal Reservoir. This report has identified seven categories of potential contaminating activities for evaluation, which were selected based on the findings of the Original Survey from March 1993, the First Update from January 2001, and current information. This includes:

- Agriculture/Pesticide Use
- Erosion
- Grazing
- Recreation
- · Spills/Illegal Dumping
- Urban Runoff
- Wildfires

AGRICULTURE/PESTICIDE USE

Solano and Yolo counties have long growing seasons, ranging from 240 to 300 days per year. Most agriculture in the watershed occurs in Solano County. Irrigation is required to obtain good growth of most crops. Dry-farmed grains are planted early in winter and harvested in June and rely on rainfall for moisture. Agricultural production in the Putah Creek and Putah South Canal watersheds is very limited and primarily occurs in small acreage farms, including some organic farms. Crops include pasturelands, walnuts, almonds, prunes, apricots, peaches and a growing number of citrus fruits.

In 2005, the Solano County Agricultural Report listed about 30 different crops grown on a commercial scale (Solano County Agriculture Report, 2006). Of these, there are five present in the watershed for either Lake Solano or Putah South Canal, including rangeland, irrigated pasture, walnuts, wine grapes, and nursery stock. These are discussed further below. Again, it should be noted that agriculture only accounts for a small portion of the watershed for Lake Solano and even less along the Putah South Canal.

Rangeland acreage has increased about five percent between 2002 and 2005, to a total of 168,737 acres in the entire County. The presence in this watershed is discussed further in the grazing section below. Irrigated pastureland has increased tremendously, more than doubling between 2002 and 2005, to a total of 32,566 acres in the entire County. Most irrigated pasture is located in the east side of the County, but there is a small amount located along the Putah South Canal. Walnut orchards have remained very stable with less than three percent increase between 2002 and 2005, to a total of

7,142 acres in the entire County. Their presence in the watershed has also been stable. Wine grapes have also remained stable with essentially no change in acreage between 2002 and 2005, for a total of 4,291 acres. Their presence in the watershed has also been stable. Nursery stock has grown also, increasing from 1,035 acres in 2002 to 1,533 acres in 2005. Their presence in the watershed has grown over the study period.

Constituents of Interest

Although agricultural practices can cause erosion of soil and increased turbidity in receiving waters, pesticides used on crops in the watershed are the primary constituents of interest. A key group of pesticides is organophosphate pesticides typically used on orchards during the dormant spray season (typically January and/or February). Regulated pesticides, including organophosphate pesticides, are monitored quarterly at the North Bay Regional Water Treatment Plant intake and have not been detected in the Putah South Canal. A review of the Consumer Confidence Reports (CCRs) for the cities of Fairfield, Benicia, Vacaville, Vallejo, and Suisun-Solano Water Authority did not evidence detection of any organic compounds. However, the monitoring may not be conducted during the periods when these chemicals are used and are most likely to be found in the water.

Organophosphate pesticides, including chlorpyrifos and diazinon, are dormant season sprays and are typically applied to orchards in January and February. Few pesticides are applied to the orchard crops during the irrigation season.

It is expected that storm runoff would be largely responsible for contribution of solids, specifically organic carbon, since irrigation practices do not typically result in runoff. Because agricultural drainage comes off of irrigated cropland and through earthen canals and ditches, it has organic content. Standing water, suspended sediment, fecal waste and decomposing vegetation all contribute to total organic carbon (TOC) levels. TOC is detected in the Putah South Canal, generally at levels between 2 and 3 mg/L. The highest levels of TOC occur during and immediately after storm events, indicating that runoff from agricultural land could contribute to the source level.

Presence in the Watershed

Putah Creek and Lake Solano

Agriculture activities occur along the south side of Putah Creek to Lake Solano and also along the north shore of Lake Solano. There are also some orchards and grazing along Pleasants Valley Road. This area is known as the Pleasants Valley Farming District.

The Creekside Ranch is located approximately 1.7 miles northwest of the intersection of Putah Creek Road and Pleasants Valley Road, at the end of Sackett Lane on the south side of Putah Creek. Four Winds Growers have been in business here since the 1950's. The ranch is approximately 80 acres, with a wholesale nursery facility on 14

acres, and is located within close proximity to Putah Creek. The nursery consists of pole and cable shade structures that include a white fabric liner for cold weather protection. They grow edible ornamentals, mostly citrus trees, for homeowner use.

The owners practice best management practices including the use of drip emitters, rather than overhead watering, to minimize irrigation run-off that is contained on site. Their Integrated Pest Management (IPM) program means that pesticide use is limited, using mostly soap and oils. The ranch management is permaculture-based with a focus on maintaining the oak, alder, buckeye, cottonwood and grass riparian zone as a natural habitat. The owners are also involved with the Putah Creek Discovery Corridor and the Putah Creek Council. (Mary and John Seeger, Personal Communication)

A walnut orchard owned by the Putah Creek Walnut Company is also located along the south side of Putah Creek. Downstream slightly further, on the north side of Lake Solano, is the Terra Firma Organic farm that also is an orchard.

The primary crops in the watershed for Lake Solano include citrus trees, walnuts, and irrigated pastureland. **Table 2-1** provides a summary of the key pesticides used for each crop and their annual application in Solano County from 2000 through 2004.

Table 2-1. Selected Pesticide Use Summary for Solano County (pounds) 1

Crop	Pesticide	2000	2001	2002	2003	2004
Citrus	Petroleum Oil	365	104	50	134	210
	Potash Soap	22	0	0	61	49
Walnuts	Maneb	2,065	504	2,125	4,312	2,107
	Paraquat	1,601	0	723	827	964
	Copper	18,800	13,287	15,714	22,066	12,007
	Glyphosate	2,242	2,639	4,471	5,312	3,544
	Chlorpyrifos	3,638	2,767	6,595	3,141	6,506
Pasture	2,4-D	1,545	2,639	1,534	522	437
	Clopyralid	200	229	43	58	0
	Glyphosate	150	70	377	0	25

California Department of Pesticide Regulation – Pesticide Use Reporting Database

The table shows that there is a relatively low use of pesticides in the watershed. The most extensively used pesticides include copper, glyphosate, chlorpyrifos, and maneb. Maneb is a fungicide used on wine grapes and walnuts which has no human health level designated for drinking water. Maneb and its degradates have very short half-lives, typically less than one day in water, and are therefore not considered a drinking water health concern. Clopyralid is a broad-leaf herbicide used to control broadleaf weeds such as clover, thistle and dandelions. Clopyralid is water-soluble and very persistent, with a long half-life.

Putah South Canal

Hines Nursery

The Hines Nursery currently has two facilities located near Winters, adjacent to the Putah South Canal. The Winters North facility is a 259-acre commercial nursery, growing largely ornamental plants, located approximately three miles south of Winters on the western side of the Putah South Canal. The Winters South facility is expected to be built out by 2008, and will include a 500-acre commercial nursery, growing largely ornamental plants. The site is located further south, along both sides of the canal, but largely on the western side of Putah South Canal. Both facilities implement irrigation of nursery crops using sprinklers. Fertigating, using the irrigation system to provide the fertilizer, is also practiced at both sites. Since the facility is a separate public water system, it has standard backflow prevention and cross-connection control programs on-site. Pesticide use is limited, and is hand applied.

The Winters North facility has been fully developed and no additional expansion is planned at this site. A Stormwater Management Plan was designed and implemented on site to provide stormwater detention basins for a 100-year storm event. (Don Molina, Personal Communication) There are several basins that capture all the runoff flow, which flows from the west to the east. The soils under the nursery are nearly impervious, therefore providing limited or no percolation. These basins are allowed to overflow and discharge to a local drainage swale. The San Francisco Bay Regional Water Quality Control Board (Regional Board) does require the nursery to capture all first flush storm water and hold on site to provide sedimentation prior to discharge.

The Winters South facility has been partially developed and the plans for future expansion are complete and ready to be implemented over the next two years. A Stormwater Management Plan has been designed and will be implemented in stages on site to provide stormwater detention basins for a 100-year storm event (Don Molina, Personal Communication). There will be several basins that capture all the runoff flow, which flows from the west to the east. The Regional Board is requiring that all stormwater be managed on site, with no discharges allowed. Since the soils here are also impervious the size of the stormwater basins is quite large.

Solano Irrigation District Practices

Below the Monticello Dam, the predominant use of pesticides and herbicides that might impact drinking water sources would be from the Putah South Canal, maintained by the Solano Irrigation District (SID). There are several types of weed and pest control programs, including: algae, weed/brush control, and rodent control. The only chemical applied directly to the water in the canal is copper sulfate for algae control. **Table 2-2** lists the various chemical compounds applied by SID, in order of most commonly used.

Table 2-2. Weed and Pest Control Chemicals for Putah South Canal

Pesticide (Chemical Name)	Reason for Use	Rates	When Applied
Copper sulfate ¹	Algae control in water	1 to 2 pounds/ cubic feet per second	April – early October
Diuron ²	Pre-emergent weed control (Use decreased from past)	8 to 9 pounds/ acre	November – February
Glyphosate ² (Roundup)	Some post-emergent weed control and brush control and some chemical "mowing"	48 ounces/acre	Mainly February – October
2,4-Damine ²	Broadleaf weed control	32 ounces/acre	January – April
Triclopyr ² (Garlon 3A)	Broadleaf weed control	32 to 42 ounces/acre	January – April
Activator 90 ²	Spreader - activator	48 to 64 ounces/100 gallons of spray	As needed
Clopyralid ²	Thistle control	4 to 7 ounces/ acre	January – April
Aluminum phosphide ²	Ground squirrel control	3 to 4 tablets/burrow	February - March

Applied directly to the water in the Putah South Canal

The following information was confirmed by SID personnel regarding weed and pest abatement programs along the Putah South Canal.

"All applicators, except one, are certified by the State with Qualified Applicator Certificates and must undergo yearly training on proper safety and application of pesticides used. This training is done by an on staff licensed Pest Control Advisor and has State accreditation. The Pest Control Advisor also writes Pest Control Recommendations for the pesticides used on the different sites. Some of the Weed and Pest Control Program goals or objectives are to remove noxious weeds such as yellow star thistle and fennel, promote the growth of grasses to decrease erosion and hinder growth of other undesirable weeds (tumbleweed and puncture vine, etc.), and to decrease the overall use of herbicides. Weed growth must also be maintained for fire suppression within city limits and enable us to inspect and maintain the facilities. The Algae Control Program keeps algae from hindering water flow and clogging screens while the Rodent Control Program stops serious erosion problems from occurring." (Mark Veil, Personal Communication)

The main alga that SID controls is filamentous green algae (genus *Cladophera*). There have been variations in the type of algae that grows, including a bloom of an alga in the genus *Rhizoclonium* (also filamentous green algae) and more recently a bloom of

²Applied in right-of-way adjacent to the Putah South Canal

Tetraspora gelatinosa during the same time when Cladophera appeared. Despite the potential variation in genus, there is rarely a significant change in the control program on an annual basis.

SID uses a very low rate of glyphosate (2 to 3 ounces/acre) to stunt or chemically "mow" the grass next to the Putah South Canal. This keeps the grass low enough to allow for inspection from the access roads. In addition to the pesticide use, the canal is taken off-line for several weeks every fall to conduct manual cleaning of the canal. This begins at the Putah Diversion Dam and continues through to the Terminal Reservoir. This includes removal of large amounts of attached algae and other dirt and debris.

During both pesticide treatment and manual cleaning of the canal, SID coordinates closely with the municipal water treatment plants to ensure that they are aware of their practices.

Several ephemeral streams traverse the Putah South Canal along its alignment from Lake Solano to the Terminal Reservoir. In most cases the Canal siphons under the streams. In a few instances the stream is conveyed across the Canal in concrete flumes with open tops. The Canal siphons under Sweeney Creek and water is released from the Canal to Sweeney Creek through a controlled outfall to serve agriculture customers. On occasion, during large storm events, water from Sweeney Creek would backflow into the Canal through the outfall when the water surface elevation in the creek was higher than that in the Canal. This problem was recently resolved with the installation of a flap gate on the outfall from the Canal to Sweeney Creek to prevent the backflow.

During extreme storm events such as those that occurred in December 2002 and 2005, some of the flume crossings may over-top allowing rural storm runoff to temporarily spill into the canal. This is typically caused from downstream back-water effects, debris clogging, and the flow exceeding the capacity of the overchutes. Pleasants Creek crosses the Canal approximately one mile downstream of the PSC headworks at Lake Solano. The capacity of the Pleasants Creek overchute is currently being increased and will be completed before the 2006-2007 winter storm season commences. During extreme storm events when there is widespread flooding, uncontrolled floodwaters flow down the slopes, across the Putah South Canal maintenance roads, and into the Canal. This occurred during the December 2005 storm throughout the Suisun Valley and City of Vacaville areas.

Regulation and Management

The agricultural regulatory arena has changed over the past five years. The Irrigated Lands Waiver now requires identification of water quality issues in agricultural drainage and actions to address such issues.

Irrigated Lands Waiver

In July 2003, the Central Valley Regional Water Quality Control Board adopted the Irrigated Lands Waiver. This was developed as an interim program until a long-term program could be developed. This waiver requires all irrigated agriculture, including rice, row crops, field crops, tree crops, commercial nurseries, managed wetlands, and pastureland, to develop a monitoring program to assess the sources and impacts of discharges from irrigated lands, and to determine if reduction strategies need to be implemented. Dischargers have the option of obtaining individual permits or joining a coalition. Two main coalitions have formed in the Sacramento River watershed; the Rice Waiver Program and the Sacramento Valley Water Quality Coalition (SVWQC).

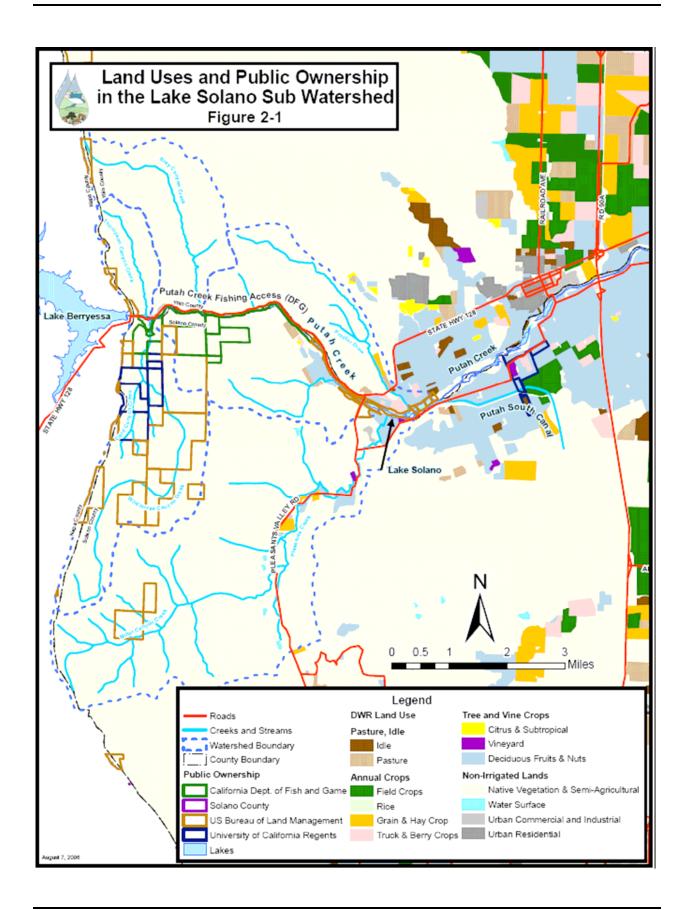
All irrigated crops in the Sacramento Valley, other than rice, are being represented by the SVWQC. In April 2004, the SVWQC submitted a Watershed Evaluation Report (WER) and a Monitoring and Reporting Program Plan (MRP). The WER was organized into ten sub watersheds, including the Solano-Yolo sub watershed.

Figure 2-1 shows the land uses and public ownership in the Lake Solano sub watershed, showing crop types and locations. For the Putah Creek South drainage area, within the Solano – Yolo Sub watershed, the major crop types include tomatoes, grain and hay, walnuts, and pasture.

Each sub watershed represents a unique geographic region delineated by hydrologic features. These drainages in each sub watershed were prioritized according to the presence of irrigated agriculture, major crop types, pesticide use, the presence of impaired water bodies and other factors. The SVWQC's MRP was designed to evaluate the causes or contributions of toxicity in receiving waters. This information provided the basis to determine the effectiveness of selected management practices that are most effective in reducing waste discharges from irrigated lands to surface waters and provide an important tool to adaptively manage a change in those practices.

Historical monitoring results show that production practices for crops other than rice impact surface water primarily through winter storm runoff and irrigation return flows. Winter storm runoff can transport: pesticides applied to dormant orchards; sediment, which may contain dissolved nutrients or pesticides; and fecal waste and nutrients from pasture and confined animal facilities. Irrigation return flows can transport pesticides applied before irrigation; sediment (with pesticides/nutrients also) from tilled fields (row/field crops); or dissolved salts.

Based on aquatic life concerns, the SVWQC has selected orchards as the highest priority crop type for determining water quality impacts and management practices that will result in lower organophosphate pesticide; specifically diazinon and chlorpyrifos discharges into adjacent water bodies. The Phase I monitoring program, from 2005 to 2007, is being conducted during both the storm season and the irrigation season. The monitored constituents include: TOC, dissolved organic carbon (DOC), diazinon, chlorpyrifos, azinphos-methyl, malathion, methyl parathion, carbofuran, and *E. coli*.



Only carbofuran has a primary drinking water standard, at 18 μ g/L. There are Notification Levels for diazinon (6 μ g/L), malathion (160 μ g/L), and methyl parathion (2 μ g/L). Monitoring is conducted at sixteen sites throughout the watershed, none of which are located in the Putah Creek South drainage area (which constitutes part of the study area for this report).

If monitoring data indicate aquatic life toxicity in the water or sediment sampling at a specific site, the SVWQC will notify the appropriate sub watershed group who will then initiate outreach with landowners and operators within the sub watershed to solve the problem. The SVWQC will work with the sub watershed groups to implement a Response Plan framed around a three-tiered approach that is consistent with the MRP. Also, a Communications Report has been developed to enhance coordination between the various program entities.

The Solano – Yolo Sub watershed Group plans to work with the SVWQC to compile local sub watershed monitoring data and develop a Sub watershed Implementation Plan. The Watershed Evaluation Report presented information on the eight drainage basins within the sub watershed, including the Putah Creek South drainage. The report noted that of the over 37,000 acres in the drainage basin, nearly 16,000 acres were irrigated agriculture. Nearly two thirds of that acreage is annual crops with limited use of pesticides. The most commonly used pesticide in the Putah Creek South drainage is copper. Distant behind are chlorpyrifos, diazinon and maneb all at less than 1,000 pounds applied annually. Based on the limited pesticide use in the drainage basin, no Total Maximum Daily Loads listed and no apparent water quality impairments, the Putah Creek South drainage was determined to be a low priority drainage. At this time, specific pilot projects to test management practice effectiveness have not been identified for the Solano – Yolo sub watershed.

EROSION

Erosion of soils in the watershed for Putah Creek and Lake Solano has been previously identified as a significant source of turbidity, and potentially other contaminants. This is a seasonal concern as most of the erosion is evidenced during storm events.

Constituents of Interest

Erosion results in the contribution of soil and other debris to the source water. The soil will increase turbidity levels, but may also contribute to the level of organic, inorganic, and microbial content to the source water. Storm events can result in turbidity spikes and depressed alkalinity and pH, making the source water more difficult to treat with conventional filtration and masking disinfection capabilities.

Presence in the Watershed

Putah Creek and Lake Solano

Significant amounts of storm water runoff come from Cold, Thompson, and Bray Canyon creeks, Pleasants Creek, and the Proctor Draw area near Lake Solano. The watershed for these sources includes land that is steep and is comprised of soils and rock materials that are highly erodable. These watersheds have also had significant historic grazing and wildfires that have contributed to erodability.

A study conducted by Northwest Hydraulic Consultants in 1998 showed that there was significant deposition of solids from erosion in Lake Solano. These deposits have resulted in the creation of shallow areas along the margins of the lake. These shallow areas have the potential to promote aquatic plant growth and algal blooms, which can lead to increases in turbidity and taste and odor impacts. The study determined that Pleasants Creek and Proctor Draw were the two largest contributors of sediment. Highenergy storm events were largely responsible for landslides and sheet and rill erosion.

In addition, stream bank and bed erosion have been exacerbated by historic and current livestock grazing, gravel mining, and removal of riparian vegetation.

Putah South Canal

Most of the drainage on the upstream side of the Putah South Canal is conveyed under the canal or over the canal in overchutes. During large storm events, drainage from the hillside can enter the canal when the overchutes overtop or when water backs up on the upstream side of the canal because the capacity of the conveyance facilities is exceeded. During these events, highly turbid water may be discharged directly into the canal.

There are only seven known areas where local drainage flows enter the Putah South Canal during wet weather; these are located in close proximity to each other in the Fairfield/Rockville Trails rural area between post miles 27 and 30. SCWA has conducted sampling to assess the turbidity of the seven local drainages that drain into the Canal. One event was conducted from February 2 to March 1, 2004 and the other was conducted from December 30, 2004 to March 23, 2005. **Figure 2-2** provides a plot of the rainfall at Winters, the turbidity of the local discharges, and the turbidity of the Putah South Canal at Waterman WTP (located just upstream of these discharges) from the February 2004 sampling event.

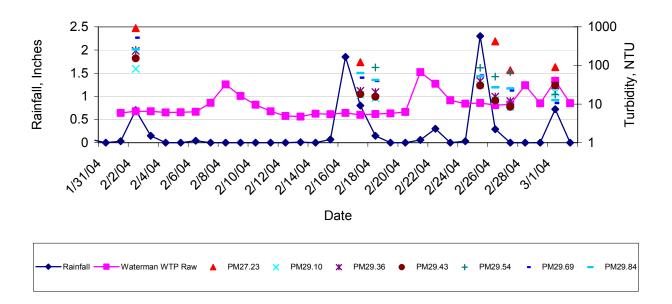


Figure 2-2. Special Study for Local Drainages

The data show that the peak turbidity in the canal is delayed from the actual storm events, as discussed in **Section 3**, while the turbidity in the local drainages is directly impacted by local precipitation. The drainages at post miles 27.23 and 29.54 typically have the highest levels of turbidity. The turbidity in the drainages can be one or two orders of magnitude higher than the canal water, but more typical is that the turbidity of most of the drainages are the same order of magnitude as the turbidity in the canal. No turbidity data is available in the canal downstream of the discharges and no flow data was collected from the drainages, so no conclusive findings can be drawn regarding the impact of these drainages on water quality. However, it does appear that most of these drainages are of limited concern from a solids loading perspective

The Putah South Canal has a road along both sides. Generally, the uphill road is the maintenance road and the downhill road is the operations road. Both roads are sloped away from the canal and into a culvert, which is then diverted to either a local storm drain system or a natural creek. Some parts of the roads are paved, but most of the roads are gravel or graded dirt. SID is working on graveling the dirt roads to minimize localized erosion impacts.

