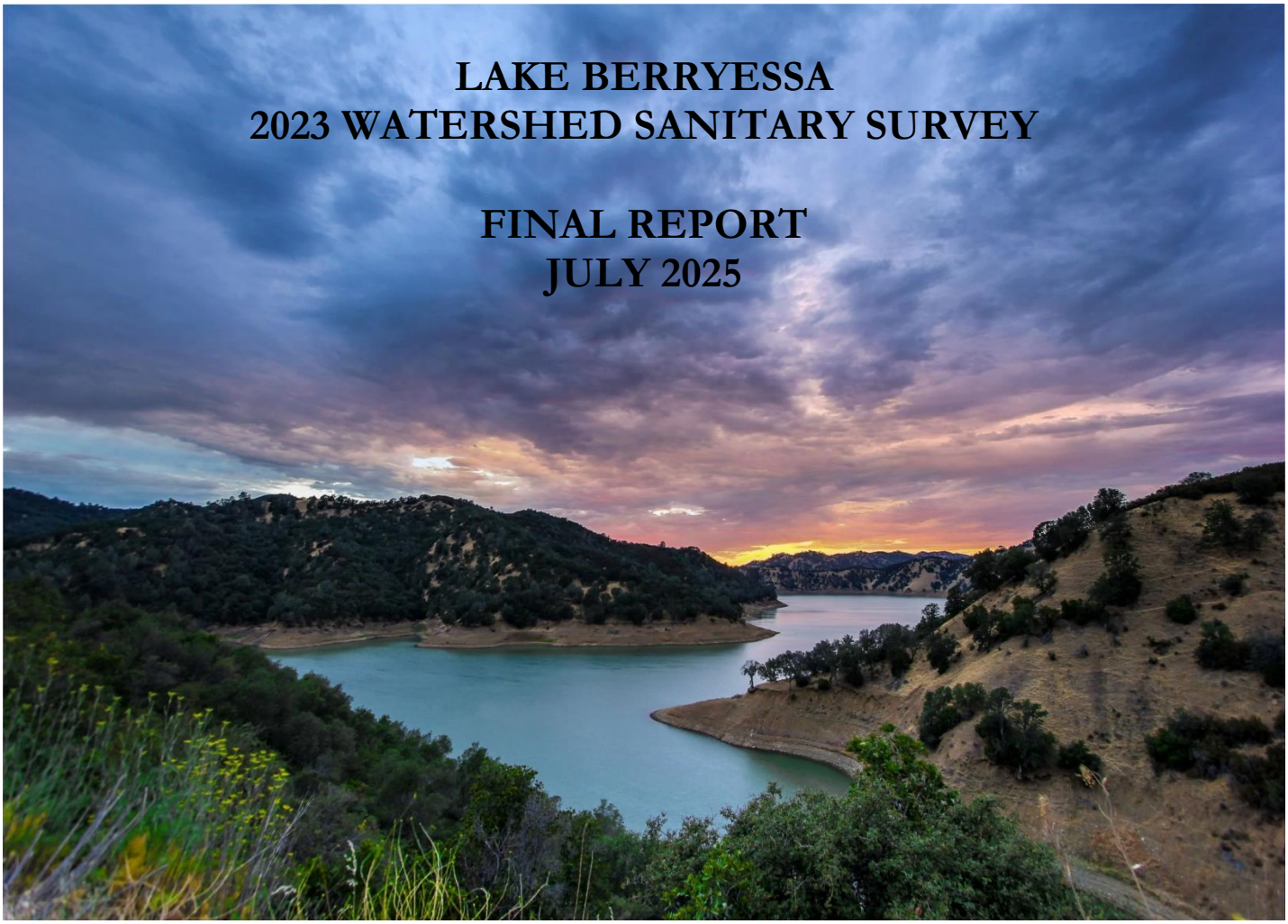
LAKE BERRYESSA
2023 WATERSHED SANITARY SURVEY

FINAL REPORT
JULY 2025



Prepared for
Napa County Flood Control Water Conservation District
and Solano County Water Agency

NAPA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
American Canyon • Calistoga • Napa
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SOLANO COUNTY WATER AGENCY

Lake Berryessa
2023 Watershed Sanitary Survey

FINAL REPORT
July 2025

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LIST OF ABBREVIATIONS

BMP – Best Management Practice
BOD – Biological Oxygen Demand

CAO – Cleanup and Abatement Order
CCR – Consumer Confidence Report
CDPH – California Department of Public Health
CIWQS – California Integrated Water Quality System
CUPA – Certified Unified Program Agency

D/DBP – Disinfectants/Disinfection By-Products
DBP – Disinfection By-Product
DDW – Division of Drinking Water

E. coli – *Escherichia coli*
ESA – Environmental Site Assessment

Gpd – gallons per day

HA – health advisory
HAA5 – Haloacetic Acids

IESWTR – Interim Enhanced Surface Water Treatment Rule
ILRP – Irrigated Lands Regulatory Program

LACOSAN – Lake County Sanitation District
LBRID – Lake Berryessa Resort Improvement District
LT1ESWTR – Long Term 1 Enhanced Surface Water Treatment Rule
LT2ESWTR – Long Term 2 Enhanced Surface Water Treatment Rule

MBR – membrane bioreactor package
MCL – maximum contaminant level
µg/L - Micrograms per Liter
mgd – Million Gallons per Day
mg/L – Milligrams per Liter
MPN/100 mL – Most Probable Number per 100 milliliters
MRTS – meridian range township section