Although the Putah South Canal is lined with concrete, there have been instances of erosion. In December 2002 there was severe flooding in the Allendale area of the canal. The flooding caused erosion of some of the canal embankment and damage to some of the concrete panels in the Putah South Canal. Some of the damage was repaired immediately after the storm and the panel replacements will be completed later in 2006. Some of the eroded soil ended up in the canal, but the increase in turbidity came from a variety of sources.

Regulation and Management

Unfortunately, there is no comprehensive way to regulate or manage the potential sources of erosion. Some efforts to minimize local erosion have been instituted. A field visit evidenced several segments of Pleasants Creek, adjacent to the bridge abutments for crossings of Pleasants Valley Road, have been improved with riprap to minimize stream bank erosion. Also, parts of Stebbins Cold Canyon Reserve have been replanted post wildfires and landslides to minimize erosion potential. SID is minimizing erosion along the canal by allowing vegetation to grow on the canal banks and by placing gravel along the canal roads.

GRAZING

Grazing occurs on both pasturelands and rangelands. Pastureland is irrigated rangeland. Discharges from pasturelands and runoff from rangeland may carry *Cryptosporidium*. Calves are known to be able to transmit *Cryptosporidium*.

Constituents of Interest

Although Cryptosporidium can come from a variety of animal populations, loading of Cryptosporidium oocysts from cattle is the source of primary interest. Loading is a function of animal density and infection rate among the herd. Calves from one to four months contribute over 99 percent of oocysts shed by cattle (Archibald & Wallberg Consultants, February 2005). According to Dr. Robert Atwill of the University of California at Davis Extension, an infected calf can shed 8.4 million oocysts per day. Dr. Atwill recently disproved a previous hypothesis that calf infections are picked up from wildlife reservoirs such as ground squirrels and field mice. DNA testing of Cryptosporidium in squirrels and other common rangeland mammals has shown it to be a different Cryptosporidium species than that which infects calves. Dr. Atwill's current hypothesis is that the daily contact between a calf and a carrier mother results in an initial infection that is then spread between calves though calf play. Given the low ratio of calves and their geographic spread, it may be that grazing cattle populations do not spread Cryptosporidium as readily as dairy cattle. Also, overland transport may be required which can reduce the viability of oocysts.

Spring is typically the calving season in Northern California and so it is likely the time of greatest risk of infected herds and also still a time when oocysts likely survive well. Most *Cryptosporidium* loading occurs within a very limited age group (the young) and therefore manure management for the young is of far more importance than manure management for adult animals. Since transport of *Cryptosporidium* overland is difficult, only pastureland located proximally to rivers and tributaries is of concern. Survival of oocysts is also likely affected by seasonal temperature. A fecal pat exposed to sunshine during summer months can become hot enough to kill all oocysts within a day. The killing rate declines as the temperature declines so that fecal pats deposited in winter may provide temperature conditions that allow for oocysts survival for 90 plus days. It is expected that storm runoff would be largely responsible for contribution of

solids, specifically organic carbon, since irrigation practices do not typically result in runoff.

Storms also will cause sheet flow over rangeland areas that can pick up fecal matter from grazing livestock. Storm runoff from rangeland grazing areas is more likely to carry *Cryptosporidium parvum* during the calving season since calves are more likely to be infected with the pathogen than adult cows. The calving season is typically in the spring. Another source is created when ranchers use check dams on small watercourses to create waterholes for grazing livestock. Ranchers typically release the boards on these check dams in anticipation of storm events, to prevent flooding of the rangeland upstream of the check dam. Since survival of oocysts depends on proximity to water bodies, overland transport increases the potential for inactivation through desiccation.

High levels of coliform in the Putah South Canal appear to be associated with precipitation, as discussed in **Section 3**. The lack of protozoa detects indicates that the risk to microbial contamination should be relatively low. Even though coliform are not considered a good indicator for *Cryptosporidium*, the bacteria data available for the canal supports the theory that storm events are the time of highest potential risk with respect to microbial contaminants.

Presence in the Watershed

Putah Creek and Lake Solano

The western one-fourth of Solano County is hilly to very steep and is used mostly for range. For areas below Monticello Dam, very limited areas of the watershed have livestock grazing capacity. Winter grazing of cattle occurs in the foothills to the west of the watershed. Some of the Lake Solano watershed may receive drainage from areas that are lightly grazed, including land along Pleasants Valley Road. A field visit indicates that the livestock graze very near the tributary creeks, with limited or no fencing to prevent their entry into the watercourse.

There are several impediments to collecting comparable, accurate data for livestock in the watershed, including the possible changes in cattle population through the year as well as the fact that the watershed boundaries are not the same as the county boundaries used to report data. Nevertheless, the numbers provide a general picture of livestock populations in the watershed. The total livestock population in Solano County, including both rangeland and dairy cows, was over 34,951 in 2005 (Solano County Agriculture Report, 2006). The population increased less than five percent between 2002 and 2005. Also of note is the large population of grazing sheep in Solano County. There were 44,607 sheep and lambs in 2005, which reflected a ten percent decrease in population between 2002 and 2005(Solano County Agriculture Report, 2005).

Terminal Reservoir

Around the Terminal Reservoir there is a small contributory area that is undeveloped agricultural land, used primarily for seasonal grazing. The land does not appear to be irrigated. There are no statistics on the number of grazing cattle, but it does not appear to be large based on field observations.

Regulation and Management

The regulatory arena has changed in this area as well since irrigated pastureland falls under the Irrigated Lands Waiver Program, as described in Agriculture/Pesticide Use previously. Good management of pastureland is no longer voluntary through elective participation in the Rangeland Water Quality Management Program. See the previous discussion under Agriculture/Pesticide Use. Non-irrigated rangeland mostly occurs higher in the watershed on public BLM lands and is managed under lease conditions set by the agency.

Runoff from rangeland is considered a nonpoint source of pollution and it is covered under the State Board's Nonpoint Source (NPS) Program. As for all nonpoint sources under this program, the state has a three-tiered approach to regulation:

- Tier 1: Self-determined implementation non-regulated management practices.
- Tier 2: Regulatory based encouragement conditional waiver of Waste Discharge Requirements (WDRs).
- Tier 3: Effluent limitations and enforcement actions WDRs.

Historically the Rangeland Water Quality Management Program (RWQMP), developed by the UC Cooperative Extension, the Cattlemen's Association, and the US Department of Agriculture's Natural Resources Conservation Service, was used a voluntary program for privately owned rangeland management. The heart of the program is a series of short courses given to ranchers to help them develop and implement water quality plans at their ranch. Between 1997 and 2004 over 70 short courses have been given, with over 1,000 participants (Mel George, Personal Communication). A survey conducted in 2003 showed that nearly two thirds of respondents were implementing some of the actions from the water quality plans. Since 2003, attendance at the courses has dropped, likely due to other pressures on ranchers, so the courses now are only given two or three times per year.

Recently, the State Board has determined that it will develop a Tier 2 regulatory program for non-irrigated, private rangeland. The State Board has spent significant time working with stakeholders to select the best regulatory framework. The future of the RWQMP will be highly dependent on how, and if, it is incorporated into the State Board permitting process, something that is not currently known. Most rangeland managers will focus on what is required, so if the RWQMP is not incorporated into State Board requirements it may not be a sustainable program into the future.

Federal lands owned by the U.S. Bureau of Land Management (BLM) continue to be used for rangeland grazing. The State Board is working with these agencies to ensure that the grazing guidelines for the federal allotments are closely coordinated with the State Board program since the lands are typically adjacent to each other allowing cattle to move between them.

Rangeland Research

The University of California Sierra Foothill Research and Extension Center east of Marysville conducts research. The principal goal of the research is to maximize the productivity of rangeland in supporting and fattening cattle while minimizing negative environmental impacts to the land and to streams. This work should assist in understanding which best management practices (BMPs) are effective and affordable in reducing contaminant levels in rangeland runoff. The research is conducted through the University of California Cooperative Extension (UCCE), in cooperation with County Agricultural Commissioners and industry groups such as the Cattlemen's Association. Research during the study period has included:

- Distribution of Livestock. Global Positioning System (GPS) technology has significantly improved the ability to study cattle distribution patterns, which is preliminary information needed to develop management distribution techniques that discourage congregation in sensitive areas like riparian corridors but still satisfy the animal's instincts and needs. Management distribution techniques include BMPs like fencing, herding, placement of salt licks and mineral supplements, and placement of water tanks.
- Riparian Friendly Grazing. Development of a model to predict improvements to rangeland riparian health that result from varying grazing management practices is underway. Management practices included in the model are stock density, frequency of grazing, rest between grazing, herding, and off-site attractants (feed, salt licks, etc.).
- **Buffer Studies**. Field trial studies are being conducted on the effects of buffers of different widths on the water quality (fecal coliform and *E. coli.*) that runs off grazed rangeland.
- Paired Watershed Study. Comparison monitoring (fecal coliform and E. coli) is being conducted on several small watersheds with varying intensities of cattle grazing.

RECREATION

Putah Creek and Lake Solano have been administered as recreational areas since 1971. Lake Solano County Park has more than 200,000 visitors a year, both on and off the water. The recreation in this area is primarily non-body contact, such as fishing and boating, but can include body contact such as wading and swimming.

Constituents of Interest

Non-body contact recreation is less likely to be a significant source of contamination, but could result in the contribution of turbidity and pathogen contamination from local shore erosion and potentially other constituents from improper use or disposal of chemicals. Body contact recreation is a source of pathogen contamination, resulting partly from personal sanitary conduct and partly from a natural shedding process. Pathogens shed by recreationalists include bacteria, viruses, and protozoa. Moreover, because their origin is human, microorganisms shed by recreationalists are transmissible to other humans.

Presence in the Watershed

Putah Creek and Lake Solano

Putah Creek Wildlife Area

The Putah Creek Wildlife Area is owned and operated by the California Department of Fish and Game. It is located 10 miles west of Winters on Highway 128. It comprises 670 acres of gently sloping to steep hillsides of oaks and chamise chaparral. It is just downstream of Monticello dam, where Cold Creek enters Putah Creek. This area includes Stebbins Cold Canyon Reserve.

Stebbins Cold Canyon Reserve

The Stebbins Cold Canyon Reserve is set in a steep, north-facing canyon of the northern Coast Range, and is managed by the University of California at Davis. It provides opportunities to study plant and animal communities of both the inner and outer Coast Ranges. Year-round springs provide watering areas for many wildlife species, such as bear, mountain lion, deer, ringtail, and turkey. All together, 108 bird species (35 nesting), eight amphibian, eighteen reptile, 43 mammal, and more than 290 plant species have been found at the reserve. Also available for study, adjacent protected lands held by the BLM and the California Department of Fish and Game greatly expand the effective research area.

Historically the land has been grazed, mainly by goats, and has resulted in extremely compacted soils. These soils are now covered with star thistle, which can contribute to wildfires and landslides.

The site is fully open to the public; up to 5,000 people, mostly local hikers, visit the reserve annually and explore its canyon bottoms and ridgetops. The reserve is available for field trips by elementary and secondary schools. The site is visited by university courses in wildlife field techniques, California floristics, range science, wildlife biology, botany, plant ecology, and geology field studies. The Reserve also serves as a location where research on post-landslide plant succession is conducted. There is a

parking area provided at the trailhead as well as a larger lot across Highway 128. No restrooms or portable toilets are provided.

Canyon Creek Resort

Canyon Creek Resort Recreational Vehicle (RV) Park is located on Highway 128, just below Monticello Dam. This is a membership resort that is open year-round, but has peak occupancy between May 1 and September 30. There are a total of 115 camping sites; 32 that provide full hookups and 83 that provide partial hookups. The RV Park also has two clubhouses, a creek-side swimming pool, a general store, a snack bar, and a creek-side recreational area. There is also a dump station available for members. This RV Park is popular with fishermen, as it is located just downstream of the weekly fish replenishment drop-off point on Putah Creek. Pets are allowed at the RV Park, but a strict leash rule is implemented as well as a pet-waste pickup program.

The RV Park is comprised of three land parcels, two along Putah Creek and one north of Highway 128, each of which has a separate permitted septic system. There are two two-stage septic systems and leachfields located along Putah Creek. The date the park was established is unknown, but it was prior to current permitting requirements, therefore Yolo County Environmental Health Department has limited information on file. It is possible that the leachfields are located within 100 feet of Putah Creek

The current owners of the RV Park have a maintenance crew that takes regular care of the grounds and the facilities. The septic systems are inspected and cleaned regularly, with the frequency varying based on occupancy. Also, the maintenance crews pick up litter and debris along Putah Creek in the vicinity of the RV Park. The RV Park also provides security 24 hours per day, seven days per week.

Yolo County Fishing Access

The Yolo County Department of Parks and Recreation has the Putah Creek Fishing Access located on 150 acres, along a 3-mile stretch of Putah Creek and State Highway 128, six miles west of the town of Winters. There are five fishing access points, located between one and four miles downstream of Monticello Dam. The park offers picnic tables, barbecues, fishing, parking, and sanitary facilities. A \$4.00 day use fee is required. Overnight camping is prohibited at this location. There are picnic tables and portable toilets provided at the first and third access points. The portable toilets are maintained as necessary by Yolo County. The third access point also has a park host located there, in a camp environment. The park host conducts visits to the other access points.

Lake Solano County Park

Lake Solano Recreation Area, administered by the Solano County Parks Department, offers camping, picnicking, swimming, boating, and fishing. Lake Solano Park is located west of Winters and offers many recreational opportunities. Lake Solano Park caters

especially to anglers, boaters, campers, swimmers, and picnickers. The park includes a day-use area as well as a campground. Lake Solano Park allows for fishing access, non-motorized boating and camping at designated campsites. Body contact water sports such as swimming are not popular due to the very cold temperature of the deepwater discharge drawn from Lake Berryessa.

Day Use Area

The day use area has picnic sites, group picnic facilities, a free boat launch for non-powered vessels, parking, restrooms, and a public telephone. The picnic area is located directly east of the campground. No pets are allowed in the day use area. There are several flush-toilets provided at the day use area. All wastewater is collected and pumped up-hill to a leachfield located in the southeast corner of the park, behind the parking facilities.

Campground

Lake Solano County Park offers 90 RV/tent sites, each accommodating up to 10 people. Water and electric hookups are provided at 40 of the sites. The RV sites are generally close in proximity, while tent sites are somewhat more spaced apart. The campsites have picnic tables and fire pits with grills, and are close to Putah Creek. There are restrooms that have flush toilets, sinks and hot showers. There are also two RV dump stations available for campers. All wastewater is collected and pumped up-hill to one of two leachfields. One is located in the southwest corner of the campground and one is located in the southeast corner of the campground.

Multi-Use Area

A third County Park area, the Lake Solano Multi-Use Area, is located at the west end of Lake Solano on Putah Creek Road. This is a day-use area with flush toilets that also allows camping for Boy Scouts. The septic system for this toilet is located on the south corner of the use area.

SPILLS/ILLEGAL DUMPING

Spills and illegal dumping can result in the discharge of a wide variety of constituents into source water; from chemical to microbiological. These are often discrete events that can be responded to or cleaned up by a managing agency.

Constituents of Interest

Spills and illegal dumping can be associated with discharges from either a permanent or temporary facility. Permanent facilities could include wastewater collection or treatment facilities, industrial facilities, and agricultural facilities. Temporary facilities could include accidents involving vehicles, deliberate acts of contamination, or construction activities. Any of these facilities could result in a wide variety of constituents such as microbiological constituents or chemical constituents, which may or may not be hazardous or be of human health concern.

Presence in the Watershed

Putah Creek and Lake Solano

A hazardous material spill or leak into Putah Creek, its tributaries, or Lake Solano could occur as a result of a vehicular traffic accident or other incident. In the event of a leak or spill, timely notification is critical to ensure that the water treatment plant operators are provided with sufficient time and information to best respond to potential treatment concerns. SID has direct notification procedures with the local Certified Unified Program Agency (CUPA), see Regulation and Management section below for more discussion, to ensure that they will receive notification in the event of a spill upstream of its diversion into the Putah South Canal.

Highway 128 is part of the California Surface Transportation Assistance Act (STAA) Network. These are the preferred routes for trucking in California. The STAA Network designation ends just west of Winters, where a small stretch of the highway (Post Mile 5.9 to 6.8) becomes a California Legal Network only. This limits access to trucks with a king-pin to rear-axle (KPRA) length less than 40 feet. The remainder of the Highway, from Post Mile 5.9 to the Napa County line is a California Legal Advisory Route. This means that access is not advised for trucks with a KPRA length greater than 38 feet. There are no limitations on the type of materials transported on Highway 128.

Pleasants Valley Road crosses Putah Creek and runs parallel to Pleasants Creek. This is a double lane road with numerous curves.

A summary of vehicular accidents on Highway 128 was obtained from the California Department of Transportation (Caltrans). Between July 2000 and June 2005 there were 31 accidents reported. There were equal amounts of accidents in the east and westbound directions. Most accidents occurred between 4:00 and 7:00 PM. Only one accident involved hazardous materials. The vehicle containing the hazardous materials went over the embankment and into Putah Creek, at Post Mile 2. There were three other accidents that resulted in vehicles going over the embankment and into Putah Creek.

A review of the Response Information Management System (RIMS) indicated that during the past five years there have been very few reported hazardous materials spills. In September 2001, drug lab waste was found and recovered from the side of Highway 128. In April 2001, a vehicle ran into Lake Solano and was removed with no spill reported. In August 2003, a PG&E transformer failed on Putah Road releasing a small amount of polychlorinated biphenyls.

Unauthorized activities below Monticello Dam include illegal dumping along roadways, such as Highway 128 and Pleasants Valley Road, and fishing access points. Debris is removed either by CalTrans or by Yolo County Department of Recreation.

Putah South Canal

A review of the RIMS indicated that during the past five years there was only one reported hazardous materials spill in the watershed. In August 2000 a vehicle was reported in the Putah South Canal at Mankas Road. Although most of the canal is fenced, there are numerous vehicle and pedestrian bridges that provide access to the canal for illegal dumping of materials. SID staff drive along the canal three times a week and report that although they do not routinely see people in the act of dumping materials in the canal, dumping does occur (Don Burbey, Personal Communication).

SID has a supervisor available 24 hours per day, seven days per week. SID receives direct notification from the Solano County Sheriff in the event of a spill impacting the Canal. Currently, SID has a final Emergency Action Plan for both the Monticello and Diversion Dams as well as the Terminal Reservoir and is in the process of finalizing an Emergency Action Plan for the Putah South Canal.

Regulation and Management

When a hazardous material spill or leak of a reportable quantity occurs, notification to emergency response agencies is required by state and federal law. A sewage spill is required to be reported if 1,000 gallons or more are released. An oil or petroleum product spill is required to be reported if 42 gallons or more are released. Any other hazardous material spill is required to be reported if there is a reasonable belief that the release poses a significant present or potential hazard to human health and safety, property, or the environment. When a hazardous material spill or leak occurs, it is the owner's or operator's responsibility to notify the local designated emergency response agency, which is called the CUPA as well as the State Office of Emergency Services (OES).

OES developed RIMS as part of the development of the State's Standardized Emergency Management System (SEMS). This was developed in response to the US Department of Homeland Security's National Incident Management System (NIMS). NIMS was developed so responders from different jurisdictions and disciplines can work together better to respond to natural disasters and emergencies, including acts of terrorism. NIMS benefits include:

- Unified approach to incident management;
- Standard command and management structures; and
- Emphasis on preparedness, mutual aid and resource management.

The purpose of RIMS is to provide a single point for tracking the status and progress of hazardous materials spills statewide. Only registered users can input data into RIMS, but anyone can access the website to review current or archived OES cases. The current cases, including those from 2003 to the present, can be accessed at:

http://rimsinland.oes.ca.gov/operational/malhaz.nsf/\$defaultview

The archived cases, including those from 1993 through 2002, can be accessed at:

http://rimsinland.oes.ca.gov/rims.nsf/RIMS Archive Databases?OpenPage

In July 2003 the Unified Program (who delegates Certified Unified Program Agencies [CUPAs]), which is administered by the California Environmental Protection Agency, published a Strategic Plan that addresses the coordination between OES and the State Fire Marshall (SFM) regarding hazardous materials responses. Under OES, CUPAs are required to prepare Hazardous Materials Release Response Plans (Business Plans) and under the California Fire Code a Fire Agency is required to prepare Hazardous Materials Management Plans/Hazardous Materials Inventory Statements. The purpose of this work is to streamline the two programs to increase coordination.

URBAN RUNOFF

Urban runoff (URO) occurs on a year-round basis and includes wet and dry weather discharges. Wet weather runoff results from seasonal storms. Wet weather runoff is of relatively short duration and can have highly variable pollutant concentrations. Because of the high degree of imperviousness, urban areas generally generate higher per acre volumes of runoff than undeveloped or agricultural lands. Dry weather runoff results from activities such as lawn irrigation and car washing.

Constituents of Interest

Data on urban runoff discharges indicate that the runoff is turbid, a source of TOC, a source of bacteria and probably *Giardia* and *Cryptosporidium*, and a source of other constituents such as pesticides and organic compounds.

Presence in the Watershed

Putah Creek and Lake Solano

There are currently no urban areas in the Putah Creek and Lake Solano watershed. Solano County passed Measure A, the Orderly Growth Initiative that requires any urban development to be annexed to a city. Since there are no urban areas in the Solano County part of the watershed, no future urban development is planned or expected in the part of the watershed south of Putah Creek or Lake Solano.

Currently, the City of Winters is located to the east of the watershed and does not contribute to Putah Creek or Lake Solano.

Putah South Canal

For the first ten miles, the Putah South Canal flows primarily through agricultural/rural land. There are some areas where "ranchettes" are being developed on large parcels

of land. The canal then flows through the cities of Vacaville and Fairfield. In some areas there is high-density development on both sides of the canal. In other areas, there are plans to develop land along the canal. All urban runoff is channeled over or under the Canal.

Regulation and Management

The USEPA developed its stormwater regulation in two phases. The Phase I regulation was promulgated in 1990 for cities or contiguous unincorporated urban areas with populations greater than 100,000. The Phase II regulation was promulgated in 1999 for cities and other contiguous areas with populations less than 100,000.

Both the Phase I and Phase II stormwater regulations require municipalities to reduce URO pollution to the maximum extent practicable (MEP) through implementation of control measures called BMPs. Management programs must include public education, pollution prevention and good housekeeping for municipal operations, implementation of new development BMPs, erosion and sediment control at construction sites, and control of illicit discharges. Phase I programs must also include control programs for industrial sites. Both the Phase I and II regulation provide the regulated municipalities with the flexibility to make their own selection of BMPs in designing their own individual programs. Although the entire slate of program elements (new development BMPs, municipal activities [street sweeping], etc.) is designed to improve water quality, program elements of special interest to downstream drinking water agencies are the construction site element, illicit discharges element, new development element and the public outreach element.