NBRID – Napa Berryessa Resort Improvement District
ND – nondetectable
NOM – natural organic matter
NOV – notice of violation
NTU – Nephelometric Turbidity Unit

OES – California Office of Emergency Services

PACl – Polyaluminum Chlorhydate
PAMP – Principal Areas of Mine Pollution
PCAs – Potential Contaminating Activities

RCD – Resource Conservation District
Reclamation – US Bureau of Reclamation
Regional Board – Central Valley Regional Water Quality Control Board
RFP – Request for Proposal
RIMS – Response Information Management System
RV – Recreational Vehicle

SCADA - Systems Control and Data Acquisition
SCWA – Solano County Water Agency
SDWA – Safe Drinking Water Act
SEGEP – Southeast Geyers Effluent Pipeline
SEMS – Standardized Emergency Management System
SID – Solano Irrigation District
SOC – Synthetic Organic Compound
SSO – Sanitary Sewer Overflow
SVWQC – Sacramento Valley Water Quality Coalition
SWRCB – State Water Resources Control Board
SWTR – Surface Water Treatment Rule

TOC – Total Organic Carbon
TTHM – Total Trihalomethanes

USEPA – US Environmental Protection Agency
USGS – US Geological Survey
UST – Underground Storage Tank
UV – Ultra violet

VOC – volatile organic compound

WDR – Waste Discharge Requirements
WTP – Water Treatment Plant
WWTF- wastewater treatment facility
WWTP – wastewater treatment plant

INTRODUCTION

Watershed Sanitary Surveys were prepared on the Lake Berryessa watershed in 1993, 2001, 2013 and 2018. The 1993 Watershed Sanitary Survey was conducted for Solano County Water Agency (SCWA) and was focused on the Solano Project. Information was provided on contaminant sources in the Lake Berryessa watershed and the significance of the contaminant sources was assessed for the SCWA facilities downstream of Lake Berryessa. The 2001 Watershed Sanitary Survey Update contains a limited amount of information on the lake water systems.

The State Water Resources Control Board Department of Drinking Water (DDW) agreed that the 2013 Update could be a simplified report that focuses on the Lake Berryessa Resort Improvement District (LBRID) and the Napa Berryessa Resort Improvement District (NBRID) water systems and describes the changes in the watershed since the 2001 Update was prepared. This 2023 Update follows the same technical approach as undertaken for the 2013 and 2018 Update.

This report presents the findings of the Current Update to the Lake Berryessa Watershed Sanitary Survey. This study covers the period January 2018 through December 2022.

For assistance with abbreviations and acronyms, the reader is referred to the List of Abbreviations at the front of the report. A bibliography and list of contacts are provided in **Appendix A**.

OBJECTIVES OF THE UPDATE

A watershed sanitary survey focuses on the first barrier to contamination of the drinking water supply, namely source water protection. Evaluating source water quality and watershed contaminant sources provides key information to aid in understanding how to maintain and possibly improve the first barrier.

This Update is intended to accomplish the following objectives:

1) Fulfillment of the California Surface Water Treatment Rule (SWTR) and the Interim Enhanced Surface Water Treatment Rule (IESWTR) requirements that surface water agencies conduct a sanitary survey of the source watershed once every five years. Any significant changes within the last five years that affect source water quality are to be identified in each update. In addition, it is required to comment on the appropriate level of treatment for pathogens, specifically for *Giardia*, viruses, and *Cryptosporidium*.

2) Review and evaluation of selected constituents of interest to identify potential water quality or treatment issues for Lake Berryessa water users.

3) Review and evaluation of selected potential contaminating activities to identify impacts on source water quality. Determine whether it may be useful to conduct

additional monitoring to further assess contaminant levels in the source water or contaminants from a particular watershed source.

4) Identification of appropriate watershed management actions to protect and possibly improve source water quality. Development of recommendations for watershed management actions that are economically feasible and within the authority of the Napa County Flood Control and Water Conservation District and the SCWA to implement is critical.

CONSTITUENTS AND POTENTIAL CONTAMINATING ACTIVITIES COVERED IN THE CURRENT UPDATE

Several water quality constituents were selected for evaluation as part of the Current Update. **Table 1-1** presents a summary of the water quality constituents selected and the reason for selection.

Table 1-1
Water Quality Constituents Selected for Evaluation as Part of the Current Update

Constituent	Reason for Inclusion in Current Update
Turbidity	Turbidity is a measurement of suspended solids in water. Treated water turbidity levels are regulated in the SWTR and the IESWTR.
Total Coliform	Evaluation recommended under the SWTR to determine appropriate level of treatment for *Giardia* and viruses.
E. coli	*E. coli* is a more specific surrogate for fecal contamination and is used in the Long Term 2 Enhanced SWTR (LT2ESWTR) to determine the appropriate level of action for *Cryptosporidium*.
Total Organic Carbon	Total organic carbon (TOC) is a surrogate measure of disinfection by-products (DBP) precursor material in water. TOC levels in either source or treated water are used to determine treatment requirements in the Stage 1 Disinfectant/Disinfection By-Product Rule (D/DBP).
Cyanotoxins	These are of emerging concern and any available data is important to assemble.

Seven potential contaminating activities were selected for review as part of the Current Update: spills, recreation, agriculture, wastewater, leaking underground storage tanks, fires, and abandoned mines. Each of these activities can contribute at least one of the constituents identified in **Table 1-1** to the source water. These activities were selected based on their presence in the watershed, and were identified as key contaminating activities.

REPORT ORGANIZATION

Section 1 – Introduction

This section describes the objectives of the Current Update, lists the main constituents and potentially contaminating activities covered, and includes a description of the basic report organization.

Section 2 - The Watershed and Supply Systems

This section is largely descriptive and provides: (1) a brief overview of the hydrologic, and land use characteristics of the watershed, (2) a description of the existing water supply system, and (3) contains a watershed map delineating the watershed and land use in the watershed. For more detailed descriptive information on watershed characteristics, the reader is referred to the 1993 Watershed Sanitary Survey.

Section 3 – Source Water Quality Review

This section provides a review of the constituents of interest, including an explanation for their selection and a summary of the data obtained for the period of study for each constituent.

Section 4 – Watershed Contaminant Sources Review

This section describes pertinent characteristics of each of the seven potential contaminating activities that were reviewed as part of this Update. If applicable, each potential contaminating activity will include a discussion on background and occurrence, seasonal patterns, water quality issues and data review, regulation and management, and source water protection activities.

Section 5 – Key Findings and Recommendations

This section consists of a discussion of key findings, update on recommendations from the 2018 watershed sanitary survey and a list of current recommendations.

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SECTION 2 – WATERSHED AND WATER SUPPLY SYSTEMS

BACKGROUND

Lake Berryessa was created by the construction of the Monticello Dam in 1958. It 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.

Watershed Sanitary Surveys were prepared on the Lake Berryessa watershed in 1993, 2001, 2013 and 2018. The 1993 Watershed Sanitary Survey was conducted for Solano County Water Agency (SCWA) and was focused on the Solano Project. Information was provided on contaminant sources in the Lake Berryessa watershed and the significance of the contaminant sources was assessed for the SCWA facilities downstream of Lake Berryessa. The 2001 Watershed Sanitary Survey Update contains a limited amount of information on the lake water systems.

The State Water Resources Control Board Division of Drinking Water (DDW) agreed that the 2013 Update could be a simplified report that focuses on the Lake Berryessa Resort Improvement District (LBRID) and the Napa Berryessa Resort Improvement District (NBRID) water systems and describes the changes in the watershed since the 2001 Update was prepared. This 2023 Update follows the same technical approach as undertaken for the 2013 and 2018 Update.

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.

The Lake and Napa Berryessa Resort Improvement Districts (LBRID and NBRID or District's) are two separate Special Districts of the State of California located in Napa County on Putah Creek and Lake Berryessa respectively. Both Special Districts were formed under the Resort Improvement District Law created in 1961 and amended in 1971, and under this law, each District is allowed to provide water and sewer utility services to their respective communities. By Agreement with Napa County through its Board of Supervisors, the Napa County Public Works Department provides administrative and engineering services to each District for their water and sewer utility services. Public Works staff also administers agreements for LBRID and NBRID with third party consultants for services such as operations, maintenance, and others services that may be needed for their facilities. The Napa County Board of Supervisors also acts as each District's Board Directors through these Agreements.

WATERSHED DESCRIPTION

Land Use

The majority of the land use in the study watershed is shrub and forest. **Table 2-1** provides further information for the major land use categories, and **Figure 2-1** shows land use in the watershed. Major changes since 2018 were a decrease in Forest from 23.1% in 2018 to 6.8% in 2023, and an increase in Shrub from 66.5% in 2018 to 84.2% in 2023. This is due to the 2020 LNU Complex Fire. There are no incorporated cities in the watershed.

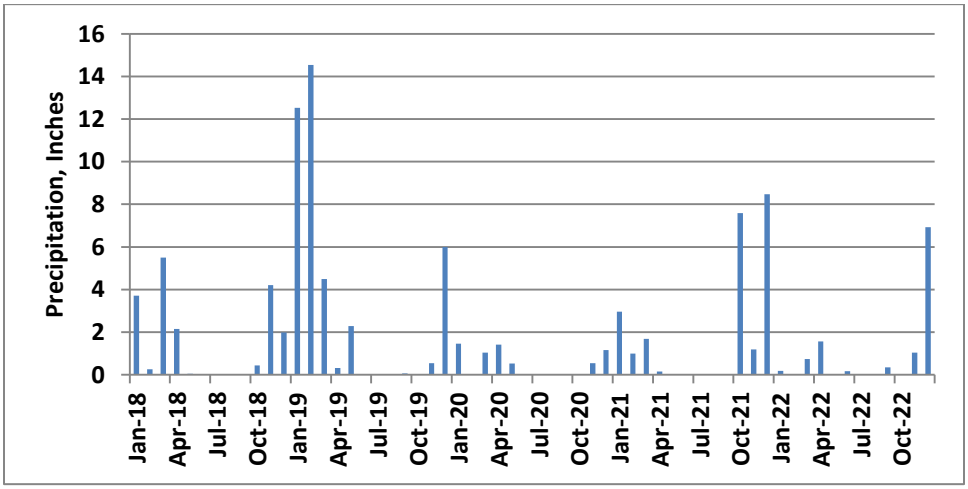
Table 2-1.
Land Use in the Lake Berryessa Watershed

Land Use	Percent of Watershed
Shrub	84.2%
Forest	6.8%
Other	5.8%
Developed, Open Space	1.6%
Agriculture	0.7%
Developed, low-high intensity	0.95%