Solano County developed a Stormwater Management Plans in 2003 for unincorporated county areas (Solano County, 2003). The cities of Fairfield and Vacaville have developed their own storm water management plans (Fairfield-Suisun Urban Runoff Management Program and cities of Vacaville and Dixon).

- Solano County Stormwater Management Plan (unincorporated areas including Green Valley, Rockville, and Cordelia) – February 2003: Solano County has used mostly existing county programs to meet the six minimum control measures. BMP implementation is phased in between 2003 and 2008. Solano County does not own or operate storm drain systems other than roadside culverts and bridge piping. Unincorporated areas use grassy swales and intermittent streams to channel storm runoff. The Plan identifies the Department of Transportation, Environmental Health, and the County CUPA for hazard management.
- Vacaville City of Vacaville and City of Dixon Stormwater Management Plan: The
 City of Vacaville developed a joint plan with the City of Dixon. Some of the BMPs
 are implemented regionally, such as public education, while most BMPs are
 implemented independently. One of the prime watersheds is the Ulatis Creek
 system, which crosses the Putah South Canal. The plan lays out the six program
 elements and the BMPs that will be implemented to meet those requirements.

Fairfield – The Fairfield-Suisun Sewer District and the cities of Fairfield and Suisun City joined together, under the Phase I regulation, to form the Fairfield-Suisun Urban Runoff Management Program. Together they oversee operation and maintenance of drainage facilities. The agencies have a National Pollutant Discharge Elimination System (NPDES) Permit from the San Francisco Bay Regional Water Quality Control Board. Duties encompass operation and maintenance of pumping stations, pipelines, natural creeks, detention basins, sloughs and culverts. The agencies have established storm water discharge ordinances that set requirements for discharges into the community storm water drainage system. It prohibits spills, dumping or disposal of pollutants and all materials other than storm water into the storm drainage system.

Growth

Growth trends were examined in order to assess the long-term impacts of growth on urban runoff. Population growth was recently identified by the American Water Works Association (AWWA) as one of the primary future trends of concern for water utilities. AWWA cites concerns over shifting land uses, use of marginal water supplies, aging population with health concerns, more educated and involved consumers, and changing diversity in population (Means et Al., 2005).

Population statistics from the California Department of Finance are provided in **Table 2-3**. It can be seen that there has been a significant increase in the population over the past five years, and that the overall projection for the 15 and 45-year horizons is even more substantial. Most of the growth has happened, and is projected to continue to happen, in the urban environment. Both the cities of Fairfield and Vacaville grew at over nine percent. Although the City of Winters is currently outside of the watershed boundary, its western edge borders the watershed. Winters population growth between 2000 and 2005 was 13.9 percent.

Table 2-3. Population Change

County	Population					
	2000	2005	<u>Change</u>	2020	2050	
Solano	397,207	422,094	+6%	555,264	830,830	
Yolo	170,004	188,858	+11%	271,040	407,691	

This increasing human population in the watershed will likely mean an increasing urbanization of the watershed. The change in land use may be significant in terms of the potential contaminating activities and resultant source water quality. As land use near Putah Creek and the Putah South Canal is converted from rural and agricultural, there will be a shift from agricultural drainage considerations to concerns such as urban runoff and recreation. It is uncertain if, and to what extent, this shift will result in notable changes in source water quality.

WILDFIRES

The watershed is comprised largely of oak chaparral vegetation on steep mountainous terrain. This habitat is highly vulnerable to wildfires. Periodic natural fires clear brush and promote the growth of grasses which creates the savanna-type woodlands and open grasslands. Large, uncontrolled fires can cause significant damage and lead to increased erosion from these burned areas until the vegetation becomes re-established.

Constituents of Interest

Wildfires typically cause the destruction of vegetation including grass, brush and trees, and result in bare, exposed soils. The exposed soil results in reduced infiltration of water and increased soil runoff and greater amounts of sheet flow. Also, fires in chaparral areas, such as this watershed, often develop hydrophobic soils that increase surface runoff. This increase in runoff causes increased erosion and the subsequent contribution of turbidity and potentially other constituents to the source water.

Presence in the Watershed

Putah Creek and Lake Solano

The watershed for Putah Creek and Lake Solano falls largely within two fire districts; City of Winters in Yolo County and Vacaville Fire District in Solano County. These fire districts are the first responders to any wildfire and work in close coordination with the California Department of Forestry.

A review of fires in the past five years shows very few incidences in this part of the watershed. Most of the fires begin as roadside fires that are arson induced. Fire district staff indicated that wildfires in this area have been largely limited to less than 200 acres. This is partly due to the quick response time by each agency, but also is assisted by the natural terrain. The steep hills encourage the fire to go uphill quickly but then it is easily arrested with helicopters at the ridges.

It should be noted that Solano County Water Agency has previously provided funding for a re-vegetation effort in Miller Canyon to minimize impacts to water quality after a fire in the 1980s.

Putah South Canal and Terminal Reservoir

The watershed for the Putah South Canal and the Terminal Reservoir encompass several fire districts; Vacaville Fire District, City of Vacaville, City of Fairfield, and Cordelia Fire District. Similar to Putah Creek and Lake Solano these fire districts coordinate with the California Department of Forestry as appropriate.

A review of fires in the past five years also shows very few incidences in this part of the watershed. Most of the fires begin as roadside fires, also arson induced. Fire district staff indicated that wildfires in this area have been largely limited to less than 100 acres.

WATERSHED PROGRAMS

There are several watershed programs focused on Putah Creek, including Putah Creek Discovery Center and the Lower Putah Creek Coordinating Committee. These programs are supported by numerous of the participating agencies that receive Solano Project water.

The Putah Creek Discovery Center is a water education group intended to promote education on water issues between Monticello and Putah Diversion dams. The program conducts educational outreach to local Solano County schools as well as creating a visitors center at the Lake Solano Park.

The Lower Putah Creek Coordinating Committee was created from a legal settlement between Yolo and Solano parties. The Committee is made up of representatives from Yolo and Solano counties and implements a program identified in the settlement agreement that includes fish and wildlife monitoring, vegetation management, and stream restoration. The Lower Putah Creek Coordinating Committee has received several grants for planning in Lower Putah Creek, below the Putah Diversion Dam and restoration projects. The Lower Putah Creek Coordinating Committee has just completed a watershed assessment and is developing a management plan.

INTRODUCTION

The water quality staff from the agencies and cities that treat Solano Project water were interviewed to identify the primary water quality challenges that they face. The treated water quality from all water treatment plants that treat Solano Project water meets all drinking water maximum contaminant levels (MCLs) and treatment technology (TT) requirements. There was universal agreement that Solano Project water is generally a high quality source but storm events in the watershed degrade water quality and present treatment challenges. High turbidity during storm events is the primary challenge that often requires optimization of treatment processes or reliance on stored treated water to avoid treating the highly turbid water. Concern was also expressed about occasional low alkalinity levels and algal blooms during the summer months.

This section focuses on the water quality concerns identified by the staff and on several other constituents identified as potential concerns due to the contaminant sources in the watershed identified in **Section 2**. These include turbidity, microbiological contaminants, disinfection byproduct precursors, algal blooms, and pesticides. **Appendix A** contains a detailed discussion of drinking water regulations that are pertinent to the agencies and cities treating Solano Project water.

MONITORING PROGRAMS

Water quality data for the period from 2000 to 2005 were obtained from a number of sources. **Table 3-1** provides a summary of the data evaluated in this section. The monitoring locations were shown previously on Figure 1-3.

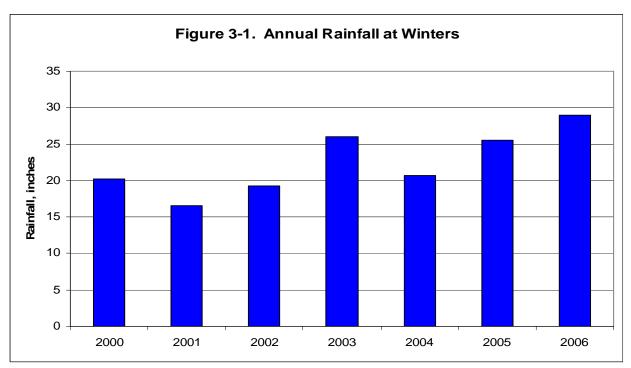
Table 3-1. Water Quality Data Evaluated in this Report

Location	Canal Milepost	Data Source	Data
Headworks	0	SCWA	Real-time turbidity
Sweeney Check	6.15	SCWA	Real-time turbidity
Eldridge Pumping Plant	11.8	SCWA	Real-time turbidity
Vacaville WTP	12.84	City of Vacaville	Weekly coliforms
North Bay Regional WTP	16.85	City of Fairfield	Daily turbidity and coliforms Weekly TOC and alkalinity Quarterly pathogens and copper Twice yearly pesticides
Waterman WTP	23.5	City of Fairfield	Daily turbidity and coliforms Weekly TOC and alkalinity
Terminal Reservoir		City of Vallejo	Weekly turbidity, coliforms, TOC, and alkalinity Monthly bromide and algal counts
Various		Cities of Benicia, Fairfield, Vacaville, and Vallejo, Suisun-Solano Water Authority	Constituents included in Consumer Confidence Reports

WATER QUALITY EVALUATION

Rainfall

Water quality in Northern California is greatly affected by storm events and drought conditions. **Figure 3-1** shows the rainfall data from Winters, which is near the headworks of the Putah South Canal, for July 1, 1999 to April 30, 2006 (rainfall years are July 1 to June 30). The average annual rainfall at Winters is 22.8 inches.



Data Source: CIMIS

Turbidity

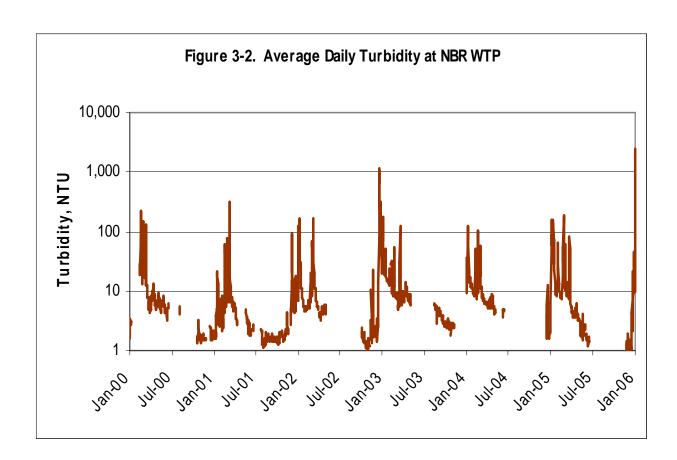
Many of the agencies treating Solano Project Water indicated that high turbidity during storm events was the greatest treatment challenged posed by this source of water. Excessive turbidity in the source water results in shortened filter run times and can potentially shield microorganisms from disinfection. An extensive amount of turbidity data has been collected on the Putah South Canal. These data are examined to identify trends over time, trends along the canal, and the impact of storm events in the watershed.

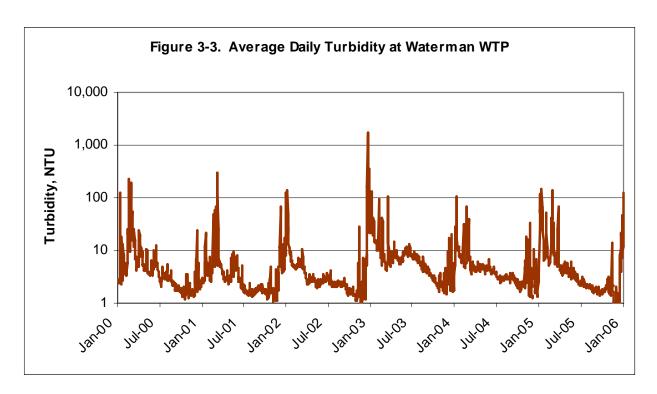
Temporal and Spatial Trends

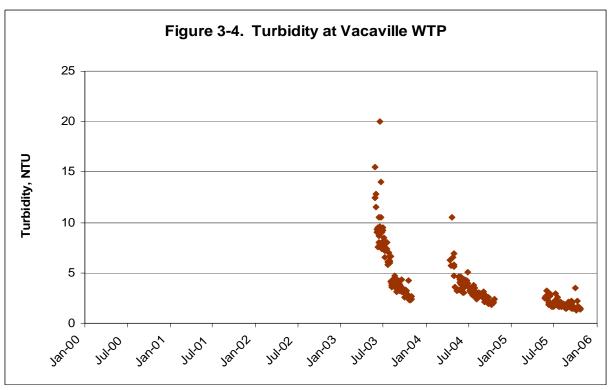
Figures 3-2 and **3-3** present the daily average turbidity monitored at the intakes of the North Bay Regional (NBR) and Waterman Water Treatment Plants (WTPs). As discussed previously, the NBR WTP does not treat Solano Project water during the

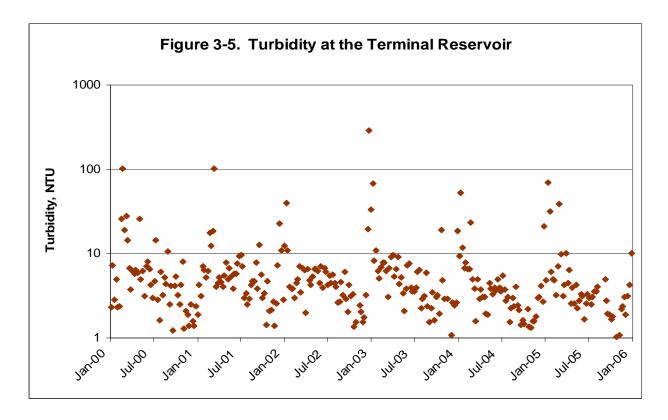
summer months when North Bay Aqueduct water is of its highest quality. The daily data collected at the NBR and Waterman WTPs are remarkably consistent. These data show that turbidity levels are low (less than 10 nepholometric turbidity units [NTU]) during the spring, summer and early fall months and rise rapidly during the late fall and early winter. Peaks exceeding 100 NTU occur every year. During December 2002 peaks in excess of 1000 NTU were observed at both plants. The Vacaville WTP is located upstream of the other plants on the Putah South Canal but is only operated during the late spring to early fall months, therefore turbidity data are only collected when it is operating resulting in considerably lower turbidity levels, as shown on **Figure 3-4**.

Figure 3-5 presents the weekly data collected by the City of Vallejo at the Terminal Reservoir. These data show the same general trend as the data at the intakes of the NBR and Waterman WTPs but the effect of settling along the Putah South Canal and in the Terminal Reservoir is clearly seen. The peak turbidities are considerably lower in the Terminal Reservoir, although peaks in excess of 100 NTU have occurred.



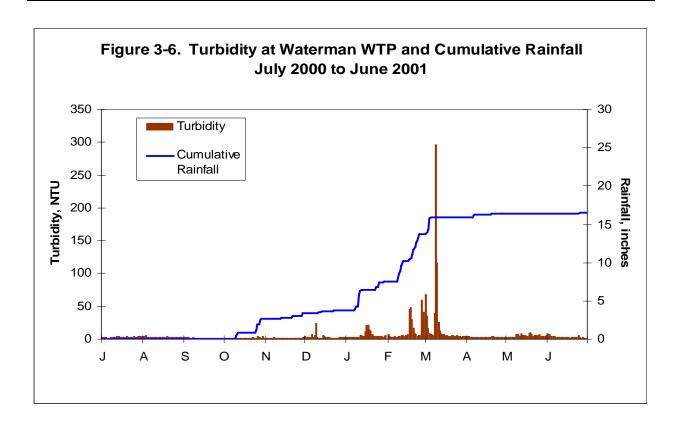


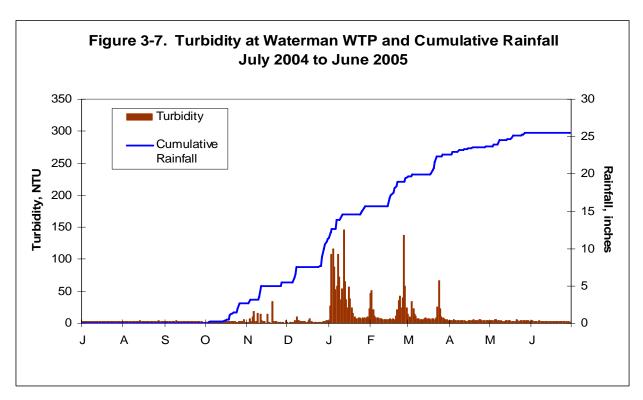




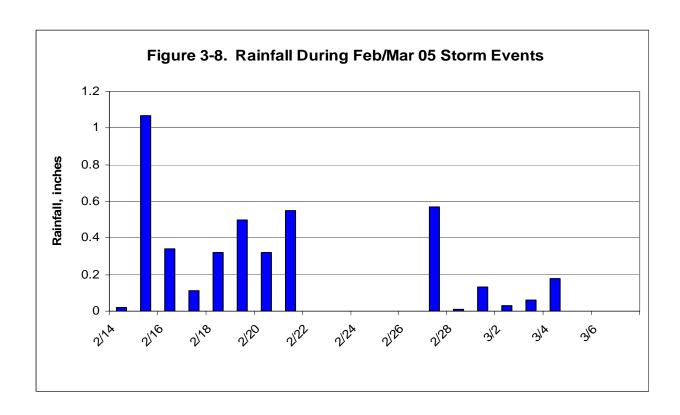
Impact of Storm Events

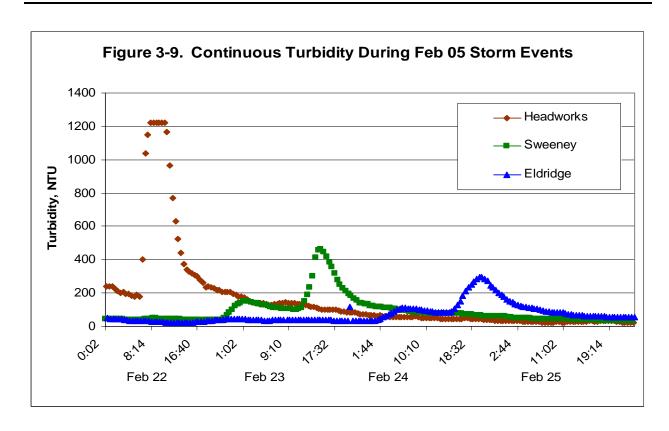
The relationship between rainfall at Winters and turbidity is shown on **Figures 3-6** and **3-7**. The data from the Waterman WTP is shown since there is a continuous daily turbidity record at this location. **Figure 3-6** presents the data for July 2000 to June 2001, which had below average rainfall and **Figure 3-7** presents the data for July 2004 to June 2005, which had above average rainfall. In both years it is clear that rain events drive the high turbidity events in the Putah South Canal. The data indicate that it takes about 5 to 6 inches of cumulative rain in the season to saturate the ground and begin to cause sufficient erosion in the watershed to result in turbidity spikes over 50 NTU.

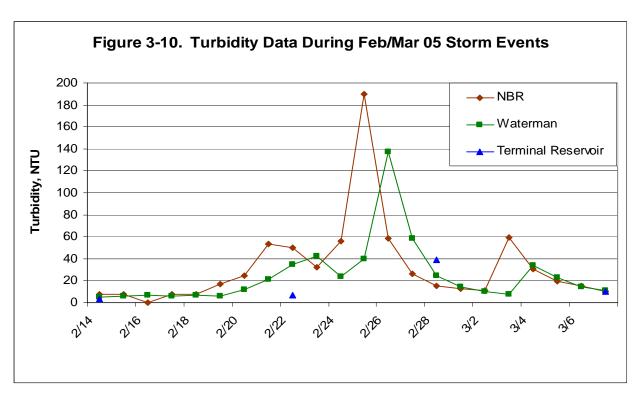




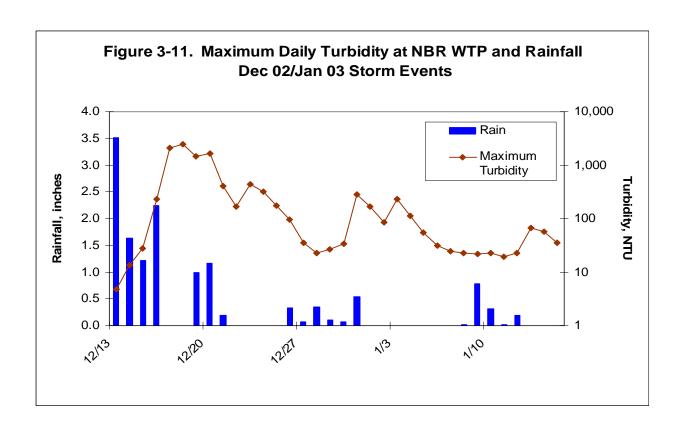
Solano County Water Agency (SCWA) has installed continuous turbidity monitors on the Putah South Canal at the headworks, Sweeney Check, and Eldridge Pumping Plant. Data were available at all three locations in 2005. February 2005 was selected for an analysis of the relationship between rain events and turbidity episodes along the Putah South Canal because significant rain fell during this month and all three continuous monitors were operational. Figure 3-8 presents the daily rainfall recorded at Winters from mid February to early March. Over 3.2 inches of rain fell between February 14 and February 21. Figure 3-9 presents the continuous turbidity data collected at the three locations along the canal. This figure clearly shows the turbidity slug traveling along the canal and indicates that turbidity is dampened with distance down the canal. turbidity (1220 NTU) occurred at the headworks on February 22, followed by a peak of 463 NTU at Sweeney Check, six miles from the headworks on February 23 and a peak of 297 NTU at Eldridge Pumping Plant, 12 miles from the headworks on February 24. Figure 3-10 shows the data for NBR WTP, Waterman WTP, and the Terminal Reservoir. This figure shows the turbidity slug continuing to travel down the canal with the peak (190 NTU) reaching NBR WTP on February 25, Waterman (137 NTU) on February 26 and the Terminal Reservoir (39 NTU) on February 28. Since the data are collected weekly, rather than daily, at the Terminal Reservoir, the actual peak may have been higher.

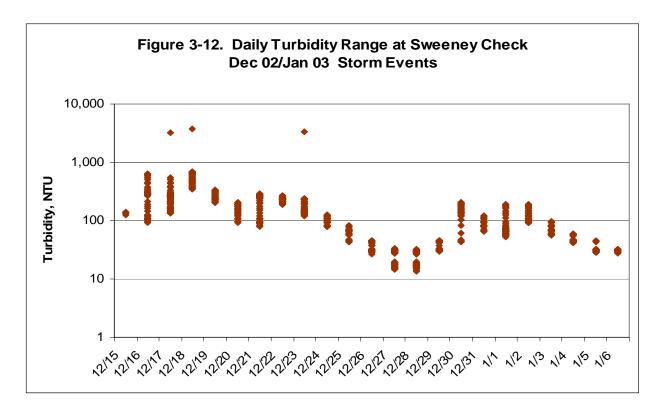






The maximum turbidities observed during the 2000 to 2005 period occurred between mid December 2002 and mid January 2003. Figure 3-11 presents the maximum daily turbidity measured at the NBR WTP and rainfall during this period. These data indicate that more intense rain such as occurred in mid December results in much higher turbidity measurements in the Putah South Canal. In three days 8.6 inches of rain fell at Winters. This storm had a 10 year return frequency for a 24-hour duration storm at Winters and 20 to 30 year return frequency in the Vacaville and Fairfield areas. The runoff from this storm resulted in a maximum turbidity reading of 2493 NTU on December 18, 2002 at NBR WTP. These data also indicate that it takes two to three days for the high turbidity generated in the watershed to reach the NBR WTP. Continuous turbidity data were available for Sweeney Check during this time period. These data are plotted on Figure 3-12 to examine the daily variability in turbidity measurements. This figure indicates that turbidity can vary over an order of magnitude in one day. The peak turbidity recorded at Sweeney Check was 3687 NTU, also on December 18, 2002.





Treated Water Turbidity

The daily treated water turbidity data for the Vacaville, NBR, and Waterman WTPs and the Consumer Confidence Reports (CCRs) for the other WTPs were reviewed to determine if the plants are meeting the treated water turbidity standards established by the Interim Enhanced Surface Water Treatment Rule (IESWTR). This rule requires that 95 percent of the combined filter effluent turbidity measurements be less than 0.3 NTU and turbidity cannot exceed 1 NTU at any time. The WTPs consistently meet the treated water turbidity standards. The data for the December 2002 storm events were examined as a worst case influent turbidity scenario. During this period the maximum treated water turbidity measurement at the NBR WTP was 0.09 NTU and the maximum at the Waterman WTP was 0.14 NTU. The Vacaville WTP was not operating during the storm event. Even during challenging source water turbidity levels, the WTPs are meeting the treated water turbidity standards.

Microbiological Contaminants

Under the Surface Water Treatment Regulation (SWTR), the general requirements are to provide treatment to ensure at least 3-log reduction of *Giardia lamblia* cysts and at least 4-log reduction of viruses. The IESWTR requires 2-log reduction of *Cryptosporidium*. Additional inactivation of *Cryptosporidium* may have to be provided based on source water monitoring for *Cryptosporidium* that will be conducted to comply with the recently promulgated Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

The California SWTR Staff Guidance Manual provides a description of source waters that require additional treatment above the minimum 3-log Giardia and 4-log virus reduction (California Department of Health Service [CDHS], 1991). The Guidance Manual states "...in a few situations, source waters are subjected to significant sewage and recreational hazards, where it may be necessary to require higher levels of virus and cyst removals...". Due to the expense and uncertainties associated with pathogen monitoring, CDHS staff historically relied on monthly median total coliform levels as a guide for increased treatment. More recently, CDHS staff has started to rely upon fecal coliform and E. coli as more specific indicators of mammalian fecal contamination. Evaluation of pathogen reduction levels based on coliform bacterial density is not as scientifically valid as basing them on actual pathogen concentrations. The relationship between coliforms and pathogenic cysts is tenuous, but in the absence of other information, CDHS uses coliform density to determine required pathogen reduction levels for individual water treatment plants. Historically, CDHS relied on monthly median total coliform densities as an indicator of pathogen contamination. When monthly medians exceeded 1000 most probable number per 100 milliliters (MPN/100 ml), CDHS staff considered requiring additional log removal. More recently, CDHS staff has relied on monthly median fecal coliform or E. coli levels. When the monthly median E. coli or fecal coliform density exceeds 200 MPN/100 ml, CDHS staff considers requiring additional log removal.

Pathogens

A great deal of total and fecal coliform data have been collected on the Putah South Canal and the Terminal Reservoir but limited data have been obtained on the pathogens, *Giardia* and *Cryptosporidium*. **Table 3-2** presents the pathogen data that have been collected at the intake of the NBR WTP. *Giardia* was detected in one sample and *Cryptosporidium* was detected twice. As shown in **Table 3-2**, many of these samples were collected during rain events and during periods of time when there had been significant rain during the preceding week. Although most samples were collected when the turbidity was less than 10 NTU, samples were collected on December 31, 2002 when turbidity was 162 NTU and on January 7, 2004 when turbidity was 124 NTU. These data are therefore representative of the variable water quality conditions of the Putah South Canal.

Total and Fecal Coliforms

Since there are limited pathogen data, the available total and fecal coliform data were also analyzed to provide more information on the microbial quality of the Solano Project water.

Date	<i>Giardia</i> , cysts/L	Cryptosporidium, oocysts/L	Turbidity, NTU	Rainfall in Prior Week, inches
12/31/02	<0.2	0.2	162	5.82*
03/17/03	<0.1	<0.1	29.3	1.94
04/21/03	<0.1	<0.1	7.1	0.04*
12/01/03	<0.1	<0.1	2.3**	0.96*
01/07/04	<0.1	<0.1	124	1.62*
04/06/04	<0.1	<0.1	5.26	0.32
07/19/04	<0.1	<0.1	2.76	0
10/25/04	<0.1	<0.1	2.0**	1.45*
01/19/05	0.1	<0.1	10.3	0.02*
04/11/05	<0.1	<0.1	4.23	0.24
07/11/05	<0.1	0.1	2.23	0
10/10/05	<0.1	<0.1	1.6**	0

Table 3-2. Pathogen Data for the NBR WTP

Vacaville WTP

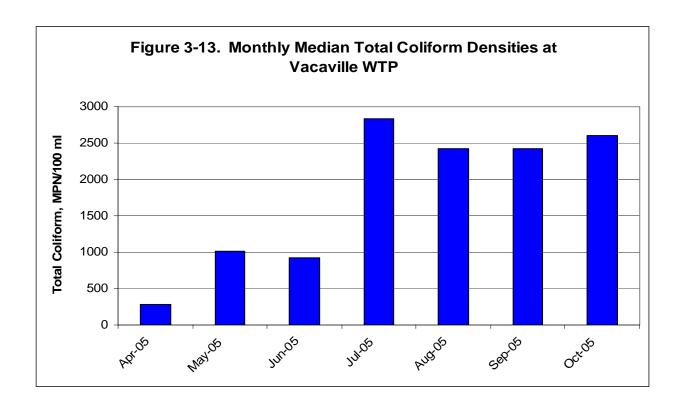
The Vacaville WTP provides water from April through October and is shut down during the remainder of the year. There are limited coliform data prior to April 2005 and weekly data for 2005. **Figures 3-13** and **3-14** present the 2005 data. These data show that monthly median total coliform densities exceeded 1000 MPN/100 ml for July through October. The monthly median fecal coliform densities were always below 200 MPN/100 ml, and in all but one month were below 30 MPN/100 ml. Although there is only one year of data available for Vacaville, the total and fecal coliform densities are similar to those found at the Waterman WTP, which has a longer period of record.

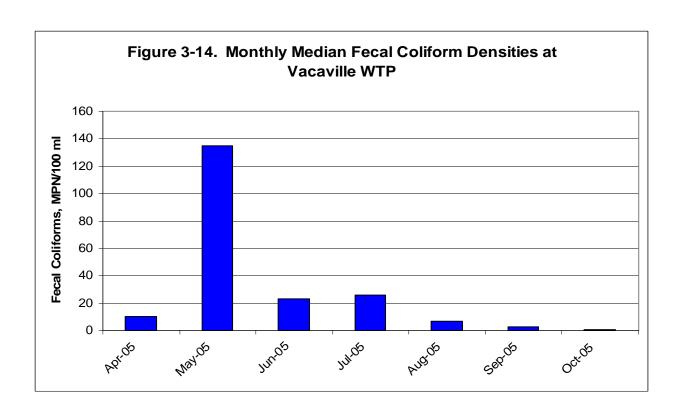
NBR WTP

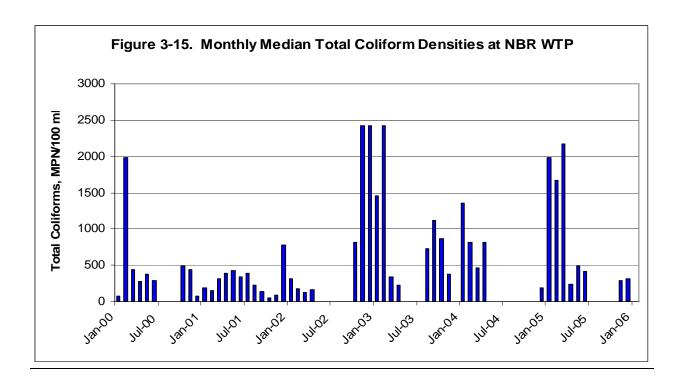
The NBR WTP primarily relies on Solano Project Water from October through April or May. When the plant is treating water from the Putah South Canal, daily total coliform samples are collected. In 2002 daily *E. coli* data were collected and since August 2003, daily fecal coliform data have been collected. **Figures 3-15** and **3-16** present the data from the NBR WTP intake. These data indicate that there are months during the wet season when median total coliform densities exceed 1000 MPN/100 ml. The peak total coliform density measured at the NBR WTP intake was 26,155 MPN/100 ml during the December 2002 storm events. A number of samples collected during the wet months were reported as greater than 2419 MPN/100 ml, so the actual peak levels cannot be determined. The monthly median fecal coliform densities were consistently below 200 MPN/100 ml and generally below 40 MPN/100 ml. Peak fecal coliform densities of greater than 1600 MPN/100 ml occurred on several events during the wet months.

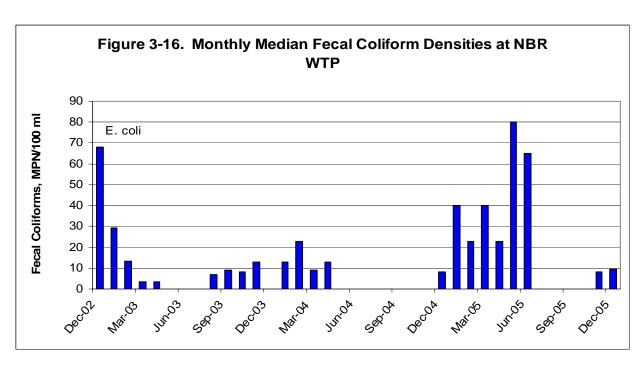
^{*}Raining on day sample was collected.

^{**} No data available at NBR WTP so Waterman WTP data shown.









Waterman WTP

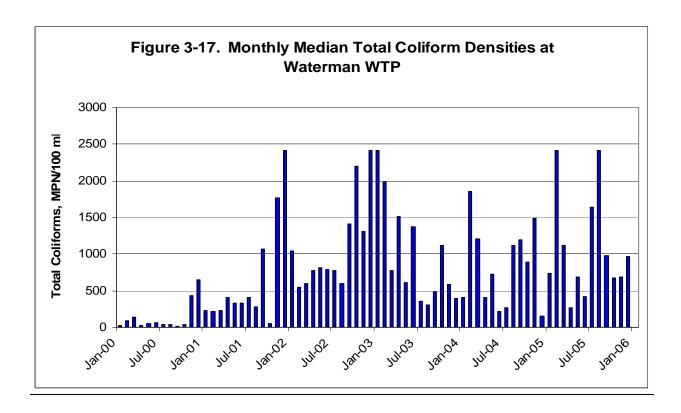
The Waterman WTP relies on Solano Project Water year-round so coliform data are available for each month of the year. Weekly coliform samples are collected at the intake. Figures 3-17 and 3-18 present the data for the Waterman WTP intake. There are a number of months when total coliform densities exceed 1000 MPN/100 ml. Most of the high monthly medians occur during the wet season but there are several dry season months that had medians in excess of 1000 MPN/100 ml. The peak total coliform density measured at the Waterman WTP intake was 4838 MPN/100 ml during January 2003. A number of samples collected during the wet months were reported as greater than 2419 MPN/100 ml. The fecal coliform data indicate that with the exception of May 2004, the monthly medians are less than 200 MPN/100 ml. The peak fecal coliform density was 1633 MPN/100 ml in January 2003.

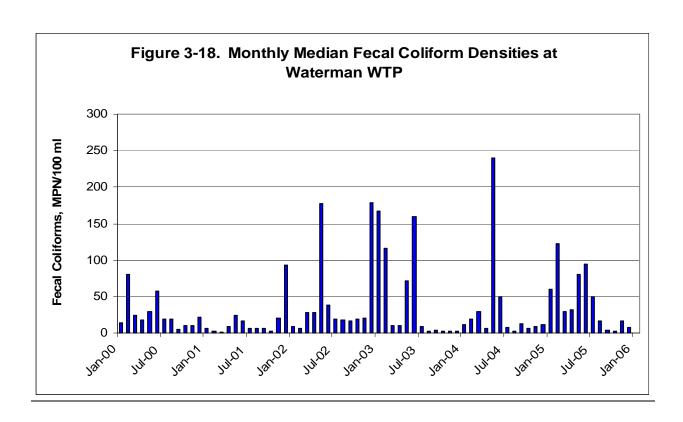
Terminal Reservoir

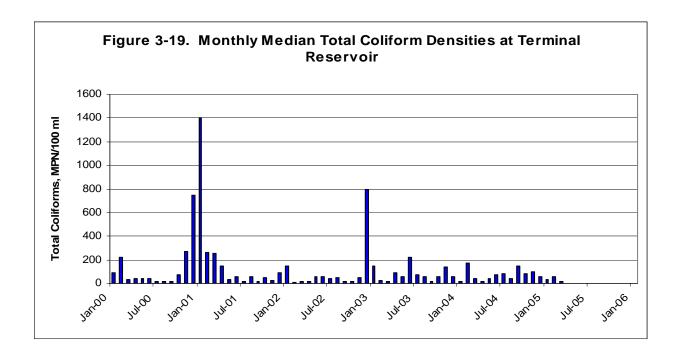
The City of Vallejo provided weekly coliform data collected at the Terminal Reservoir. These data are shown on **Figures 3-19** and **3-20**. The monthly median total coliform density was generally below 200 MPN/100 ml with one peak above 1000 MPN/100 ml in January 2001. The fecal coliform densities were consistently below 200 MPN/100 ml and usually less than 30 MPN/100 ml.

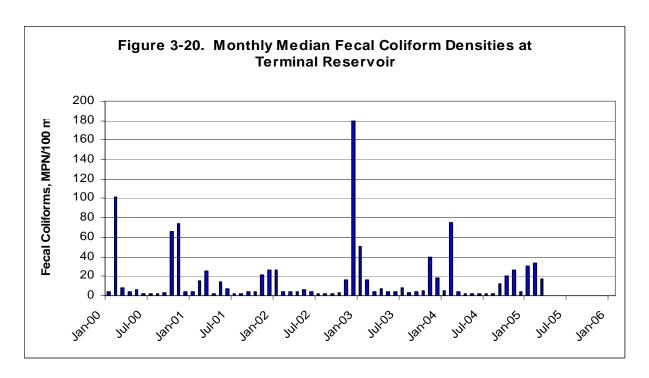
Spatial Trends

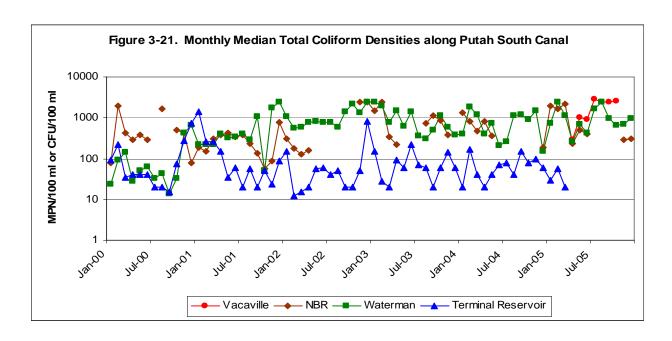
The monthly medians for all four locations are plotted on **Figures 3-21** and **3-22** to examine trends along the Putah South Canal. Due to different periods of record and different sampling frequencies, no consistent trends could be seen with the Vacaville, NBR WTP, and Waterman WTP data. The one trend that is clearly seen in both the total and fecal coliform data is that the terminal reservoir coliform densities are consistently lower than the canal locations. Settling of particulate matter in the reservoir may contribute to removal of a portion of the coliforms that are present in the flowing canal water.

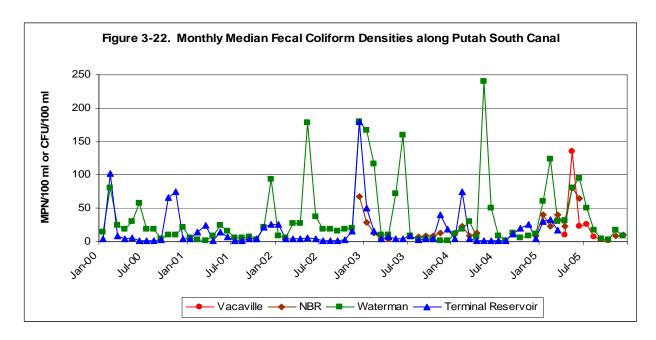








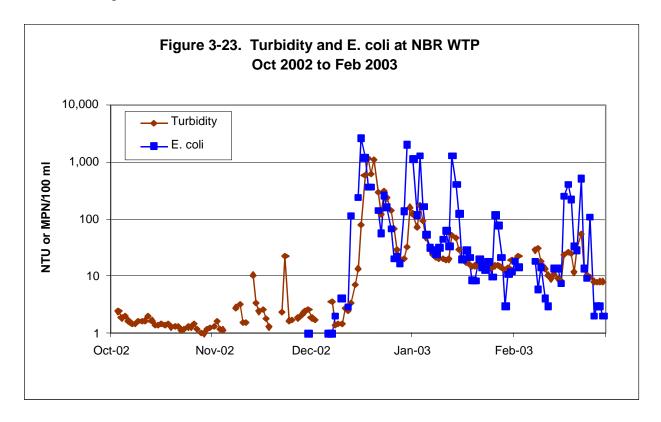


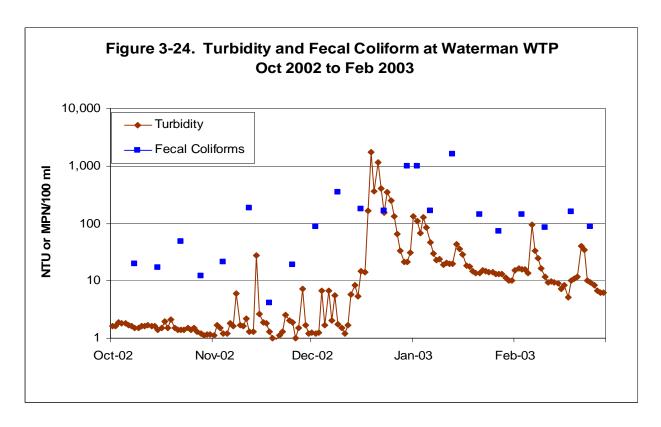


Impact of Storm Events

The NBR and Waterman WTP data were examined more closely to understand the processes driving the high coliform densities found during the winter months. The period of October 2002 to February 2003 was selected because monthly median total coliform densities at both plants exceeded 1000 MPN/100 ml and fecal coliform densities at the Waterman WTP were elevated during this time. During this period, *E. coli*, rather than fecal coliforms, was measured at the NBR WTP.

Figure 3-23 shows the relationship between turbidity and *E. coli* at the NBR WTP. In mid December, there was a large increase in turbidity due to significant rain, as described in the Turbidity Section. There was a concomitant increase in *E.coli* and densities remained high for several weeks. **Figure 3-24** presents the turbidity and fecal coliform data for the Waterman WTP. The coliform samples are collected weekly at Waterman WTP, rather than daily, so it is difficult to see a clear relationship between turbidity and fecal coliform densities. The highest fecal coliform densities occurred after the turbidity increased in mid-December. These data indicate that significant storm events can result in both turbidity and fecal bacteria levels increasing by more than two orders of magnitude.





Evaluation of Pathogen Reduction/Inactivation Requirements

Although the monthly median total coliform densities exceed 1000 MPN/100 ml during several months of the year at the intakes along the Putah South Canal, fecal coliform densities are less than 200 MPN/100 ml. A comparison of coliform levels along the Putah South Canal shows generally stable levels along the canal, with a reduction through the Terminal Reservoir. The quarterly pathogen monitoring that has been conducted at the NBR WTP intake indicates that there is minimal risk of pathogens being present in the source water from Putah Creek. In addition, as described in Section 2, there is minimal risk of contamination of the Solano Project water below Monticello Dam by human wastes. There are a few septic tanks in the watershed and minimal body contact recreation in Lake Solano and Putah Creek. The monthly monitoring for Cryptosporidium and E. coli required by the LT2ESWTR will provide additional data to determine if the current 2-log Cryptosporidium, 3-log Giardia, and 4log virus removal requirements are adequate for the WTPs that treat Solano Project water. Until that monitoring is completed, the current 2/3/4-log removal should be required by CDHS and the treatment plants should continue their current practice of optimizing treatment during storm events and avoiding the highly turbid slugs of water.

Disinfection Byproduct Precursors

Disinfection byproducts are formed when a disinfectant, such as chlorine or ozone, reacts with organic carbon and bromide. Most disinfection byproducts are carcinogenic and are regulated as treated water maximum contaminant levels. The water treatment plants that treat Solano Project Water fall into two categories; those that disinfect with

free chlorine and those that use ozone as the primary disinfectant and free chlorine as the secondary disinfectant, as indicated in **Table 3-3**.