Precipitation

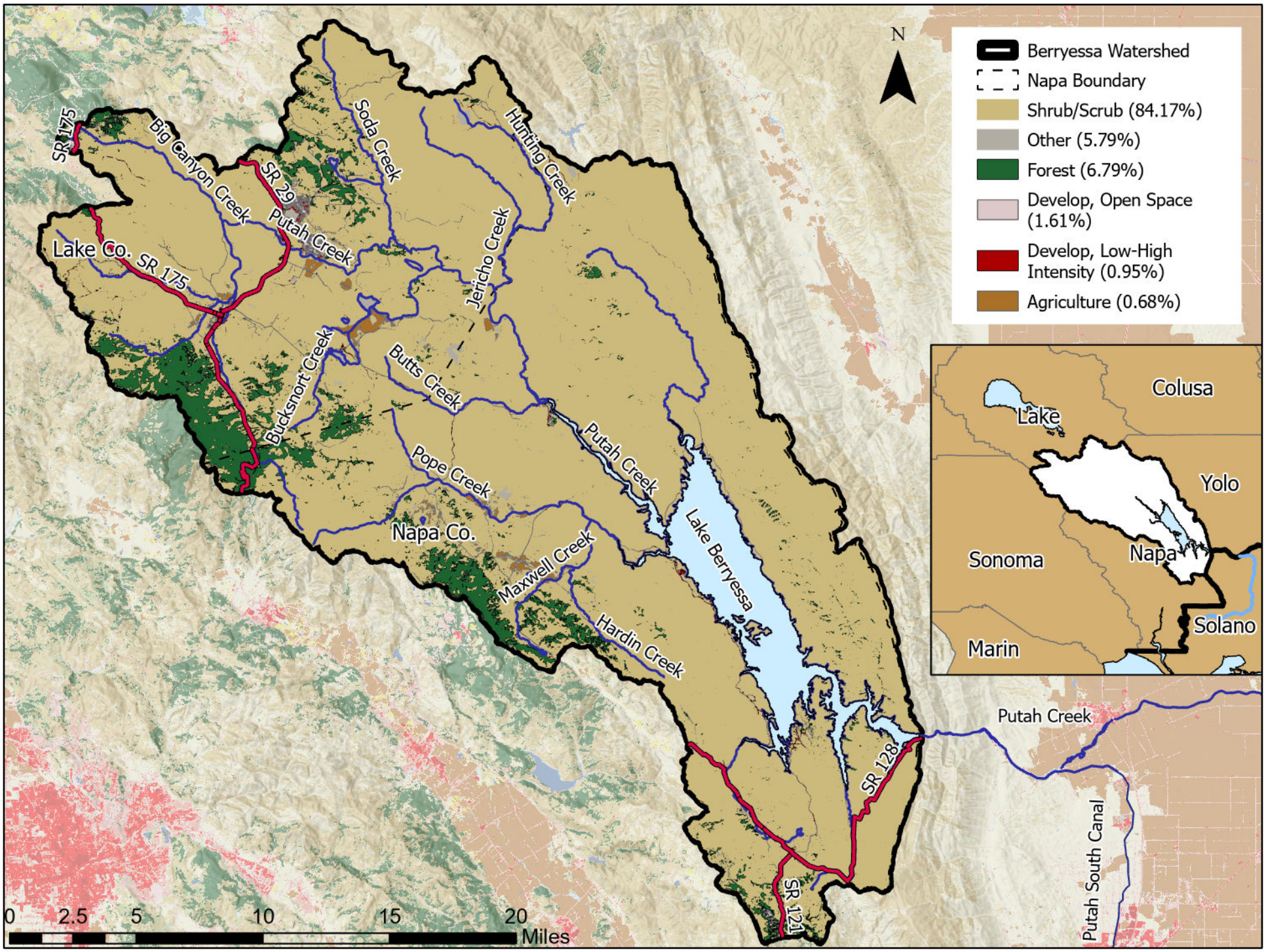
Figure 2-2 shows monthly precipitation totals from SCWA's rain gage at Spanish Flat from January 2018 to December 2022. The average annual rainfall over this five year period (by water year) was 18.9 inches. **Table 2-2** shows annual rainfall totals by water year.

Figure 2-2
Monthly Rainfall Totals at Spanish Flat, 2018-2022



Source: SCWA

Figure 2-1. Lake Berryessa Land Use-2023



Esri, NASA, NGA, USGS, County of Napa, Yolo County, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS

Table 2-2.
Annual Rainfall Totals at Spanish Flat Lake Berryessa
2018-2022

Water Year	Inches
2018	15.0
2019	40.8
2020	11.0
2021	7.5
2022	20.2

WATER TREATMENT PLANTS

There are a number of small water systems that rely on Lake Berryessa as a water source; however, this watershed sanitary survey only covers the two systems that are operated by the Napa County Department of Public Works through the service agreement described above. The LBRID and the NBRID service areas are shown in **Figure 2-3**. The water treatment plants (WTPs) and the systems served are described in this section.

Lake Berryessa also provides water to the SCWA and Solano Irrigation District (SID). The WTPs that receive water from SCWA and SID are described in the Watershed Sanitary Survey Update 2022 for Solano Project Below Monticello Dam. There are also other users which take water from Lake Berryessa, however, they are not covered in this report.

Lake Berryessa Resort Improvement District

The Community

LBRID serves an unincorporated community, Berryessa Estates, formed in 1965 and is located along Putah Creek in northeast Napa County. LBRID's municipal services are limited to providing public water and sewer services. Currently, LBRID provides water and sewer services for approximately 165 single-family residences. A complete build-out of vacant parcels potentially could result in 337 connections to the system; however, such growth is not presently anticipated in the near-term.