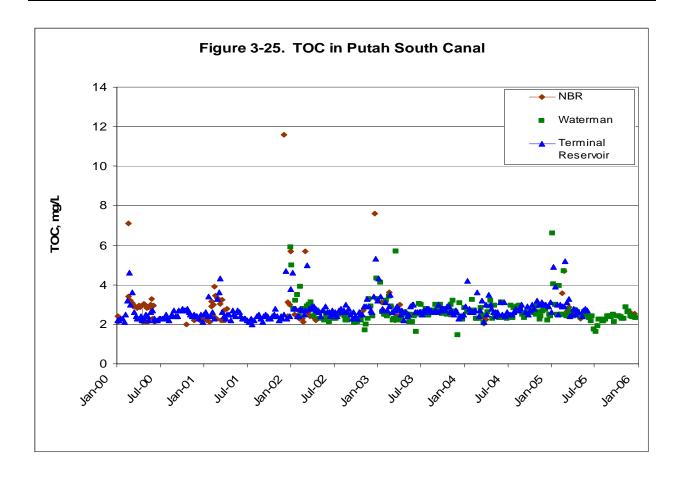
Table 3-3. Disinfectants Used at Solano Project Water Treatment Plants

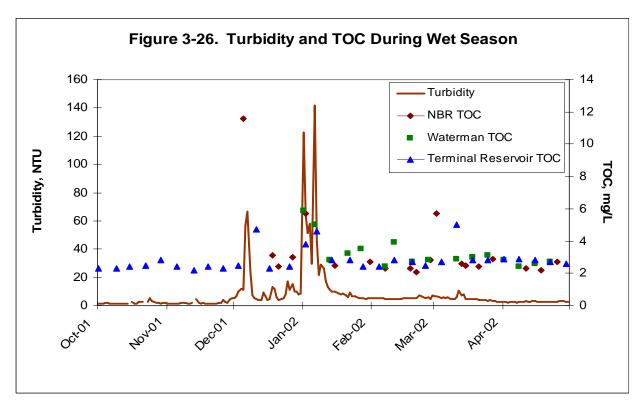
Plants Using Chlorine	Plants Using Ozone and Chlorine		
Vacaville	North Bay Regional		
California Medical Facility	Waterman		
Cement Hill	Fleming Hill		
Green Valley	_		
Benicia			

A wide variety of chemical compounds are formed during the disinfection of source waters with chlorine in the presence of organic carbon and bromide. Of the many dozen disinfection byproduct compounds that have been detected, total trihalomethanes (TTHMs) and five haloacetic acids (HAA5s) are currently regulated with MCLs of 80 micrograms per liter (μ g/L) and 60 μ g/L, respectively. Organic carbon in the source water still impacts facilities using ozone because the required ozone dose increases as total organic carbon (TOC) increases. Higher levels of ozone in the presence of bromide can increase bromate concentrations in the treated water. The MCL for bromate is 10 μ g/L.

Total Organic Carbon

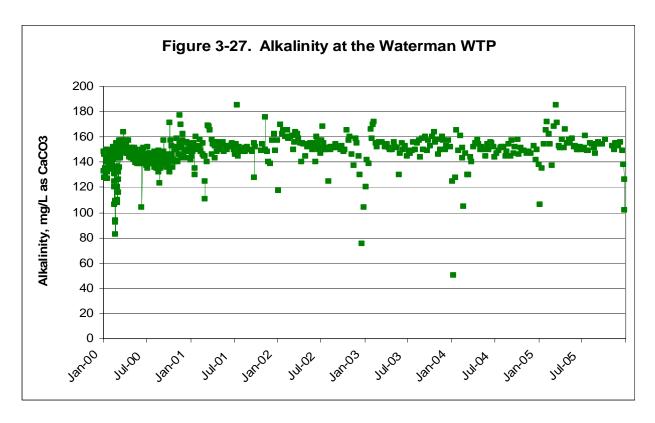
TOC data were available at the intakes of the NBR and Waterman WTPs and at the Terminal Reservoir. **Figure 3-25** shows the data at all three locations. TOC concentrations are generally between 2 and 3 milligrams per liter (mg/L) at the three locations and there are no apparent trends along the canal. TOC increases during the wet season with peaks of 4 to 8 mg/L. A peak of 11.6 mg/L was seen at the NBR WTP intake during December 2001. **Figure 3-26** presents the TOC concentrations and turbidity during the wet season of 2001/2002. These data indicate that when turbidity increases during storm events there is a concomitant increase in TOC. During the six-year period of record examined for this sanitary survey (2000 to 2005), most of the peaks in TOC are related to peaks in turbidity, indicating that storm events wash organic matter into Putah Creek and Putah South Canal along with inorganic turbidity.





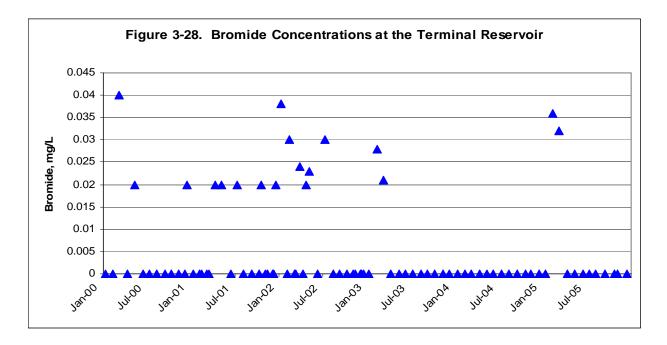
Alkalinity

Enhanced coagulation is required for the plants that treat Solano Project water because the source water TOC is routinely above 2 mg/L and they implement conventional filtration processes. The amount of TOC reduction is based on both the source water TOC and alkalinity levels. As shown on **Figure 3-27**, alkalinity is generally between 140 and 160 mg/L as CaCO₃ at the Waterman WTP. When alkalinity is greater than 120 mg/L as CaCO₃ and TOC is between 2 and 4 mg/L, 15 percent reduction of TOC is required. When alkalinity drops or TOC increases, greater removal of TOC is required. **Figure 3-27** indicates that alkalinity occasionally drops below 120 mg/L. The decreased alkalinity occurs during storm events when TOC concentrations are often elevated. The alkalinity data collected at the NBR WTP intake and the Terminal Reservoir are consistent with the data from the Waterman WTP.



Bromide

Bromide in the source water reacts with chlorine to produce brominated trihalomethanes and haloacetic acids and it reacts with ozone to produce bromate in the finished water. The bromide concentrations at the Terminal Reservoir are shown on **Figure 3-28**. Bromide is usually less than 0.02 mg/L and never exceeds 0.04 mg/L. A study conducted for California Urban Water Agencies concluded that with an average TOC of 3 mg/L or less, bromide would have to exceed 0.050 mg/L to result in disinfection byproducts at levels of potential concern (California Urban Water Agencies, 1998).



Trihalomethanes and Haloacetic Acids

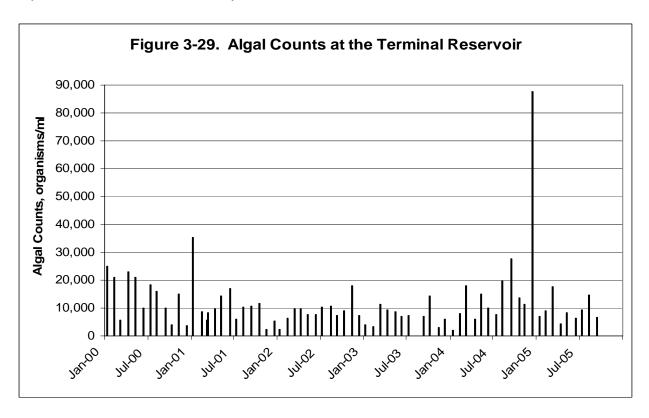
The CCRs were reviewed for the WTPs treating Putah South Canal water to determine compliance with the treated water standards of 80 μ g/L for TTHMs and 60 μ g/L for HAA5. The water providers are currently meeting the standards and most are meeting the standards with a large margin of safety. Cement Hill WTP is the only system that indicated it may have a problem meeting the locational running average required by the Stage 2 D/DBP Rule.

Algal Blooms

Algal blooms occur in the Putah South Canal during warm weather and result in the application of copper sulfate by Solano Irrigation District (SID) to control the blooms. There are no data on algal or chlorophyll levels in the canal but the City of Vallejo conducts algal counts on the Terminal Reservoir. **Figure 3-29** presents the data from the Terminal Reservoir. These data do not show high algal counts during the summer months. This is likely due to the fact that SID applies copper sulfate from April to September to control algal blooms.

The algal blooms are likely the result of nutrient rich water released from the hypolimnion of Lake Berryessa, combined with the warm temperatures, abundant light, and shallow condition of the canal. There are however, no data to support this statement. Some nutrient species are measured at the NBR WTP intake and at the Terminal Reservoir. The detection limits are too high to detect nutrients at levels that could stimulate algal growth. A limited amount of data is available from a 1977 to 1980 U.S. Geological Survey study of Lake Berryessa and Putah Creek at Winters. These data indicate that total phosphorus concentrations at that time were in the range of 0.02 to 0.08 mg/L and total nitrogen concentrations ranged from 0.1 to 1.1 mg/L. Both

nutrients exceed U.S. EPA Ecoregion I phosphorus and total nitrogen reference conditions of 0.047 mg/L and 0.31 mg/l, respectively (USEPA, 2001). Ecoregion I includes the Central Valley. The EPA reference conditions are guidance based on the 25th percentile of all nutrient data assessed for the ecoregion. The reference conditions are to be used by the states for establishing water quality standards or objectives. The Central Valley Regional Water Quality Control Board has not adopted nutrient objectives for the Central Valley.



Pesticides

As described in **Section 2**, copper is the most widely used pesticide in the watershed, followed by organophosphate pesticides. Although copper is a drinking water contaminant, the primary source of copper in treated supplies is plumbing. The major concern for copper in source water is that it is concentrated in the WTP sludge and can result in the sludge being classified as a hazardous waste. Quarterly copper data are collected at the NBR WTP intake. The data from January 2000 through October 2005 were examined. All samples were reported as less than 50 µg/L. Although this detection level is sufficiently low to determine compliance with the secondary MCL of 1.0 mg/L, it is not low enough to examine any trends in copper. Quarterly monitoring is also not sufficient to examine trends over time to determine if peaks in copper occur after SID uses copper sulfate to control algae in the Putah South Canal or after copper is applied to agricultural crops in the watershed. SID notifies the water agencies and cities when a copper sulfate application is planned. The water providers avoid taking water into the treatment plants during these periods.

SECTION 3 - WATER QUALITY EVALUATION

The Title 22 pesticides are monitored twice a year at the NBR WTP intake. Samples are collected in January to characterize wet season conditions and in October to characterize dry season conditions. The only pesticide that has been detected is simazine and it was detected at levels below the CDHS reporting limit.

INTRODUCTION

This Second Update of the Solano Project Watershed Sanitary Survey focuses on the watershed below Monticello Dam. This section presents the key findings and recommendations from this survey. The Solano Project water is high quality and poses few treatment challenges, with several exceptions. Solano Irrigation District (SID), Solano County Water Agency (SCWA), and the individual water providers are doing an excellent job managing the contaminant sources to the extent feasible and providing high quality drinking water.

TURBIDITY

Finding

Storm events occurring during the wet season can result in extremely high turbidity levels in the Putah South Canal (in excess of 1000 NTU at times). The water treatment plant operators respond in several ways, depending upon the operational flexibility at each plant. Whenever possible, water is not diverted from the Putah South Canal until the turbidity slug passes by the intake; water is blended with other supplies, if available; treatment is optimized; and occasionally a water treatment plant (WTP) is shut down until water quality improves. The turbidity comes from highly erodable soils, exposed soils left by wildfires, and historically overgrazed land in the watershed; none of which are controlled by SID or SCWA. SID has taken measures to avoid diverting highly turbid water into the canal and has constructed overchutes and other drainage system improvements to carry water from the Putah South Canal watershed over and under the canal. SID, SCWA, and the individual water providers have developed an alert system to notify the WTP operators of highly turbid water in the canal. Despite all of these efforts, the episodic high turbidity creates increasing difficulties for the WTP operators as the demand for water in Solano County grows. SCWA is initiating the Putah South Canal Turbidity and Sediment Management Study to quantify sources of turbidity to the canal and to evaluate source control measures.

Recommendation

SID, SCWA, and the individual water providers are doing all that they reasonably can to lessen the impact of the highly turbid water on the drinking water supplies. The real-time monitoring network along the Putah South Canal should be maintained and the results should be monitored during storm events so that decisions on diverting water into the canal and at individual water intakes can be made, to the extent feasible, based on the turbidity levels. The real-time data are a valuable tool to monitor the progression of turbidity slugs along the canal. The WTP operators should continue their current practice of optimizing treatment during periods of elevated turbidity. The feasibility and cost effectiveness of implementing source control measures should be determined after the Putah South Canal Turbidity and Sediment Management Study is completed.

MICROBIOLOGICAL CONTAMINANTS

Finding

Monthly median total coliform densities are generally below 1000 MPN/100 ml, but can exceed that level during the wet weather months at the intakes along the Putah South Canal. More importantly, the fecal coliform and E. coli data and the quarterly protozoa monitoring that has been conducted at the North Bay Regional (NBR) WTP intake show low levels for all constituents and indicate that there appears to be minimal risk of pathogens being present in the source water. In addition, as described in Section 2, there is minimal risk of contamination of the Solano Project water by human wastes downstream of Monticello Dam. There are a few septic systems in the watershed but there are no wastewater discharges into Putah Creek or the Putah South Canal. There is limited body contact recreation in Lake Solano and along Putah Creek due to the cold water released from the bottom of Lake Berryessa. There is cattle grazing in the watershed and cattle, particularly calves, have been shown to have the potential to be infected with Cryptosporidium parvum. The greatest risk to contamination of Solano Project water supplies is likely to occur during wet weather events in the spring when young calves may be present and storm runoff can mobilize fecal matter containing oocysts into the water.

Recommendation

The monthly monitoring for *Cryptosporidium* and *E. coli* required by the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) will provide additional data to determine if the current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements are adequate for the WTPs that treat Solano Project water. Until that monitoring is completed, existing data suggest that the current 2/3/4-log reduction required by CDHS is adequate. The treatment plants should continue their current practice of optimizing treatment during storm events and avoiding the highly turbid slugs of water. Although not required by the LT2ESWTR, water providers may consider collecting total coliform and fecal coliform data along with the protozoa data to determine if there is a correlation between the coliform data and the pathogen data. The monitoring results for each of the intakes along the canal should be reviewed collectively to determine if there are any inconsistencies or trends in the data. The need to address control of pathogens in the watershed should be reevaluated based on the monitoring results.

DISINFECTION BYPRODUCT PRECURSORS

Finding

Disinfection byproduct precursors in the Solano Project water do not pose any treatment challenges for the WTP operators. Total organic carbon (TOC) concentrations are generally between 2 and 3 mg/L along the Putah South Canal with peaks of 4 to 8 mg/L during storm events. Enhanced coagulation is required for the plants that treat Solano

Project water because the source water TOC is routinely above 2 mg/L and they implement conventional filtration processes. Based on the normal alkalinity levels of 140 to 160 mg/L as CaCO₃ and average TOC concentrations, 15 percent of the source water TOC must be removed. Bromide concentrations are generally less than 0.02 mg/L. All of the water providers are currently able to meet the total trihalomethane (TTHM) and haloacetic acid (HAA5) maximum contaminant levels.

Recommendation

The water providers should conduct their Initial Distribution System Evaluations (IDSE) required by the Disinfectants/Disinfection Byproducts (D/DBP) Rule. An IDSE must be performed to identify locations with representative high TTHM and HAA5 concentrations throughout a system's retail distribution system. The IDSE results will be used in conjunction with the Stage 1 D/DBP Rule compliance monitoring to identify and select Stage 2 D/DBP Rule routine compliance monitoring locations.

ALGAL BLOOMS

Finding

Algal blooms in the Putah South Canal during the summer months result in the need to apply copper sulfate to control the blooms to avoid taste and odor problems in the treated drinking water. The algal blooms are likely due to nutrient rich water, abundant light, and warm water temperatures due to the shallow conditions in the canal. There are limited nutrient data available for the Putah South Canal but the source is likely the nutrient rich hypolimnetic water that is released from Lake Berryessa. Another potential source is sediment that remains in canal sections not cleaned the previous fall. SID alerts the water providers when they plan a copper sulfate application. The water providers generally minimize diversions into their WTPs during these treatment events.

Recommendation

A nutrient monitoring program may provide further insight into the sources and trends of nutrients in the Putah South Canal. Unless a specific, controllable source is identified, there is little more SID can do beyond treating the canal with copper sulfate.

PESTICIDES

Finding

Copper and organophosphate pesticides are the primary pesticides used to control pests in agricultural operations in the watershed. Quarterly pesticide data from the NBR WTP intake were available for evaluation in this sanitary survey update, and did not result in any detection of organic compounds in the raw water. A review of the Consumer Confidence Reports for other water providers did not reveal any organic

SECTION 4 – FINDINGS AND RECOMMENDATIONS

compounds detected. This monitoring may not be conducted during the times of the year when pesticides are most likely to be present in the water.

Recommendation

Although pesticides are not likely to be a drinking water quality concern, an effort should be made to conduct organophosphate pesticide monitoring at the drinking water intakes during the dormant spray season, typically December through February.

SPILLS AND ILLEGAL DUMPING

Finding

Vehicle accidents and illegal dumping of materials in Putah Creek and the Putah South Canal have the potential to adversely affect water quality at the WTP intakes. SID has direct notification procedures with the local Certified Unified Program Agency (CUPA) to ensure that they will receive notification in the event of a spill upstream of its diversion into the Putah South Canal. Most of the canal is fenced and SID patrols the canal three times a week to identify illegal dumping. The remainder of the canal will be fenced as development occurs along that portion of the canal to prevent public access. In the event of a spill, SID notifies the WTP operators so they can take necessary precautions.

Recommendation

The existing coordination between emergency response agencies, SID, and the WTP operators is effectively protecting drinking water quality and should be continued.

URBAN RUNOFF

Finding

There is currently no urban development in the Putah Creek watershed and no discharge of urban runoff directly to the Putah South Canal. The watershed that drains to Putah Creek is being developed with low density ranchettes. Immediately to the east of the watershed, near Winters, there is on-going residential development. The area around the canal, particularly in Vacaville and Fairfield, is rapidly urbanizing.

Recommendation

SCWA should maintain its current policy of not allowing urban runoff to be discharged to the Putah South Canal except under extreme storm conditions. As rural land is converted to urban uses, developers should be required to route the urban runoff over or under the canal. SCWA should monitor growth in the Winters area and, if growth proceeds to the east along Lake Solano and upper Putah Creek, SCWA should insist that Winters develop a storm water management plan that addresses protection of

SECTION 4 – FINDINGS AND RECOMMENDATIONS

drinking water quality. SID should maintain its current practice of requiring developers to route all urban runoff under or over the Putah South Canal.

WATERSHED PROGRAMS

Finding

There are several watershed programs focused on Putah Creek, including Putah Creek Discovery Center and Lower Putah Creek Coordinating Committee. Both of these programs are supported by various agencies, including SCWA and SID among others.

Recommendation

SCWA and SID should continue to support these public education programs.

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- 39. California Department of Health Services. 1991. Surface Water Treatment Staff Guidance Manual. Office of Drinking Water.
- 40. California Urban Water Agencies. 1998. Bay-Delta Water Quality Evaluation Draft Final Report.

This Appendix provides a review of current and anticipated drinking water regulations as promulgated by the United States Environmental Protection Agency (USEPA) and the California Department of Health Services (DHS). Under the provisions of the Safe Drinking Water Act (SDWA), the DHS has the primary enforcement responsibility (referred to as "primacy"). The Health and Safety Code of the California Administrative Code establishes DHS' authority and stipulates drinking water quality and monitoring standards. To maintain primacy, a state's drinking water regulations can be no less stringent than the federal standards (a state's regulations can be more stringent).

The USEPA and DHS establish primary regulations for the control of contaminants that affect public health and secondary regulations for compounds that affect the taste or aesthetics of drinking water. For each contaminant that is regulated, the USEPA is required to establish a maximum contaminant level (MCL) or a treatment technique (TT) to limit the level of these compounds in drinking waters. USEPA is also required to recommend a Best Available Technology (BAT) for removal of each contaminant during treatment.

CURRENT REGULATIONS

The most significant drinking water quality regulations are shown in **Table A-1**. **Attachment 1** contains a summary of each of the contaminants currently regulated in drinking water by both the USEPA and the DHS. The table identifies the regulation and the MCL or the TT associated with each of the contaminants listed. The following is a general discussion of the requirements of those regulations.

NIPDWR

Prior to the establishment of the USEPA, the US Public Health Service had established 22 drinking water standards. These standards were adopted by the USEPA as National Primary Drinking Water Regulations (NIPDWR) by the SDWA. These contaminants have been updated or replaced by subsequent regulations.

Phase I Regulations

The Phase I Regulations were finalized in July 1987 and compliance for large utilities was required by January 1989. The Phase I Regulations included MCLs for eight VOCs and required utilities to collect quarterly samples from each source water supply for one year. After one year, utilities could qualify for reduced monitoring based on the first year monitoring results (one sample every three years). The Phase I Regulations also included monitoring requirements for unregulated contaminants. All systems were required to monitor for a minimum of 34 unregulated volatile organic contaminants; 2 additional

contaminants if the system is determined vulnerable; and 15 additional contaminants at the State's discretion.

Table A-1
Summary of Major Federal and State Drinking Water Quality Regulations

Regulation	Year of Promulgation	Number of Contaminants	Targeted Contaminants
National Interim Primary	1975-1981	7	Trihalomethanes,
Drinking Water Regulations (NIPDWR)			Arsenic, Radiologicals
Phase I Standards	1987	8	VOCs
Phase II Standards	1991	36	VOCs, SOCs, and IOCs
Phase V Standards	1992	23	VOCs, SOCs, and IOCs
Surface Water Treatment Rule (SWTR)	1989	5	Microbiological and Turbidity
Total Coliform Rule (TCR)	1989	2	Microbiological
Lead and Copper Rule (LCR)	1991/2003 ¹	2	Lead and Copper
Drinking Water Source Assessment and Protection	1996	-	Source Water Protection
Program			T TOTOGRAFIT
Stage 1	1998	14	D/DBPs and
Disinfectants/Disinfection By-			Precursors
Products (D/DBP) Rule			
Interim Enhanced Surface	1998	2	Microbiological and
Water Treatment Rule			Turbidity, Systems
(ESWTR)			>10,000
Radionuclides Rule	2000	4	Radionuclides
Arsenic Rule	2001	1	Arsenic
Filter Backwash Recycling	2001	-	Microbiological and
Rule			Turbidity
Stage 2 D/DBP Rule	2006	9	DBPs
Long Term 2 ESWTR	2006	1	Cryptosporidium

¹California Adoption of Federal Rule Minor Revisions

Phase II Regulations

The Phase II Regulations were proposed in May 1989 and finalized in July 1991. Monitoring under the Phase II Regulations was required to begin in January 1993. The Phase II Regulations established MCLs for 38 contaminants (7 inorganic constituents (IOCs), 10 volatile organic compounds (VOCs), and 19 synthetic organic compounds (SOCs), plus nitrate, nitrite, and total nitrate and nitrite) and TT requirements for two additional treatment additives (polymers). In order to simplify the increasing number of monitoring requirements, the

Standardized Monitoring Framework (SMF) was developed. The SMF is based on a 9-year cycle divided into three, three-year monitoring periods. Under the new monitoring schedule, initial monitoring, baseline monitoring, reduced monitoring, and increased monitoring requirements were established.