Water Supply and Treatment

LBRID's water supply is entirely drawn from Putah Creek and secured through an agreement with Napa County Flood Control and Water Conservation District. Raw water was originally taken from a slotted 14" steel intake pipe buried within the alluvium bed of Putah Creek. In 2014 pool levels in the creek declined to critically low yield prompting immediate action. The intake pipeline was re-designed –namely by increasing the depth of bury of the intake pipe and carrier line. Unfortunately, the drought of 2021 saw an even greater decline of pool levels than in 2014, and the raw

water intake once again required re-working and a project to extend and bury a new combination HDPE and steel intake pipe further into the creek alluvium which was completed in Fall 2022.

Currently, potassium permanganate is injected into the raw supply to oxidize metals and neutralize odorous compounds. New chemical storage, mixing and containment for batching granulated potassium permanganate was completed in June 2025. This project was called the Water Supply Intake Building Project. An existing pump motor VFD inverter was moved into a precast concrete structure that houses electrical and instrumentation for the intake facility.

After raw water transmission to the water plant site, approximately 1,000 feet from the intake diversion, primary coagulant (an aluminum chlorohydrate formulation under the trade name Pro Pac) is introduced upstream of a pre-sedimentation tank (installed in 2018) to promote the formation of filterable natural organic matter (NOM) and settle larger particulates along with flocculated solids. Muriatic acid is also injected to lower pH when raw water pH exceeds 8.0. Plant flow then enters into twin immersed ultrafiltration membrane trains manufactured by Zenon (now Veolia, Inc.). The Z-Box contains 12 membranes per train and is capable of providing 4-log removal of *Giardia* and *Cryptosporidium* and 3.5-log removal of viruses.

Inactivation of microbes not captured by membrane filtration is achieved through liquid chlorine (NaOCl) and contact time within a 7,500 gallon serpentine channeled contact basin before entering a buried 10,000 gallon clearwell tank. Finished water is then pumped from the clearwell into LBRID distribution system with high lift pumps. The water treatment facility is designed and permitted to process up to 200 gallons per minute (100 gpm each train), but not to exceed a daily capacity of 250,000 gallons or 0.77 acre-feet. The total plant production for 2023 was 10.8 million gallons, with maximum daily plant production for the 2023 calendar year registered at 81,000 gallons (August) as totalized by the finished water flow meter. Hence, there is over 150 percent surplus capacity to operate the facility under days of maximum water demand.

LBRID's water distribution system consists of three pressure zones to which the hydraulic grade line is established by atmospheric storage level.

In 2019, two of three original redwood potable water storage tanks were replaced with new bolted steel tanks of 178,000 and 110,000 gallons respectively. The booster pump stations for each tank site, that transfer water between the tank systems (1 through 3) were also rehabilitated/constructed. Standby generators for the two booster pump stations were installed in 2021. A project to replace the third and final existing redwood storage tank was funded in the fall of 2022 by the Drinking Water SRF program. The third tank was demolished and sequentially replaced by a bolted steel water storage tank in July 2024. The new tank has a capacity of 91,000 gallons.

Napa Berryessa Resort Improvement District

The Community

NBRID serves an unincorporated community, Berryessa Highlands, formed in 1965 and located on the south shore of Lake Berryessa. Municipal services of the District were limited in 1971 to providing public water and sewer services to the Berryessa Highlands and Oakridge Estates communities and the Steele Canyon Recreation Area, a currently limited development resort area currently managed by Napa County. Napa County is currently in negotiations with a prospective developer interested in planning a larger resort development for Steele Canyon.

In August 2020, the LNU Lightning Complex Fire burned through the community, destroying over 100 homes and damaging several others. As of January 2024, NBRID currently has 241 active water and sewer accounts for single-family residences, down from ~ 350 prior to the fire. Upon full build-out, the District will have as many as 562 connections to the water / sewer utilities.

Water Supply and Treatment

NBRID's sole source of water supply is pumped from two deep screened water intake(s) in Lake Berryessa placed at different depths to give withdrawal flexibility based on raw water quality analyses.

In 2013 the original Water Treatment Plant, commissioned in 1967, was replaced with a dual train Roberts Filter style package treatment plant with a total capacity of 504,000 gallons per day (gpd) – adequate to handle average and peak potable water demands.

Raw water is lifted from Lake Berryessa to the treatment plant building. Primary coagulant (an alum/cationic polymer blend formulation under the tradename 926, distributed by NTU Technologies, Inc.) is injected to the flow in header piping into flocculation tanks (installed 2017) to add time upstream of the packaged treatment units.

Inlet control valves regulating the amount of flow into the pair of clarifiers / filters and the majority of destabilized floc particles are retained by granular media contact clarifiers. After several hours of runtime, a clarifier is scrubbed with air and flushed of alum solids. Remaining clarifier headwater turbidity (less than 1 NTUs) is then captured by a dual media (anthracite and sand) filter bed. Filters can be programmed to run on time, turbidity, and headloss. Filter media is also air scoured, washed and then rinsed to waste. An in-ground tank (formerly sedimentation basin) stores the process backwash waste volume. As level rises in the tank water and suspended solids are pumped to the District's WWTF. Approximately 15 percent of the raw water pumped from Lake Berryessa is treatment process waste discharged into the sewer collection system. Filter media is annually cored and tested for foulant scale, microbes and gradation.

Inactivation of microbes of post-filtered water is achieved through liquid chlorine (NaOCl) and contact time within a 67,000 gallon bolted steel storage tank. Chlorinated

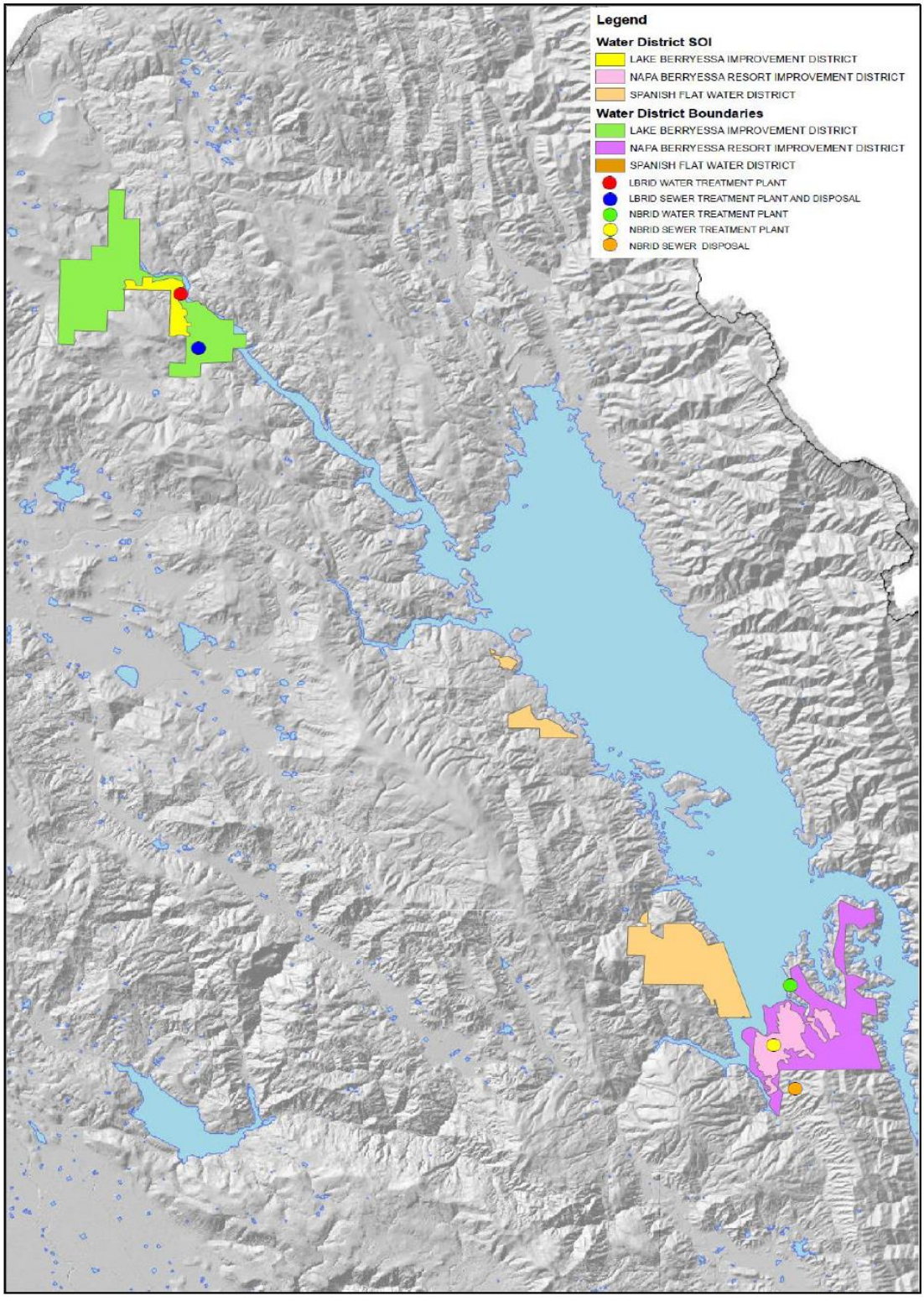
water is pumped from the tank into NBRID distribution system with 100 Hp high lift pumps. The total plant production for 2023 was approximate 16 million gallons, with maximum daily plant production for the 2023 calendar year registered at 214,100 gallons (October) as totalized by the finished water flow meter.

NBRID's water distribution system consists of seven pressure zones to which the hydraulic grade line is maintained by a 500,000 gallon atmospheric storage. Water storage acts to maintain adequate working pressure under peak day demand and provides fire protection in accordance with ISO needed fire flow guidelines. All customers in each pressure zone have dynamic pressure greater than the 20 psi regulatory standard. A tank bubbling system was installed to deter stratification and the formation of disinfection byproducts. Exterior coatings of the storage tank are chalked with spot delamination. A solar powered radio telemetry system communicates real-time level signal to the District's WWTF and WTP sites.

Future improvements to the WTP will include:

- Rehabilitation of the dual pump intake structure, including the addition of variable frequency drives for the pumping equipment and rehabilitating the electrical panels onsite.
- Backwash wastewater collection, treatment and disposal upgrades.
- Replacement or rehabilitation of the existing 500k gallon potable water tank.
- Addition of potable water storage for enhanced fire flow.
- Rehabilitation of the six pressure regulating stations in the distribution system.

Figure 2-3. LBRID and NBRID Water Service Areas



Source: Napa County Department of Public Works

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This section provides an overall review of the water quality data available for Lake Berryessa source water. The sources of raw water quality data include data from the Lake and Napa Berryessa Resort Improvement Districts (LBRID and NBRID or District's), as shown in **Table 3-1**. This section provides a review of the constituents of interest, including an explanation for their selection and a summary of the data obtained for the period of study, for each constituent. The period of study for this watershed sanitary survey is January 2018 through December 2022. The frequency of data collection varies by constituent.