Phase V Regulations

The Phase V Regulations were proposed in July 1990 and finalized in July 1992. The SMF was incorporated into the Phase V Regulations with the first compliance period for large utilities beginning January 1994. Phase V established regulations for 23 contaminants including 22 from the original list of 83 included in the 1986 SDWA Amendments (originally included a proposal for sulfate that was not included in the final Phase V regulations). The 23 Phase V contaminants include 5 IOCs, 3 VOCs, and 15 SOCs. The MCL for nickel, 0.1 mg/L, was remanded in February 1995 by the US Court of Appeals for the District of Columbia Circuit. The USEPA is required to reconsider the nickel MCLG and the MCL, but no action has been taken yet.

Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated to control the levels of turbidity, *Giardia lamblia*, viruses, *Legionella*, and heterotrophic plate count bacteria in U.S. drinking waters. Many of the detailed requirements of this regulation will be enhanced or superceded by the Interim and Long Term 2 Enhanced Surface Water Treatment Rules described later.

The California SWTR requires all utilities utilizing a surface water supply or a groundwater supply under the influence of a surface water supply, to provide adequate disinfection and, under most conditions, to provide filtration. Exemptions from filtration of surface water supplies are provided in rare occasions where the source water supply meets extremely rigid requirements for water quality and the utility possesses control of the watershed.

General Requirements

The SWTR includes the following general requirements to minimize human exposure to microbial contaminants in drinking water.

- Utilities are required to achieve at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts (3-log removal) and a minimum 99.99 percent removal and/or inactivation of viruses (4-log removal). The required level of removal/inactivation must occur between the point where the raw water ceases to be influenced by surface water runoff to the point at which the first customer is served.
- The disinfectant residual entering the distribution system must not fall below
 0.2 mg/L for more than 4 hours during any 24-hour period.

- A disinfectant residual must be detectable in 95 percent of distribution system samples. An heterotrophic plate count (HPC) concentration of less than 500 colonies/mL can serve as a detectable residual if no residual is measured.
- Each utility must perform a watershed sanitary survey at least every five years.

Removal Credit

The level of removal credit given a utility for both *Giardia lamblia* and viruses is determined by the type of treatment process used. For a conventional water treatment plant, the SWTR provides a 2.5-log removal credit for *Giardia lamblia* and a 2.0-log removal credit for viruses. Alternative treatment technologies are awarded removal credit from DHS based on performance tests.

Disinfection Credit

Disinfection during conventional treatment (assuming all operational criteria and performance standards are met and the plant receives 2.5-log credit for physical removal of *Giardia* and 2.0-log credit for physical removal of viruses), must achieve 0.5-log inactivation of *Giardia lamblia* and 2.0-log inactivation of viruses. To determine the inactivation of *Giardia lamblia* and viruses achieved at a treatment plant, the SWTR established the concept of disinfection contact time (CT). CT is the product of the concentration of disinfectant remaining at the end of a treatment process ("C" in mg/L) and the contact time in which 10 percent of the water passes through the treatment process ("T" or "T₁₀" in minutes). The contact time in which 10 percent of the water travels through a unit process can be conservatively estimated from DHS guidelines or more accurately determined by conducting a tracer study. The USEPA Guidance Manual to the SWTR includes tables that identify the log removal of both *Giardia lamblia* and viruses achieved for a calculated CT value based on the type of disinfectant, the water temperature, and pH.

Total Coliform Rule

The Total Coliform Rule (TCR) was promulgated by the USEPA in June 1989 with compliance required eighteen months after promulgation (January 1991). DHS promulgated the Total Coliform Rule in January 1992 and the Rule went into effect on May 1, 1992. Under the TCR, utilities must submit a monitoring plan to the DHS for approval. The plan must provide for representative sampling of the distribution system (including all pressure zones and reservoir areas), describe any sample rotations proposed and include a statement that the sample collector has been trained. The total number of samples and frequency of sampling required is dependent on the population served by the utility. For all but the smallest utilities, weekly sampling is required. If any sample is coliform-

positive, two actions must be taken within 24 hours of notification of the positive result:

- A set of repeat samples must be collected. The location of the repeat samples must include the tap that tested positive, and one upstream and downstream location, both of which must be within five service connections of the positive sample location. If one or more of the repeat samples tests positive for the presence of coliforms, an additional set of repeat samples must be taken. This process continues until all of the samples are total coliform-negative or an MCL has been violated.
- The sample must be analyzed for the presence of fecal coliform or E. Coli.

The previous coliform standard was a density based standard. This was replaced by a presence/absence regulation. There are three potential scenarios in which an MCL is violated. These scenarios consist of the following:

- For utilities that analyze less than 40 samples per month, no more than 1 monthly sample may be coliform-positive (this includes repeat samples). If more than 1 monthly sample is coliform-positive than an MCL has been violated. For >40 samples per month collected, an MCL has been violated if more than 5.0% are positive.
- Utilities are in violation of an MCL if an original sample is fecal coliform/*E. Coli*-positive and any repeat sample is total, fecal, or *E. Coli*-positive.
- Utilities are in violation of an MCL if an original sample is total coliform-positive and any repeat sample is fecal coliform/*E. Coli*-positive.

Furthermore, there are two conditions that result in a "Significant Rise in Bacterial Count" classification. This condition is not considered a violation of an MCL; however, it does require notification to DHS. The two conditions that result in this classification are listed below:

- An initial sample that is total coliform-positive is determined to be either fecal coliform or *E. Coli.*-positive, as well.
- At least two repeat samples are total coliform-positive but neither sample is fecal coliform or *E. Coli*-positive.

Best Available Technology

The TCR includes a list of four preventative measures a utility can institute to minimize the presence of coliforms in the distribution system. These four items include the following:

- Ensure proper well protection.
- Maintain of a minimum 0.2 mg/L disinfectant residual through the entire distribution system.
- Institute a distribution system maintenance program including:
 - o appropriate pipe replacement and repair procedures,

- flushing program,
- proper operation and maintenance of distribution system reservoirs, and
- maintenance of a positive water pressure throughout system.
- Provide adequate filtration and disinfection treatment processes.

Lead and Copper Rule

The Lead and Copper Rule (LCR) was promulgated by the USEPA on June 7, 1991. The objective of the LCR is to minimize the corrosion of lead and copper-containing plumbing materials in public water systems (PWS) by requiring utilities to optimize treatment for corrosion control. The LCR establishes "action levels" in lieu of MCLs for regulating the levels of both lead and copper in drinking water. The action level for lead was established at 0.015 mg/L while the action level for copper was set at 1.3 mg/L. An action level is exceeded when greater than 10 percent of samples collected from the sampling pool contain lead levels above 0.015 mg/L or copper levels above 1.3 mg/L. Unlike an MCL, a utility is not out of compliance with the LCR when an action level is exceeded. Exceedance of an action level requires a utility to take additional steps to reduce lead and copper corrosion in the distribution system. There is a California state secondary standard, of 1.0 mg/L, for copper.

In October 1999, USEPA made minor revisions to the LCR to clarify the original rule, streamline implementation, promote consistent national implementation, and reduce the reporting requirements. The revisions do not include any changes to the action levels for lead and copper. The revisions include requiring monitoring for public water systems with optimized corrosion control, which was inadvertently left out of the original LCR. The revisions also include changing the definition of the word "control" in the LCR to only require public water systems to replace lines that it owns or has authority to replace to protect the water quality. The revisions allow systems with low lead and copper tap levels to reduce the number and frequency of sample collection sooner. Finally, there are numerous modifications to the system reporting requirements to minimize the reporting burden.

Drinking Water Source Assessment and Protection Program

The 1996 SDWA Amendments included a requirement for States to develop a program to assess sources of drinking water and encourage States to establish protection programs.

California has developed the Drinking Water Source Assessment and Protection (DWSAP) Program in response to this requirement. When bringing a new source into service, a source assessment must be conducted as part of the permitting process.

Once an original assessment is performed for a source water, the assessment must be reviewed and updated as necessary every five (5) years. It is also

APPENDIX A – REGULATORY FRAMEWORK

expected that a completed assessment will be required to obtain and continue to obtain chemical monitoring waivers for source waters.

There are eight components identified by California which are required as part of its DWSAP Program.

- Source Identification: Systems must locate the source using Global Positioning System.
- Delineation of the Watershed and the Near Intake Zones: Surface water systems must delineate the watershed contributing to the source and may, optionally, identify the near intake zones which are close to the point of diversion where contaminant activities may have a greater influence.
- Evaluation of the Physical Barrier Effectiveness: Surface water systems
 must complete the forms developed by the State to determine the
 effectiveness of the natural physical barriers for preventing contaminants
 from entering the source.
- Identification of Potential Contaminating Activities (PCAs): Surface water systems must develop an inventory of PCAs within the near intake zone or the entire watershed. The PCAs on the inventory must then be ranked for risk using the table from the DWSAP guidance.
- Perform a Vulnerability Assessment: Systems must perform a vulnerability assessment for each PCA identified. This assessment is based on the risk ranking, location, and the physical barrier effectiveness. After assessment, the PCAs will be prioritized.
- Develop an Assessment Map: Systems must develop an assessment map, at a minimum using USGS quad maps 7.5 minute series. The map must show the location of the source, the watershed or recharge area, the near intake zones, and the location of the PCAs.
- Prepare a Drinking Water Source Assessment Report: Systems must prepare a report on the assessment to submit to the State for review. The report must include the assessment map, the methods used to locate the source, the recharge area delineation calculations, the physical barrier effectiveness forms, the potential contaminating activity forms, and the vulnerability assessment forms.
- Include a Summary of the Report in the Annual Consumer Confidence Report: Systems must prepare a summary of the assessment to include in the annual Consumer Confidence Report. The report must also be available to the public for review.

After the final report has been reviewed and accepted by DHS, systems can begin the voluntary Source Water Protection Program if desired. There are some loan and grant funds available to assist with these programs. The program requirements have been highlighted by the State and will include: public involvement, report review, initiation of protection measures, and information transfer to the public.

Stage 1 Disinfectants and Disinfection By-Products Rule

The purpose of the Stage 1 Disinfectants/Disinfection By-Product (D/DBP) Rule is "..to minimize risks from disinfection by-products and still maintain adequate control over microbial contamination."

Maximum Residual Disinfectant Level Goals

The USEPA has set maximum residual disinfectant level goals (MRDLGs) for chlorine, chloramines, and chlorine dioxide. These are shown in **Table A-2**.

Table A-2
Maximum Residual Disinfectant Level Goals

Disinfectant	Goal
Chlorine	4 mg/L as Cl ₂
Chloramines	4 mg/L as Cl ₂
Chlorine Dioxide	0.8 mg/L as ClO ₂

The MRDLGs are set at levels for which no known or anticipated adverse health effects occur. These goals are non-enforceable health goals based only on health effects and exposure information.

Maximum Residual Disinfectant Levels

The Stage 1 D/DBP Rule established maximum residual disinfectant levels (MRDLs) for chlorine, chloramines, and chlorine dioxide. These are shown in **Table A-3**.

Table A-3
Maximum Residual Disinfectant Levels

Disinfectant	Level
Chlorine	4.0 mg/L as Cl ₂
Chloramines	4.0 mg/L as Cl ₂
Chlorine Dioxide	0.8 mg/L as ClO ₂

Chlorine

The residual disinfectant level must be monitored at the same points in the distribution system and at the same time as when sampling for total coliforms. Compliance with the MRDL will be based on the running annual average of the monthly average of all samples, computed quarterly. Operators may increase the residual chlorine level in the distribution system above the MRDL if necessary to protect public health from acute microbiological contamination problems

including; distribution line breaks, storm runoff events, source water contamination, or cross-connections.

Chloramines

The residual disinfectant level must be monitored at the same points in the distribution system and at the same time as when sampling for total coliforms. Compliance with the MRDL will be based on the running annual average of the monthly average of all samples, computed quarterly. Operators may increase the residual chloramine level in the distribution system above the MRDL if necessary to protect public health from acute microbiological contamination problems including; distribution line breaks, storm runoff events, source water contamination, or cross-connections.

Chlorine Dioxide

Systems that use chlorine dioxide must measure the residual disinfectant level at the entrance to the distribution system on a daily basis. Non-compliance with the MRDL can result in acute or non-acute violations. If the daily sample at the entrance exceeds the MRDL, then the system is required to take three additional samples in the distribution system on the next day as described below. If any samples collected the second day in the distribution system exceed the MRDL, or if the distribution system samples were not collected, the system will be in acute violation of the MRDL. If only the sample collected at the entrance to the distribution system exceeds the MRDL on the second day, or if the entrance sample was not collected, the system will be in a non-acute violation of the MRDL.

Follow up monitoring in the distribution system will be governed by the type of residual disinfectant used. Systems using chlorine as a residual disinfectant and operating booster stations after the entrance to the distribution system must take three samples in the distribution system; one close to the first customer, one at an average residence time, and one at the maximum residence time. Systems using chlorine dioxide or chloramines as a residual disinfectant or chlorine without operating booster stations after the entrance to the distribution system must take three samples in the distribution system as close as possible to the first customer at intervals of not less than six hours.

Operators may not increase the residual chlorine dioxide level in the distribution system above the MRDL under any circumstances.

Maximum Contaminant Level Goals (MCLGs) for TTHMs, HAA5, Chlorite, and Bromate

The USEPA has set MCLGs for four trihalomethanes, two haloacetic acids, chlorite, and bromate. These are shown in **Table A-4**.

Table A-4
Maximum Contaminant Level Goals

Disinfection By-Product	MCLG
Bromodichloromethane	0 mg/L
Dibromochloromethane	0.06 mg/L
Bromoform	0 mg/L
Dichloroacetic Acid	0 mg/L
Trichloroacetic Acid	0.3 mg/L
Chlorite	0.8 mg/L
Bromate	0 mg/L

The MCLGs are set at levels for which no known or anticipated adverse health effects occur. These goals are non-enforceable health goals based only on health effects and exposure information.

Maximum Contaminant Levels for TTHMs, HAA5, Chlorite, and Bromate

The Stage 1 D/DBP Rule set MCLs for TTHM, HAA5, chlorite, and bromate. These are shown in **Table A-5**.

Table A-5
Maximum Contaminant Levels

Contaminant	Level
TTHM ¹	0.080 mg/L
HAA5 ²	0.060 mg/L
Chlorite	1.0 mg/L
Bromate	0.010 mg/L

¹TTHM includes chloroform, bromodichloromethane, dibromochloromethane, bromoform.

Total Trihalomethanes and Haloacetic Acids

TTHMs and HAA5 are formed when disinfectants react with naturally occurring organic matter in water. All systems must monitor the distribution system for TTHMs and HAA5. Compliance for surface water, GWUDIS and groundwater systems with population greater than 10,000 is based on the running annual average of quarterly averages of all samples taken in the distribution system, computed quarterly.

Chlorite

Chlorite is produced when chlorine dioxide reacts with naturally-occurring organic material. Systems using chlorine dioxide for disinfection are required to conduct

² HAA5 includes mono, di and tri-chloroacetic acids and mono and dibromoacetic acids.

sampling for chlorite. Systems are required to monitor chlorite on a daily basis at the point of entry to the distribution system. If chlorite is detected at levels greater than 1.0 mg/L at the entrance to the distribution system, then additional distribution system monitoring is required the following day. Systems must monitor three locations in the distribution system (at the same time); close to the first customer, representative of average residence time, and representative of maximum residence time, on a monthly basis.

Bromate

Bromate is produced when ozone reacts with naturally occurring bromide. Systems using ozone for disinfection are required to conduct sampling for bromate. Systems must collect one sample per month at the entrance to the distribution system while the ozonation system is operating under normal conditions. Compliance with the MCL is based on a running annual average, computed quarterly, of monthly samples.

Treatment Technique for Disinfection By-Product Precursors

The USEPA requires systems that have surface water or groundwater under the direct influence of surface water (GWUDIS) as a supply to use conventional filtration treatment to remove specific amounts of organic material by implementing a treatment technique, either by enhanced coagulation or enhanced softening. The percent of removal required depends on source water TOC and alkalinity. **Table A-6** provides a summary of the removal requirements.

Table A-6
TOC Removal Requirements (Percent)

	Alkalinity, mg/L as CaCO₃		
TOC, mg/L	0 – 60	> 60 – 120	> 120
> 2.0 - 4.0	35	25	15
> 4.0 - 8.0	45	35	25
> 8.0	50	40	30

Compliance with this treatment technique must be calculated on a quarterly basis, once 12 months of data are available. Each month the system must calculate percent actual TOC removal, determine the percent required TOC removal (from above), and calculate the removal ratio (must be greater than 1.0). Systems have the opportunity to be granted a 1.0 for the monthly removal ratio under the four following conditions, regardless of the calculated removal ratio:

- Remove greater than or equal to 10 mg/L of magnesium hardness (as CaCO₃),
- Raw water TOC is less than 2.0 mg/L,

- Raw water or treated water specific UV absorbance (SUVA) is less than or equal to 2.0 L/mg-m, or
- Treated water alkalinity is less than 60 mg/L (only for systems practicing enhanced softening).

The USEPA has also provided alternative compliance criteria from the treatment technique requirements. Utilities will not be required to achieve the specified TOC removals provided one of the following conditions are met:

- Source water TOC is less than 2.0 mg/L,
- Treated water TOC is less than 2.0 mg/L,
- Source water TOC is less than 4.0 mg/L, source water alkalinity is greater than 60 mg/L, and distribution system TTHM is less than 0.04 mg/L and HAA5 is less than 0.03 mg/L,
- Distribution system TTHM is less than 0.04 mg/L and HAA5 is less than 0.03 mg/L and only chlorine is used for primary disinfection and distribution system residual,
- Source water SUVA, prior to any treatment, is less than or equal to 2.0 L/mg-m, or
- Treated water SUVA is less than or equal to 2.0 L/mg-m.

Interim Enhanced Surface Water Treatment Rule

The Interim ESWTR applies to public water systems (PWSs) that use surface water or GWUDIS and serve > 10,000 population. The purpose of this regulation is "..to improve control of microbial pathogens, including specifically *Cryptosporidium*, in drinking water; and address risk trade-offs with disinfection by-products."

Cryptosporidium

The rule set an MCLG for the protozoan genus *Cryptosporidium* of zero (0). Since there was not a reliable means for monitoring this constituent in the drinking water at the time of promulgation, a treatment technique requirement was established in lieu of setting an MCL. The treatment technique requires a 2.0-log (99 percent) *Cryptosporidium* removal or control for PWSs that are currently required to filter under the existing SWTR. This removal must be achieved between the raw water intake and the first customer.

The rule provides that systems with conventional or direct filtration water treatment plants will be granted the 2.0-log removal credit, provided turbidity requirements are met for the existing SWTR (1.0/5.0 NTU) and the combined filter effluent requirements for this rule (0.3/1.0 NTU).

The rule also provides that systems with slow sand or diatomaceous earth filtration water treatment plants will be granted the 2.0-log removal credit, provided turbidity requirements are met for the existing SWTR (1.0/5.0 NTU). For systems applying to use an "alternative filtration technology", the system must show that the treatment, in combination with disinfection, consistently achieves 99.9 percent removal/inactivation of *Giardia*, 99.99 percent removal/inactivation of viruses, and 99 percent removal of *Cryptosporidium*.

Turbidity

For surface water and GWUDIS systems that are required to filter their source water under the existing SWTR, that employ conventional or direct filtration for treatment, the combined filter effluent turbidity requirements have been tightened. For alternative filtration technologies, the State will set turbidity performance requirements at a level that, in combination with disinfection, will consistently achieve 99.9 percent removal/inactivation of *Giardia*, 99.99 percent removal/inactivation of viruses, and 99 percent removal of *Cryptosporidium*.

The combined filter effluent turbidity must be less than 0.3 NTU in 95 percent of measurements and may never exceed 1 NTU (based on four hour measurements). The combined filter effluent turbidity shall not exceed 1.0 NTU for more than eight hours (based on 15-minute measurements). Combined filter effluent and individual filter effluent continuous turbidity monitoring shall be recorded every 15 minutes. Monthly reports must show total number of measurements taken and have two options for value reporting:

- Report 15-minute measurements and show the 50th, 90th, 95th, 98th, and 99th percentiles and report all measurements greater than 1 NTU.
- Report 4 hour measurements and show all results greater than 0.3 NTU (based on 15 minute measurements) and percent of measurements less than or equal to 0.3 NTU (based on 15-minute measurements).

The rule requires continuous, on-line measurement of turbidity for each individual filter. These data must be recorded every 15 minutes. Systems with two or fewer filters may conduct continuous monitoring of the combined filter effluent turbidity in lieu of individual monitoring. Individual filter effluent turbidity monitoring shall be less than 0.3 NTU within 60 minutes after return to service.

DHS is expected to add several other requirements to the rule including:

- All filters shall be visually inspected once per year as part of the operations plan based on DHS guidance.
- Raw water shall be sampled for total coliform and either fecal coliform or *E. Coli* at least once per month.
- Chlorine residual shall be confirmed in 95 percent of distribution samples every month.

- On-line turbidimeters shall be manually verified once per month for combined filter effluent and once per month for individual filter effluent.
- Turbidity shall be recorded and reported for sedimentation effluent at least once per day.
- Flow rate and turbidity shall be recorded and reported for recycled backwash water at least once per day.
- System must report turbidity data to the State within 10 days after the end of each month.

Disinfection Profiling and Benchmarking

The purpose of disinfection profiling and benchmarking is to develop a process to assure that there is no significant reduction in microbial protection as a result of significant disinfection process modifications to meet the new MCLs for TTHMs and HAA5 from the Stage 1 D/DBP Rule.

Profiling will be required for surface water systems that have either TTHM levels greater than or equal to 80 percent of the new MCL (0.064 mg/L) or HAA5 levels greater than or equal to 80 percent of the new MCL (0.048 mg/L).

The disinfection profile is developed using a minimum of one year of weekly *Giardia lamblia* log inactivation. The month with the lowest average log inactivation will be identified as the critical period or benchmark. When only one year of data is used, the benchmark inactivation shall be the same as the critical period. When multiple years of data are used, the benchmark inactivation shall be the average of the critical period from each year.

After the profiling and benchmarking is complete, a utility must submit it to the State as part of the sanitary survey. If a utility decides to make changes to the disinfection practices, then the utility must consult with the State to ensure that microbial protection is not compromised. Changes that would require a benchmark analysis include; changes in the point of disinfection, the type of disinfectant, the disinfection process, or any other modification identified by the State.

Finished Water Reservoirs

Under this rule, surface water and GWUDIS systems must cover all new treated water reservoirs, holding tanks, and other storage facilities.

Sanitary Surveys

Primacy states, such as California, must now conduct sanitary surveys for all surface water and GWUDIS systems, regardless of size. These surveys must be conducted every three years for community water systems (CWS) and every five years for non-community water systems (NCWS). DHS may grant a waiver to

water utilities to perform the sanitary survey every five years if the system has outstanding performance based on previous sanitary surveys. DHS must determine how outstanding performance will be evaluated to allow for the reduced frequency of the sanitary survey.