Table 3-1
Summary of Water Quality Data Evaluated

Agency	Data Collected
Napa County Department of Public Works for Lake Berryessa Resort Improvement District WTP	Turbidity, coliforms, TOC
Napa County Department of Public Works for Napa Berryessa Resort Improvement District	Turbidity, coliforms, TOC
State Water Resources Control Board	Cyanotoxins

For assistance with abbreviations and acronyms, the reader is referred to the List of Abbreviations at the front of the Report.

SELECTED CONSTITUENT REVIEW

This section contains a general discussion of selected water quality constituents and the reasons why they were selected for further evaluation. The constituents selected for further review in this report include turbidity, microbial constituents, total organic carbon, and cyanotoxins. The constituents' general characteristics, seasonal and historical trends, and significance with respect to existing and potential future regulations are presented, along with data analysis and review.

Turbidity

General Characteristics and Background

Turbidity is the measurement of light scatter in water and provides a measure of the degradation of clarity in water. Clarity is typically degraded by suspended colloids and fine suspended solids such as clay, organic particulates, and microorganisms such as *Giardia* and *Cryptosporidium,* if present. Turbidity is measured to evaluate the efficiency of the treatment process at removing these particles and also to comply with regulatory requirements.

Turbidity was selected for further evaluation since most facilities optimize treatment processes to maximize turbidity removal in order to reduce the potential for pathogens, such as *Giardia* and *Cryptosporidium,* in treated drinking water. Turbidity is monitored throughout the treatment plant to ensure that particles are removed. Turbidity has been assumed to be an indicator constituent for the presence of *Giardia* and *Cryptosporidium*. However, turbidity alone may be a poor predictor of microbiological quality.

High turbidity levels in surface water sources are typically the result of erosion and sediment transport during precipitation and high flow events, and are undesirable because high turbidity may mask the presence of harmful particulates. The principal source of turbidity is general watershed runoff, and can also be contributed by other potential contaminating activities such as wildfires. It is common for turbidities to vary seasonally as a result of precipitation and flow.

Evaluation

Turbidity has been selected for evaluation not only because it is a regulated constituent, but also because it is commonly used as an indicator of general water quality and overall plant performance. **Table 3-2** provides a summary of raw water turbidity data using the monthly averages of the daily averages for the water treatment plants (WTPs).

Table 3-2. Turbidity Summary Table, 2018 to 2022

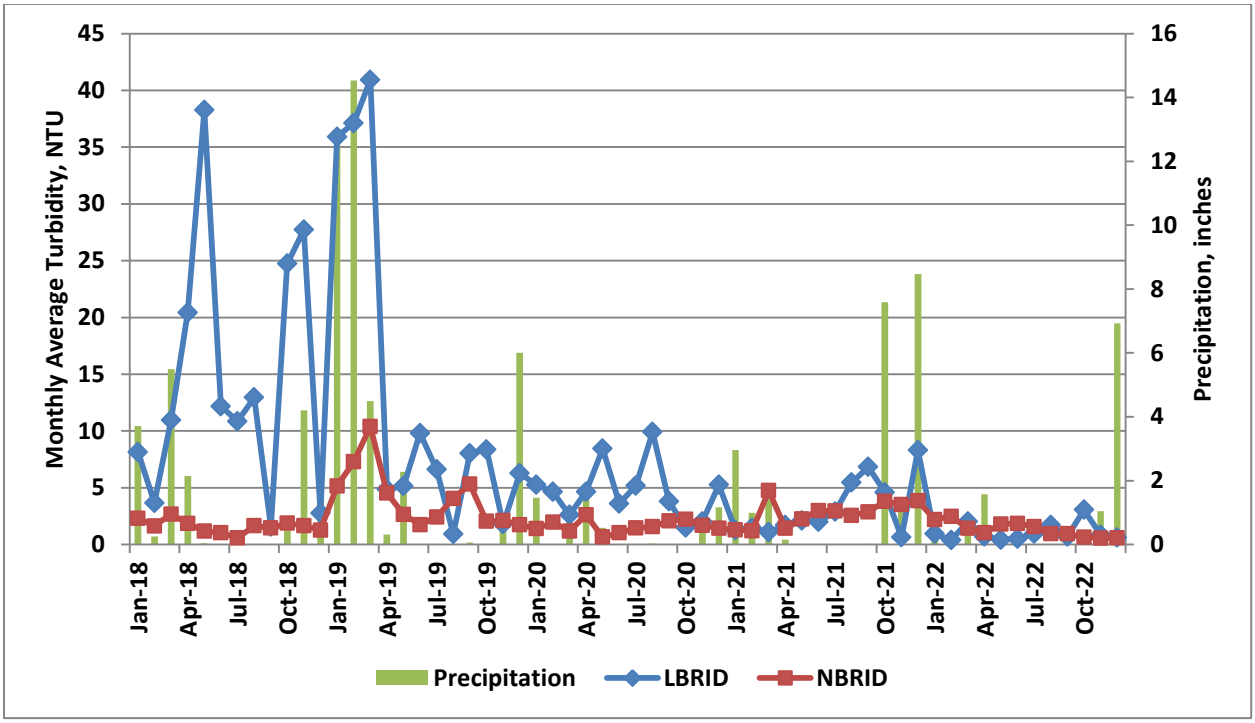
WTP	Range	Average	Median	90th
LBRID	0.4 – 40.9	7.5	4.2	20.8
NBRID	0.6 – 10.4	2.3	1.8	4.1

Figure 3-1 shows raw water turbidity over time for each of the WTPs. Both WTPs had elevated source water turbidities in March 2019, with daily turbidities reaching over 100 NTU at the Lake Berryessa Resort Improvement District (LBRID) and 20 to 70 NTU at the Napa Berryessa Resort Improvement District (NBRID) due to over 10 inches of precipitation in January and February 2019. Please note that these daily peaks do not show in **Figure 3-1** as the figure shows a monthly average of the daily averages.