The sanitary surveys must meet the eight components of the 1995 USEPA/State Guidance. These components include: source assessment, treatment, distribution system, finished water storage, pumps, pumping facilities and controls, monitoring and reporting, data verification, system management and operation, operator compliance with state requirements, and disinfection profiling (if required).

Radionuclides

The USEPA published the Final Radionuclides Rule on December 8, 2000. The Rule applies to all CWSs. It included several new standards including:

- Set the Gross Alpha, Gross Beta and Photon, Combined Radium (226/228), and Uranium MCLGs at zero.
- Set the Gross Alpha MCL at 15 pCi/L.
- Set the Gross Beta and Photon MCL at 4mrem/yr.
- Set the Combined Radium MCL at 5 pCi/L.
- Set the Uranium MCL at 30 ug/L.

The Rule requires all initial monitoring to be collected at the entry point to the distribution system (EPDS). It also clarified that Gross Beta and Photon are only required to be monitored by vulnerable systems. The frequency of repeat monitoring is determined by initial monitoring results.

- Sample results less than the detection limit for reporting (DLR), then 1 sample every 9 years.
- Sample results less than half the MCL, then 1 sample every 6 years.
- Sample results less than the MCL, then 1 sample every 3 years.

Arsenic Rule

The Final Arsenic Rule was promulgated by the USEPA on January 22, 2001. The Rule sets an MCLG of 0 mg/L and an MCL of 0.010 mg/L (10 ug/L) for arsenic. DHS has not yet adopted this regulation and the State version may be more stringent, see discussion below.

Surface water systems are required to collect an annual sample. If sample results are greater than the MCL, then quarterly sampling is triggered. Waivers are available with three rounds of monitoring with results less than the MCL. With a waiver, sampling can be reduced to once every nine years.

Filter Backwash Recycling Rule

The Final Filter Backwash Recycling Rule applies to all PWSs that use surface water and employ conventional or direct filtration and recycle water within the treatment plant.

This Rule requires all recycle streams to pass through all treatment processes, therefore all streams need to be returned prior to chemical addition and coagulation. Also, each system must notify DHS in writing that they practice recycling. This notification must include a plant schematic that shows the type and location of recycle streams, typical recycle flow data, highest plant flow in the previous year, design flow of the plant, and DHS approved operating capacity.

Each system must collect and maintain the following information: copy of recycle notice to DHS, list of all recycle flows and frequency, average and maximum backwash flow rate and duration, typical filter run length and how determined, type of recycle treatment, and data on recycle treatment facilities.

Stage 2 Disinfectants and Disinfection By-Products Rule

The Stage 2 D/DBP Rule was published in January 2006. It applies to public water systems (PWSs) that are community water systems (CWSs) or nontransient noncommunity water systems (NTNCWs) that add a primary or residual disinfectant other than ultraviolet light or deliver water that has been treated with a primary or residual disinfectant other than ultraviolet light.

The key provision in this rule is the change in calculating the maximum contaminant level (MCL). Currently, compliance with the MCL is calculated using a running annual average (RAA) to average compliance samples from all distribution system sampling locations. Under Stage 2 DBPR, the MCL will be calculated using locational running annual averages (LRAAs). PWSs must maintain the LRAA for each compliance sampling location at or below 0.080 mg/L total trihalomethane (TTHM) and 0.060 mg/L haloacetic acids (HAA5). All systems, including consecutive systems, must comply with the MCLs for TTHM and HAA5 LRAA using compliance sampling locations identified from the Initial Distribution System Evaluation (IDSE) Final Report.

Initial Distribution System Evaluation

An IDSE will be performed to identify locations with representative high TTHM and HAA5 concentrations throughout a system's retail distribution system. The IDSE results will be used in conjunction with the Stage 1 DBPR compliance monitoring to identify and select Stage 2 DBPR routine compliance monitoring locations. There are four IDSE options:

- Standard monitoring program
- System specific study [based on TTHM and HAA5 monitoring] and modeling requirements
- Obtaining a 40/30 waiver
- Obtaining a very small system waiver

Both the timing and number of IDSE and routine compliance monitoring are based on the <u>retail population served</u> by the individual public water system(s). For example,

The timing of when the IDSE must be completed is based on either an individual system's retail population or in the case of a combined distribution system, the retail population served by the largest system in that combined system.

The numbers of IDSE samples in the standard monitoring option are based on each individual system's retail population.

Compliance Monitoring

Compliance with the Stage 2 DBPR will be based on calculating a LRAA, where compliance means maintaining the annual average at each compliance sampling location in the distribution system at or below 0.080 mg/L and 0.060 mg/L for TTHM and HAA5, respectively. This is in lieu of the RAA MCL calculation under the Stage 1 DBPR that averaged observed values across distribution system compliance sampling locations. Monitoring for the LRAA will occur at compliance sampling locations identified in the IDSE Final Report at specific frequencies based on system population.

If a water system is required to conduct quarterly monitoring, it must make compliance calculations at the end of the fourth calendar quarter that follows the compliance date and at the end of each subsequent quarter (or earlier if the LRAA calculated based on fewer than four quarters of data would cause the MCL to be exceeded regardless of the monitoring results of subsequent quarters). If system is required to conduct monitoring at a frequency that is less than quarterly, it must make compliance calculations beginning with the first compliance sample taken after the compliance date.

Operational Evaluation Levels

The Stage 2 DBPR includes the concept of "operational evaluation levels." Operational evaluation levels trigger a system to evaluate system operational practices and identify opportunities to reduce DBP concentrations in the distribution system in order to reduce the potential the system will exceed the MCL. The Stage 2 DBP operational evaluation levels are identified using the system's Stage 2 DBPR compliance monitoring results.

Operational Evaluation Levels

(calculated at each monitoring location)

IF (Q1 + Q2 +2Q3)/4 > MCL, then the system must conduct an operational evaluation

where

Q3 = current quarter measurement Q2 = previous quarter measurement Q1 =quarter before previous quarter measurement MCL=Stage 2 MCL for TTHM (0.080 mg/l) or Stage 2 MCL for HAA5 (0.060 mg/L)

The operational evaluation includes an examination of system treatment and distribution operational practices, including changes in sources or source water quality, storage tank operations, and excess storage capacity, which may contribute to high TTHM and HAA5 formation. Systems must also identify what steps could be considered to minimize future operational evaluation level exceedences.

Minimum Reporting Levels for DBPs

The rule establishes regulatory minimum reporting limits (MRLs) for compliance reporting of DBPs by public water systems. These regulatory MRLs also define the minimum concentrations that must be reported as part of the Consumer Confidence Reports. Beginning April 1, 2007, report quantitative data for concentrations at least as low as the ones listed for all DBP samples analyzed for compliance.

Maintain $TOC \le 4$ mg/L for Reduced TTHM and HAA5 Monitoring

In order to qualify for reduced routine compliance monitoring for TTHM and HAA5, subpart H systems (i.e., systems that use surface water supplies or ground water under direct influence of surface water) not monitoring to demonstrate compliance with TOC removal requirements of Stage 1 DBPR (i.e., plants that are not conventional filtration designs) must take monthly TOC samples every 30 days at a location prior to any treatment, beginning April 1, 2008 or earlier, if specified by the state. The source water TOC running annual average must be <4.0 mg/L (based on the most recent four quarters of monitoring) on a continuing basis at each treatment plant to reduce or remain on reduced monitoring for TTHM and HAA5. After demonstration of TOC level, the system may reduce monitoring to every 90 days.

Systems on a reduced monitoring schedule may remain on that reduced schedule as long as the average of all samples taken in the year (for systems

which must monitor quarterly) or the result of the sample (for systems which must monitor no more than frequently than annually) is no more than 0.060 mg/L and 0.045 mg/L for TTHMs and HAA5, respectively.

Long Term 2 Enhanced Surface Water Treatment Rule

The Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) was published by the U.S. Environmental Protection Agency (EPA) in early January 2006 in the Federal Register. This regulation will apply to all public water systems that use surface water or ground water under the direct influence of surface water (GWUDI).

The LT2ESWTR includes deadlines that directly affect drinking water utilities of all sizes, and many will have to meet deadlines later this year. Some systems serving more than 100,000 people will have to submit detailed monitoring plan submissions under LT2ESWTR by July 1, 2006. The Major Milestone Schedule for Stage 2 DBPR and LT2ESWTR Implementation provides an overview of key monitoring, reporting, and compliance milestones under both rules.

The requirements for filtered and unfiltered systems are different. This section summarizes only the requirements for filtered systems.

Source Water Monitoring

Filtered systems are not required to conduct source water monitoring if the system will provide a total of at least 5.5-log of treatment for *Cryptosporidium*. Otherwise, PWSs using surface water or GWUDI are required to monitor their source water (i.e., the influent water entering the treatment plant) monthly for 24 months to determine an average *Cryptosporidium* level. As described in the next section, monitoring results determine the extent of *Cryptosporidium* action requirements under the LT2ESWTR. Large systems must also monitor for *E. coli* and turbidity at the same time in source water.

Systems must adhere to the sampling plan and report results no later than 10 days after the end of the first month following the month when the sample is collected. All systems serving at least 10,000 people must report the results from the initial source water monitoring to EPA electronically using the Central Data Exchange (CDX). Submission of historical (grandfathered) data is allowed when it meets the quality assurance and quality control requirements specified in the rule.

Systems serving less than 10,000 persons may use *E. coli* as a surrogate indicator for *Cryptosporidium*. However, if the *E. coli* levels are sufficiently high, these systems must then undertake *Cryptosporidium* monitoring.

The rule also includes a second round of *Cryptosporidium* sampling for all systems. This second round of sampling will take place six years following bin classification for the source water.

Analytical Method

Systems must analyze for *Cryptosporidium* using either EPA Method 1623 or Method 1622. Systems must analyze at least a 10 L sample or a packed pellet volume of at least 2 mL. The rule contains specific quality assurance and quality control requirements. Only EPA approved laboratories can perform the *Cryptosporidium* sample analysis. Specific analytical methods are also specified for turbidity and *E. coli* measurements required by the rule.

Sampling

Filtered systems serving at least 10,000 people must sample their source water for *Cryptosporidium*, *E. coli*, and turbidity at least monthly for 24 months. Filtered systems serving fewer than 10,000 people must sample their source water for *E. coli* at least once every two weeks for 12 months. Filtered systems serving fewer than 10,000 people must sample their source water for *Cryptosporidium* at least twice per month for 12 months or at least monthly for 24 months if the system does not conduct *E. coli* monitoring or if the initial *E. coli* sample exceed the following criteria:

- For systems using lake/reservoir sources, the annual mean *E. coli* concentration is greater than 10 *E. coli*/100 mL.
- For systems using flowing stream sources, the annual mean *E. coli* concentration is greater than 50 *E. coli*/100 mL.

Systems must collect samples within a five-day period around the schedule date. If an extreme condition or situation exists that may pose danger to the sample collector, or that cannot be avoided and causes the system to be unable to sample, the system must sample as close to the scheduled date as is feasible unless the state approves an alternative sampling date. The system must submit an explanation for the delayed sampling date to the state concurrent with the shipment of the sample to the laboratory. If a system is unable to report a valid analytical result for a scheduled sampling date due to equipment failure, loss of or damage to the sample, failure to comply with the analytical method requirements, including the quality control requirements, or the failure of an approved laboratory to analyze the sample, then the system must collect a replacement sample.

Replacement samples should be collected not later than 21 days after receiving information that an analytical result cannot be reported for the scheduled date unless the system demonstrates that collecting a replacement sample within this time frame is not feasible or the state approves an alternative re-sampling date.

The system must submit an explanation for the delayed sampling date to the state concurrent with the shipment of the sample to the laboratory. Systems that fail to meet these criteria for any source water sample must revise their sampling schedules to add dates for collecting all missed samples. Systems must submit the revised schedule to the state for approval prior to when the system begins collecting the missed samples.

Monitoring Location

Systems must collect samples for each plant that treats a surface water or GWUDI source. Where multiple plants draw water from the same influent, such as the same pipe or intake, the state may approve one set of monitoring results to be used for all plants. Systems must collect source water samples prior to chemical treatment, such as coagulants, oxidants and disinfectants. The state may approve a system to collect a source water sample after chemical treatment. To grant this approval, the state must determine that collecting a sample prior to chemical treatment is not feasible for the system and that the chemical treatment is unlikely to have a significant adverse effect on the analysis of the sample. Systems that recycle filter backwash water must collect source water samples prior to the point of filter backwash water addition. Specific requirements are included from bank filtration and other special cases.

A system that begins using a new source of surface water or GWUDI after the system is required to begin monitoring under paragraph (c) of this section must monitor the new source on a schedule the state approves.

Monitoring and Treatment Compliance Dates

Starting dates for monitoring are staggered by system size, with smaller systems beginning monitoring after larger systems. Milestones for monitoring, reporting, and compliance occur first for very large systems (≥100,000 persons), then systems serving 50,000 - 99,999 persons, followed by systems serving 10,000 - 49,999 persons, and finally systems serving fewer than 10,000. Populations are based on retail population.

Bin Classification Table for Filtered Systems

Filtered water systems will be classified in one of four categories or bins based on their monitoring results. The rule specifies several calculation procedures depending on how many samples were collected or if the sample frequency was not consistent.

Calculating Bin Placement

- Total of at least 48 samples, the bin concentration is equal to the arithmetic mean of all sample concentrations.
- Total of at least 24 samples, but not more than 47 samples, the bin concentration is equal to the highest arithmetic mean of all sample

- concentrations in any 12 consecutive months during which Cryptosporidium samples were collected.
- For systems that serve fewer than 10,000 people and monitor for Cryptosporidium for only one year (i.e., collect 24 samples in 12 months), the bin concentration is equal to the arithmetic mean of all sample concentrations.
- For systems with plants operating only part of the year that monitor fewer than 12 months per year under § 141.701(e), the bin concentration is equal to the highest arithmetic mean of all sample concentrations during any year of Cryptosporidium monitoring.

Additional action for *Cryptosporidium* (beyond 3.0-log reduction awarded for conventional filtration) will be based on source water concentrations of the protozoa and the type of treatment implemented at the plant. If the maximum running annual average (MRAA) is less than 0.075 oocysts/L, the source is assigned Bin 1 classification and no additional action is required. Assuming conventional filtration credit, if the MRAA is between 0.075 and 1.0 oocysts/L the source is assigned to Bin 2 and 1-log action is required, if the MRAA is between 1.0 and 3.0 oocysts/L the source is assigned to Bin 3 and 2-log action required, and if the MRAA is greater than 3.0 oocysts/L the source is assigned to Bin 4 and 2.5-log action required.

Systems classified in Bins 2, 3 and 4 must provide 1.0 to 2.5-log additional action for *Cryptosporidium*. Systems will select from a wide range of treatment and management strategies in the "microbial toolbox" to meet their additional action requirements. Systems classified in Bin 3 and Bin 4 must achieve at least 1 log of additional treatment using either one or a combination of the following: bag filters, bank filtration, cartridge filters, chlorine dioxide, membranes, ozone, or ultraviolet (UV) light.

Microbial Toolbox

PWSs can achieve additional *Cryptosporidium* treatment credit through implementing pretreatment processes, such as presedimentation or bank filtration, by developing a watershed control program, and by applying additional treatment steps like ozone, chlorine dioxide, UV, and membranes. In addition, PWSs can receive a higher level of credit for existing treatment processes through achieving superior filter effluent turbidity or through a demonstration of performance. Taken as a whole, this list of control options is termed the "microbial toolbox." PWSs may use one or more tools to accumulate the needed treatment credits to meet the treatment requirement associated with their bin classification.

UV Dose Table

Systems receive Cryptosporidium, Giardia lamblia, and virus treatment credits for

ultraviolet (UV) light reactors by achieving the UV dose values described in the rule's. Systems must validate and monitor UV reactors to demonstrate that they are achieving a particular UV dose value for treatment credit. UV reactor validation must occur at full-scale using a test microbe with quantified dose-response characteristics using low-pressure mercury lamps. Validation must include operating conditions of flow rate, UV intensity as measured by a UV sensor, and UV lamp status, as well as other considerations including as lamp fouling and inlet/outlet hydraulics. To receive treatment credit for UV light, systems must treat at least 95 percent of the water delivered to the public during each month by UV reactors operating within validated conditions for the required UV dose.

CT Tables

CT is the product of the disinfectant contact time (T, in minutes) and disinfectant concentration (C, in milligrams per liter). Systems with treatment credit for chlorine dioxide or ozone must calculate CT at least once each day, with both C and T measured during peak hourly flow. Systems with several disinfection segments in sequence may calculate and sum the CT for each segment, where a disinfection segment is defined as a treatment unit process with a measurable disinfectant residual level and a liquid volume. Systems receive the *Cryptosporidium* treatment credit by meeting the corresponding CT value for the applicable water temperature specified in <u>CT tables</u> specified in the rule.

Open Finished Water Reservoirs

Up to now, regulations required PWSs to cover all new storage facilities for finished water but did not address existing uncovered finished water storage facilities. Under the LT2ESWTR, PWSs using uncovered finished water storage facilities must either cover the storage facility or treat the storage facility discharge to achieve inactivation and/or removal of 4-log virus, 3-log *Giardia lamblia*, and 2-log *Cryptosporidium* on a state-approved schedule.

Microbial Profiling and Benchmarking

Following the completion of initial source water monitoring (date varies by system size), a system that plans to make a significant change to its disinfection practice, must develop disinfection profiles and calculate disinfection benchmarks for *Giardia lamblia* and viruses. Significant changes to disinfection practice are defined as follows:

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

ANTICIPATED FUTURE REGULATIONS

The USEPA and DHS are developing new drinking water regulations. The major anticipated future regulations that will impact surface water supplies are shown in **Table A-7** and those regulations are discussed below.

Table A-7
Summary of Anticipated Major Federal and State Drinking Water Quality
Regulations for Surface Water Supplies

Regulation	Year Final Expected	Number of Contaminants	Targeted Contaminants
Perchlorate ¹	2006	1	Perchlorate
Arsenic ²	2006	1	Arsenic
Hexavalent Chromium ¹	2006	1	Hexavalent Chromium
Drinking Water Candidate Contaminant List/ Unregulated Contaminant Monitoring Rule 2	2006/ 2007	51/	Chemical and Microbiological
Distribution System Rule/Revised Total Coliform Rule	2008	-	Microbiological

¹ California Rule Only

California Perchlorate Regulation

DHS is in the process of developing a primary MCL for perchlorate in drinking water. DHS currently has a notification level for perchlorate of 6 ug/L. As part of the MCL development process, the Office of Environmental Health Hazard Assessment (OEHHA) published a final public health goal (PHG) for perchlorate of 6 ug/L in March 2004. DHS is using the PHG in development of the MCL, which is expected in mid to late 2006.

California Arsenic Regulation

California Senate Bill 463 was passed on October 9, 2001. This Bill required development of a revised arsenic standard for drinking water in California by June 30, 2004 but was delayed due to the change in the governor's administration. The OEHHA has developed a PHG for arsenic of 4 ng/L. This is well below the current MCL of 10 ug/L. DHS is now working on development of a revised MCL using this information, which is expected in mid to late 2006.

California Hexavalent Chromium Regulation

Senate Bill 541 was passed on October 9, 2001. This Bill required development of a new hexavalent chromium standard for drinking water in California by January 1, 2004, but development of the new standard was delayed due to the

² California Adoption of Federal Rule May be More Stringent

change in the governor's administration. The Office of Environmental Health Hazard Assessment (OEHHA) originally published a PHG of 0.2 ug/L. Then OEHHA published a regulatory advisory stating there was no basis for concluding that orally ingested hexavalent chromium is a carcinogen and repealed the PHG. The OEHHA also suggested that the current MCL of 50 ug/L is adequate. OEHHA was supposed to final a PHG in 2003, which is now expected sometime in 2006. DHS plans to develop a MCL for hexavalent chromium shortly after a final PHG is set.

Drinking Water Candidate Contaminant List/ Unregulated Contaminant Monitoring Rule 2

The 1996 Amendments provided a list of chemical and microbial contaminants for possible future regulation. Every five years the USEPA is required to update the list, select at least five constituents for evaluation, and determine to regulate. The regulations will be determined based on risk assessment and cost-benefit considerations and on minimizing overall risk.

The USEPA selected constituents to evaluate as part of the first listing in 1998 and determined in 2003 not to regulate any of those selected. The USEPA has opted to use the remaining constituents from the first listing as the second list for evaluation. From this list of 51 constituents, 42 chemical and 9 microbial, the USEPA will select at least five to determine to regulate, expected to begin in 2006.

Once a contaminant is determined to need regulation, the standard shall be promulgated within 18 months of the determination. The regulations will be determined based on risk assessment and cost-benefit considerations and on minimizing overall risk. Regulations must be based on best available, peer-reviewed science and data from best available methods. The standard will take effect three years later. For each new regulation, the USEPA is required to identify affordable technologies that will achieve compliance for small systems.

The Unregulated Contaminant Monitoring Rule 2 (UCMR2) requires CWSs to conduct "treated" water monitoring of specified unregulated constituents. The purpose is to assist the USEPA to collect information about contaminants present in drinking water supplies that are currently unregulated. In agreement with the Candidate Contaminant List, the draft UCMR2, was published in 2005. The rule is expected to be finalized in 2006. The rule requires monitoring for three lists, with only larger systems and selected smaller systems monitoring for lists 2 and 3.

List 1 - 11 constituents, three methods, sampling will be scheduled by either USEPA or DHS, conducted sometime between 7/2007 and 6/2010, surface water quarterly for one year, groundwater semi-annual for one year, sampled at entry point to distribution system only.

- List 2 15 constituents, three methods, sampling will be scheduled by either USEPA or DHS, conducted sometime between 7/2007 and 6/2009, surface water quarterly for one year, groundwater semi-annual for one year, sampled at entry point to distribution system for all constituents and also at distribution system maximum residence time for the six nitrosamines (all under one method).
- A List 3 of newer constituents is possible at a later date for 200 selected "vulnerable" systems. If this happens would be scheduled for 2010-2011.

Distribution System Rule/Revised Total Coliform Rule

The USEPA conducted a review of 69 existing drinking water regulations in April 2002. The USEPA determined only the Total Coliform Rule (TCR) was a candidate for revision. The USEPA has developed nine white papers on the most critical subjects including:

- Cross connection control
- Aging infrastructure and corrosion
- · Permeation and leaching
- Nitrification
- Biofilms/Growths
- Covered storage
- · Decay in water quality over time
- New/Repaired Water Mains

EPA, along with AWWA, has prepared a series of ten TCR issue papers. EPA will use the papers as information sources for discussions of distribution system water quality issues with the drinking water community, experts and stakeholders. The papers are:

- Distribution System Indicators of Water Quality
- The Effectiveness of Disinfectant Residuals in the Distribution System
- Analysis of Compliance and Characterization of Violations of the Total Coliform Rule
- Evaluating HACCP Strategies for Distribution System Monitoring, Hazard Assessment and Control
- Inorganic Contaminant Accumulation in Distribution Systems
- Distribution System Inventory and Condition Assessment
- Optimization of Distribution System Monitoring Strategies
- Effect of Treatment on Nutrient Availability
- Causes of Total Coliform Positive Samples and Contamination Events in Distribution Systems
- Total Coliform Sample Invalidation

The USEPA plans to publish a revised TCR by 2006 or 2007 and a final rule by 2008.

ATTACHMENT 1

Classification	Contaminant	Regulation	MCL (mg/L)
norganics (Section 6	54432)		
	Aluminum	DHS	1
	Antimony	Phase V	0.006
	Arsenic	NPDWR	0.01
	Barium	DHS	1
	Beryllium Cadmium	Phase V Phase II	0.004 0.005
	Chromium	DHS	0.005
		LCR	1.3 1,2
	Copper Cyanide	Phase V	0.15
	Fluoride	DHS	2
		LCR	0.015 1,2
	Lead Mercury	Phase II	0.013
	Nickel Selenium	Phase V Phase II	0.1 3
	Thalium	Phase II Phase V	0.05 0.002
	Hanun	i nase v	0.002
litrate, Nitrite (Secti	on 64432.1)		
	Nitrate	Phase II	10 as N (45 as NO3)
	Nitrite	Phase II	1 as N
	Nitrate + Nitrite	Phase II	10 (sum as N)
Asbestos (Section 64	432.2)		
isbesios (Section 04	Asbestos	Phase II	7 MFL (>10um)
			, (, ,
econdary Standards	(Section 64449, Table 64449-A)		
	Aluminum	DHS	0.2
	Color	DHS	15 Units
	Copper	DHS	1
	Corrosivity	DHS DHS	non-corrosive 0.5
	Foaming Agents Iron	DHS	0.3
	Manganese	DHS	0.05
	Methyl-tert-butyl-ether (MTBE)	DHS	0.005
	Odor-Threshold	DHS	3 Units
	Silver	DHS	0.1
	Thiobencarb	DHS	0.001
	Turbidity	DHS	1 NTU
	Zinc	DHS	5
	(C+: C4440 T-h1- C4440 D)		
econdary Standards	(Section 64449, Table 64449-B)	DYYG	50011 00011 500 4
	Total Dissolved Solids	DHS	500/1,000/1,500 4
	Specific Conductance	DHS	900/1,600/2,200 4
	Chloride	DHS	250/500/600 4
	Sulfate	DHS	250/500/600 4
General Mineral (Sec			
	Bicarbonate	DHS	MO
	Carbonate	DHS	MO
	Hydroxide	DHS DHS	MO MO
	Alkalinity pH	DHS	MO
	Calcium	DHS	MO
	Magnesium	DHS	MO
	Sodium	DHS	MO
	Hardness	DHS	MO
Volatile) Organic C	hemicals (Section 64444, Table 64444-A (a))		
	Benzene	DHS	0.001
	Carbon Tetrachloride	DHS	0.0005
	o-Dichlorobenzene	Phase II	0.6
	p-Dichlorobenzene	DHS	0.005
	1,1-Dichloroethane 1,2-Dichloroethane	DHS	0.005
	1,1-Dichloroethylene	DHS DHS	0.0005 0.006
	cis-1,2-Dichloroethylene	DHS	0.006
	trans-1,2-Dichloroethylene	DHS	0.00
	Dichloromethane (Methylene chloride)	Phase V	0.005
	1,2-Dichloropropane	Phase II	0.005
	1,3-Dichloropropene	DHS	0.0005
	Ethylbenzene	Phase II	0.3
	Methyl-tert-butyl ether (MTBE)	DHS	0.013
	Monochlorobenzene	DHS	0.07
	Styrene	Phase II	0.1
	1,1,2,2-Tetrachloroethane	DHS	0.001
	Tetrachloroethylene	Phase II	0.005
	Toluene 1,2,4-Trichlorobenzene	DHS Phase V	0.15 0.005
	1,2,4-1 richlorobenzene 1,1,1-Trichloroethane	Phase V Phase I	0.005
	1,1,2-Trichloroethane	Phase V	0.2
	Trichloroethylene	Phase I	0.005
	Trichlorofluoromethane	DHS	0.15
	THEMOTORIUM		
	1,1,2-Trichloro-1,2,2-Triflouroethane	DHS	1.2

	Contaminant Xylenes (total)	Regulation DHS	MCL (mg/L) 1.75
			1.70
(Non-Volatile Synthe	etic) Organic Chemicals (Section 64444, Table Acrylamide	64444-A (b)) Phase II	TT (PAP)
	Alachlor	Phase II Phase II	0.002
	Atrazine	Phase II	0.002
	Bentazon	DHS	0.018
	Benzo(a)pyrene	Phase V	0.0002
	Carbofuran	DHS	0.018
	Chlordane	DHS	0.0001
	2,4,-D Dalapon	Phase II Phase V	0.07 0.2
	Dibromochloropropane	Phase II	0.0002
	Di (2-ethylhexyl) Adipate	Phase V	0.4
	Di (2-ethylhexyl) Phthalate	DHS	0.004
	Dinoseb	Phase V	0.007
	Diquat	Phase V	0.02
	Endothall Endrin	Phase V Phase V	0.1 0.002
	Epichlorohydrin	Phase II	TT (PAP)
	Ethylene Dibromide	Phase II	0.00005
	Glyphosate	Phase V	0.7
	Heptachlor	DHS	0.00001
	Heptachlor Epoxide	DHS	0.00001
	Hexachlorobenzene	Phase V	0.001
	Hexachlorocyclopentadiene	Phase V	0.05
	Lindane Mathoxychlor	Phase II Phase II	0.0002
	Methoxychlor Molinate	Phase II DHS	0.03 0.02
	Oxamyl	Phase V	0.02
	Pentachlorophenol	Phase II	0.001
	Picloram	Phase V	0.5
	PCBs	Phase II	0.0005
	Simazine	Phase V	0.004
	Thiobencarb	DHS	0.07
	Toxaphene	Phase II	0.003
	2,3,7,8-TCDD (Dioxin) 2,4,5-TP (Silvex)	Phase V Phase II	3.00E-08 0.05
	2,4,5-11 (SHVCX)	Thase II	0.03
Inregulated (Volatile	e) Organic Chemicals (Section 64450, Table 64	1450-A)	
	Dichlorodifluoromethane	DHS	1.0 1
	1,2,3-Trichloropropane	DHS	0.000005^{-1}
	Ethyl-tert-butyl-ether (ETBE)	DHS	MO (if vulnerable)
	tert-Amyl-methyl ether (TAME)	DHS	MO (if vulnerable)
	Perchlorate	DHS	0.006 1
	Boron	DHS	1.0 1
	Hexavalent Chromium	DHS	MO (if vulnerable)
	tert-Butyl alcohol	DHS	0.012 1
	Vanadium	DHS	0.05 1
Additional Organics	with Current Action Levels		Current Action Levels
Additional Organics	n-butylbenzene	DHS	0.26
	sec-butylbenzene	DHS	
			0.26
	tert-butylbenzene	DHS	0.26 0.26
	Carbon disulfide	DHS DHS	
	Carbon disulfide Chlorate	DHS DHS	0.26 0.16 0.8
	Carbon disulfide Chlorate 2-chlorotoluene	DHS DHS DHS	0.26 0.16 0.8 0.14
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene	DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane	DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol	DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde	DHS DHS DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol	DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene	DHS DHS DHS DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Istrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.266 0.33 0.33 Archived Action Levels 0.007 0.000002
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03
udditional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.266 0.33 0.33 Archived Action Levels 0.007 0.000002
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000015
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chlorpropham (CIPC)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056 1.2
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chloproppham (CIPC) 1,3-Dichlorobenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.7 0.056 1.2 0.6
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chlorpropham (CIPC)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056 1.2

Classification	Contaminant	Regulation	MCL (mg/L)
	Dimethoate	DHS	0.001
	Diphenamide	DHS	0.2
	Ethion	DHS	0.004
	Malathion	DHS	0.16
	Metam sodium	DHS	0.02
	Methylisothiocyanate	DHS	0.05
	Methyl parathion	DHS	0.002
	Parathion	DHS	0.04
	Pentachloronitrobenzene	DHS	0.02
	Phenol	DHS	4.2
	Trithion	DHS	0.007
	2,3,5,6-tetrachloroterephthalate	DHS	3.5
Natural Radioactivity	(Section 64441)		
ruturur Rudioactivity	Gross Alpha Particle Activity	NPDWR	15 pCi/L
	Combined Radium 226 & 228	NPDWR	5 pCi/L
	Uranium	DHS	20 pCi/L
Man-Made Radioacti	vity (Section 64442)		
ivian-iviaue Rauioacii	Tritium	DHS	20,000 pCi/L
	Strontium-90	DHS	
			8 pCi/L
	Gross Beta Particle Activity	NPDWR	50 pCi/L
Disinfection By-Prod			
	Total Trihalomethanes (Chloroform,		
	Bromoform, Chlorodibromomethane,	Stage 1 D/DBP	
	Bromodichloromethane)	Rule	0.08
	Haloacetic Acids 5 (Mono, di, and tri-		
	chloroacetic acid, mono and di-bromoacetic	Stage 1 D/DBP	
	acid)	Rule	0.06
		Stage 1 D/DBP	
	Chlorite	Rule	1
		Stage 1 D/DBP	
	Bromate	Rule	0.01
Disinfection By-Prod	luct Precursors		
		Stage 1 D/DBP	
	Total Organic Carbon	Rule	TT (% Removal)
	-		
Disinfectants		Stage 1 D/DBP	
	Chlorine (as Cl2)	Rule	4 5
	emornie (as el2)	Stage 1 D/DBP	•
	Chloramines (as Cl2)	Rule	45
	emoranines (as e12)	Stage 1 D/DBP	-
	Chlorine Dioxide (as ClO2)	Rule	0.8 5
Microbial	Ciandia Lamblia	CWTD	TT(2 log Raduation)
	Giardia Lamblia	SWTR	TT(3-log Reduction)
	Legionella Viruses	SWTR	TT(4 I P - fortion)
		SWTR	TT(4-Log Reduction)
	Disinfectant Residual	SWTR	TT(detectable)
	Fecal Coliform	TCR	TT (positive sample)
	E. Coli	TCR	TT (positive sample)
			TT(<5% mo. samples pos., if
	Total Coliform	TCR	>40 samples per month)
	Turbidity	IESWTR IESWTR	TT (<0.3 in 95% CFE samples <1 in 100% CFE) TT(2-log Reduction)

^{1 -} Action Level

Acronyms:

USEPA - United States Environmental Protection Agency

DHS - California Department of Health Services

MCL - Maximum Contaminant Level

NPDWR - National Primary Drinking Water Regulation LCR - Lead and Copper Rule MO - Monitored Only

TT - Treatment Technology PAP - Polymer Addition Practices

D/DBP - Disinfectants and Disinfection By-Products

SWTR - Surface Water Treatment Rule

TCR - Total Coliform Rule

IESWTR - Interim Enhanced Surface Water Treatment Rule CFE - Combined Filter Effluent

 $^{^{\}rm 2}$ - Based on 90th Percentile of Tap Water Samples

³ - DHS MCL lower than EPA, EPA remanded in 1995

⁴ - Recommended/Upper/Short Term MCLs

⁵ - Maximum Residual Disinfectant Level (MRDL)

Classification	Contaminant	Regulation	MCL (mg/L)
norganics (Section 6	54432)		
	Aluminum	DHS	1
	Antimony	Phase V	0.006
	Arsenic	NPDWR	0.01
	Barium	DHS	1
	Beryllium Cadmium	Phase V Phase II	0.004 0.005
	Chromium	DHS	0.005
		LCR	1.3 1,2
	Copper Cyanide	Phase V	0.15
	Fluoride	DHS	2
		LCR	0.015 1,2
	Lead Mercury	Phase II	0.013
	Nickel Selenium	Phase V Phase II	0.1 3
	Thalium	Phase II Phase V	0.05 0.002
	Hanun	i nase v	0.002
litrate, Nitrite (Secti	on 64432.1)		
	Nitrate	Phase II	10 as N (45 as NO3)
	Nitrite	Phase II	1 as N
	Nitrate + Nitrite	Phase II	10 (sum as N)
Asbestos (Section 64	432.2)		
isbesios (Section 04	Asbestos	Phase II	7 MFL (>10um)
			, (, ,
econdary Standards	(Section 64449, Table 64449-A)		
	Aluminum	DHS	0.2
	Color	DHS	15 Units
	Copper	DHS	1
	Corrosivity	DHS DHS	non-corrosive 0.5
	Foaming Agents Iron	DHS	0.3
	Manganese	DHS	0.05
	Methyl-tert-butyl-ether (MTBE)	DHS	0.005
	Odor-Threshold	DHS	3 Units
	Silver	DHS	0.1
	Thiobencarb	DHS	0.001
	Turbidity	DHS	1 NTU
	Zinc	DHS	5
	(C+: C4440 T-h1- C4440 D)		
econdary Standards	(Section 64449, Table 64449-B)	DYYG	50011 00011 500 4
	Total Dissolved Solids	DHS	500/1,000/1,500 4
	Specific Conductance	DHS	900/1,600/2,200 4
	Chloride	DHS	250/500/600 4
	Sulfate	DHS	250/500/600 4
General Mineral (Sec			
	Bicarbonate	DHS	MO
	Carbonate	DHS	MO
	Hydroxide	DHS DHS	MO MO
	Alkalinity pH	DHS	MO
	Calcium	DHS	MO
	Magnesium	DHS	MO
	Sodium	DHS	MO
	Hardness	DHS	MO
Volatile) Organic C	hemicals (Section 64444, Table 64444-A (a))		
	Benzene	DHS	0.001
	Carbon Tetrachloride	DHS	0.0005
	o-Dichlorobenzene	Phase II	0.6
	p-Dichlorobenzene	DHS	0.005
	1,1-Dichloroethane 1,2-Dichloroethane	DHS	0.005
	1,1-Dichloroethylene	DHS DHS	0.0005 0.006
	cis-1,2-Dichloroethylene	DHS	0.006
	trans-1,2-Dichloroethylene	DHS	0.00
	Dichloromethane (Methylene chloride)	Phase V	0.005
	1,2-Dichloropropane	Phase II	0.005
	1,3-Dichloropropene	DHS	0.0005
	Ethylbenzene	Phase II	0.3
	Methyl-tert-butyl ether (MTBE)	DHS	0.013
	Monochlorobenzene	DHS	0.07
	Styrene	Phase II	0.1
	1,1,2,2-Tetrachloroethane	DHS	0.001
	Tetrachloroethylene	Phase II	0.005
	Toluene 1,2,4-Trichlorobenzene	DHS Phase V	0.15 0.005
	1,2,4-1 richlorobenzene 1,1,1-Trichloroethane	Phase V Phase I	0.005
	1,1,2-Trichloroethane	Phase V	0.2
	Trichloroethylene	Phase I	0.005
	Trichlorofluoromethane	DHS	0.15
	THEMOTORIUM		
	1,1,2-Trichloro-1,2,2-Triflouroethane	DHS	1.2

	Contaminant Xylenes (total)	Regulation DHS	MCL (mg/L) 1.75
			1.70
(Non-Volatile Synthe	etic) Organic Chemicals (Section 64444, Table Acrylamide	64444-A (b)) Phase II	TT (PAP)
	Alachlor	Phase II Phase II	0.002
	Atrazine	Phase II	0.002
	Bentazon	DHS	0.018
	Benzo(a)pyrene	Phase V	0.0002
	Carbofuran	DHS	0.018
	Chlordane	DHS	0.0001
	2,4,-D Dalapon	Phase II Phase V	0.07 0.2
	Dibromochloropropane	Phase II	0.0002
	Di (2-ethylhexyl) Adipate	Phase V	0.4
	Di (2-ethylhexyl) Phthalate	DHS	0.004
	Dinoseb	Phase V	0.007
	Diquat	Phase V	0.02
	Endothall Endrin	Phase V Phase V	0.1 0.002
	Epichlorohydrin	Phase II	TT (PAP)
	Ethylene Dibromide	Phase II	0.00005
	Glyphosate	Phase V	0.7
	Heptachlor	DHS	0.00001
	Heptachlor Epoxide	DHS	0.00001
	Hexachlorobenzene	Phase V	0.001
	Hexachlorocyclopentadiene	Phase V	0.05
	Lindane Mathoxychlor	Phase II Phase II	0.0002
	Methoxychlor Molinate	Phase II DHS	0.03 0.02
	Oxamyl	Phase V	0.02
	Pentachlorophenol	Phase II	0.001
	Picloram	Phase V	0.5
	PCBs	Phase II	0.0005
	Simazine	Phase V	0.004
	Thiobencarb	DHS	0.07
	Toxaphene	Phase II	0.003
	2,3,7,8-TCDD (Dioxin) 2,4,5-TP (Silvex)	Phase V Phase II	3.00E-08 0.05
	2,4,5-11 (SHVCX)	i nase ii	0.03
Inregulated (Volatile	e) Organic Chemicals (Section 64450, Table 64	1450-A)	
	Dichlorodifluoromethane	DHS	1.0 1
	1,2,3-Trichloropropane	DHS	0.000005^{-1}
	Ethyl-tert-butyl-ether (ETBE)	DHS	MO (if vulnerable)
	tert-Amyl-methyl ether (TAME)	DHS	MO (if vulnerable)
	Perchlorate	DHS	0.006 1
	Boron	DHS	1.0 1
	Hexavalent Chromium	DHS	MO (if vulnerable)
	tert-Butyl alcohol	DHS	0.012 1
	Vanadium	DHS	0.05 1
Additional Organics	with Current Action Levels		Current Action Levels
Additional Organics	n-butylbenzene	DHS	0.26
	sec-butylbenzene	DHS	
			0.26
	tert-butylbenzene	DHS	0.26 0.26
	Carbon disulfide	DHS DHS	
	Carbon disulfide Chlorate	DHS DHS	0.26 0.16 0.8
	Carbon disulfide Chlorate 2-chlorotoluene	DHS DHS DHS	0.26 0.16 0.8 0.14
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene	DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane	DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol	DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde	DHS DHS DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol	DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene	DHS DHS DHS DHS DHS DHS DHS DHS DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Istrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33
	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.266 0.33 0.33 Archived Action Levels 0.007 0.000002
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03
udditional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.266 0.33 0.33 Archived Action Levels 0.007 0.000002
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000015
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chlorpropham (CIPC)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056 1.2
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chloproppham (CIPC) 1,3-Dichlorobenzene	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.7 0.056 1.2 0.6
Additional Organics	Carbon disulfide Chlorate 2-chlorotoluene 4-chlorotoluene 1,4-Dioxane Ethylene glycol Formaldehyde Isopropylbenzene Manganese Methyl isobutyl ketone (MIBK) Napthalene N-Nitrosodiethylamine (NDEA) N-Nitrosodimethylamine (NDMA) n-propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene with Archived Action Levels Aldicarb Aldrin Baygon a-Benzenehexachloride b-Benzenehexachloride Captan Carbaryl Chloropicrin Chlorpropham (CIPC)	DHS	0.26 0.16 0.8 0.14 0.14 0.003 14 0.1 0.77 0.5 0.12 0.017 0.00001 0.00001 0.26 0.33 0.33 Archived Action Levels 0.007 0.000002 0.03 0.000015 0.000025 0.0015 0.7 0.056 1.2

Classification	Contaminant	Regulation	MCL (mg/L)
	Dimethoate	DHS	0.001
	Diphenamide	DHS	0.2
	Ethion	DHS	0.004
	Malathion	DHS	0.16
	Metam sodium	DHS	0.02
	Methylisothiocyanate	DHS	0.05
	Methyl parathion	DHS	0.002
	Parathion	DHS	0.04
	Pentachloronitrobenzene	DHS	0.02
	Phenol	DHS	4.2
	Trithion	DHS	0.007
	2,3,5,6-tetrachloroterephthalate	DHS	3.5
N-41 D - 4:4::4-	(C-+i (AAA1)		
Natural Radioactivity		, mpum	15 017
	Gross Alpha Particle Activity	NPDWR	15 pCi/L
	Combined Radium 226 & 228	NPDWR	5 pCi/L
	Uranium	DHS	20 pCi/L
Man-Made Radioacti			
	Tritium	DHS	20,000 pCi/L
	Strontium-90	DHS	8 pCi/L
	Gross Beta Particle Activity	NPDWR	50 pCi/L
Disinfection By-Prod	hicts		
	Total Trihalomethanes (Chloroform,		
	Bromoform, Chlorodibromomethane,	Stage 1 D/DBP	
	Bromodichloromethane)	Rule	0.08
	Haloacetic Acids 5 (Mono, di, and tri-	Kuic	0.08
	chloroacetic acid, mono and di-bromoacetic	Store 1 D/DDD	
	acid)	Stage 1 D/DBP Rule	0.06
	aciu)		0.00
	CI 1 :	Stage 1 D/DBP	
	Chlorite	Rule	1
		Stage 1 D/DBP	
	Bromate	Rule	0.01
Disinfection By-Prod	luct Precursors		
		Stage 1 D/DBP	
	Total Organic Carbon	Rule	TT (% Removal)
Disinfectants			
		Stage 1 D/DBP	
	Chlorine (as Cl2)	Rule	4 5
		Stage 1 D/DBP	
	Chloramines (as Cl2)	Rule	4 5
		Stage 1 D/DBP	
	Chlorine Dioxide (as ClO2)	Rule	0.8 5
Microbial	Giardia Lamblia	SWTR	TT(3-log Reduction)
	Legionella Viruses	SWTR SWTR	TT
			TT(4-Log Reduction)
	Disinfectant Residual	SWTR	TT(detectable)
	Fecal Coliform	TCR	TT (positive sample)
	E. Coli	TCR	TT (positive sample)
			TT(<5% mo. samples pos., if
	Total Coliform	TCR	>40 samples per month)
	Total Coliform	TCR	>40 samples per month)
	Total Coliform Turbidity	TCR IESWTR	

^{1 -} Action Level

Acronyms:

USEPA - United States Environmental Protection Agency

DHS - California Department of Health Services

MCL - Maximum Contaminant Level

NPDWR - National Primary Drinking Water Regulation LCR - Lead and Copper Rule MO - Monitored Only

TT - Treatment Technology PAP - Polymer Addition Practices

D/DBP - Disinfectants and Disinfection By-Products

SWTR - Surface Water Treatment Rule

TCR - Total Coliform Rule

IESWTR - Interim Enhanced Surface Water Treatment Rule CFE - Combined Filter Effluent

 $^{^{\}rm 2}$ - Based on 90th Percentile of Tap Water Samples

³ - DHS MCL lower than EPA, EPA remanded in 1995

⁴ - Recommended/Upper/Short Term MCLs

⁵ - Maximum Residual Disinfectant Level (MRDL)