As shown in **Figure 3-1**, LBRID WTP had higher source water turbidity compared to the NBRID WTP, particularly from March 2018 to March 2019. The monthly average source water turbidity from March 2018 to March 2019 was above 10 NTU for ten of the twelve months during this time period. The higher turbidities during this time period are most likely related to algal growth in Putah Creek. LBRID is more susceptible to changes in water quality as the influent to the LBRID comes from beneath the gravel bed of Putah Creek, versus a deep-screened intake from Lake Berryessa, which offers more buffering capacity for the NBRID. However, it should be noted that a new intake was installed for LBRID in the fall of 2022, which extended the intake pipe further into the creek alluvium. This should provide some natural filtration of the water prior to the

LRBID treatment processes. Monthly precipitation data was obtained from the Solano County Water Agency's (SCWA) rain gauge at Spanish Flat.

Figure 3-1. LBRID and NBRID WTP Influent Turbidity, NTU, 2018 to 2022



Summary of Results

- Median source water turbidity was 4.2 NTU for the LBRID WTP and 1.8 NTU for the NBRID WTP. There can be periods where levels exceed that substantially, up to 100 NTU and higher at the LBRID WTP and 20 to 70 NTU at the NBRID WTP. These excursions are associated with storm water runoff caused by intense winter storms, particularly evident in March 2019.
- LBRID is more susceptible to changes in water quality due to the diversion location in Putah Creek, versus lake withdrawal at NBRID. Due to the relocation of the LBRID intake pipe deeper into the creek alluvium in the fall of 2022, this should provide additional protection from fluctuation in creek water quality.

Microbial Constituents

General Characteristics and Background

The major microbiological constituents of concern include fecal coliform, *E. coli*, *Giardia lamblia*, and *Cryptosporidium parvum*. Generally speaking, pathogenic organisms carried by mammalian species may be infectious to humans although this depends on the species of microorganism. Pathogens infecting other types of animals, such as birds and reptiles, are usually not infectious to humans. However, some types of animals, such as birds, may be vectors for human pathogens. Each of these constituents was identified for further evaluation because they are currently regulated. The presence of these constituents in the raw water governs the overall treatment requirements for the water treatment plants, though detected pathogens and pathogen indicators may not be capable of infecting humans.

Fecal coliform and *E. coli* have been used to indicate the potential presence of pathogenic microorganisms in source waters. Although coliform levels do not correlate well with pathogenic microorganisms, they continue to be used as indicators due to the lack of affordable and reliable direct analytical methods for detecting pathogens. Potential sources of coliform bacteria in the Lake Berryessa watershed include general watershed runoff, sanitary sewer overflows, and recreation.

Giardia lamblia is a species of the protozoa genus *Giardia* that infects humans and can cause the gastrointestinal disease giardiasis. *Giardia* is found in the environment as a cyst from the feces of humans and animals; both wild and domestic animals may be hosts. Sources close to waterbodies have the most potential to introduce viable cysts to the source water. Cysts may be destroyed naturally in the environment by desiccation and/or heat. The cysts are effectively inactivated using chlorine disinfection. The detectability of *Giardia* has been greatly improved with USEPA Method 1623, which is better able to establish concentrations, but still does not determine viability. *Giardia* may be carried in urban runoff and wastewater sources or may be contributed directly as a result of body-contact recreation or animal defecation, including both wild and domestic animals.

Giardia lamblia is currently regulated by the Surface Water Treatment Rule (SWTR) and the Interim Enhanced Surface Water Treatment Rule (IESWTR). Under the Surface Water Treatment Rule (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. Surface water supplies must provide for 3-log reduction of *Giardia* through physical removal and chemical inactivation. Additional reduction may be required for impaired water supplies. The State Water Resources Control Board Division of Drinking Water (DDW) guidance provides that 3-log reduction is appropriate when monthly median levels of total coliform are less than 1,000 Most Probable Number per 100 milliliters (MPN/100 mL), fecal coliform or *E. coli* levels are less than 200 MPN/100 mL, or when directly measured confirmed *Giardia* levels are less than 0.01 cysts per liter.

Cryptosporidium parvum is a species of the protozoa genus *Cryptosporidium* that infects humans and can cause the gastrointestinal disease cryptosporidiosis. *Cryptosporidium* is found in the environment as an oocyst principally from the feces of domestic animals, although both wild and domestic animals are known to be hosts. Like *Giardia*, *Cryptosporidium* oocysts may be destroyed naturally in the environment by desiccation and/or heat. Once in the source water, however, viable oocysts are very resistant to traditional chemical inactivation using chlorine. Stronger disinfectants such as ozone or ultraviolet (UV) light are required to inactivate these pathogens. The detectability of *Cryptosporidium* has been greatly improved with USEPA Methods 1622 and 1623, which are able to establish true concentrations, but still do not determine viability. *Cryptosporidium* may be carried in urban runoff and wastewater sources or may be contributed directly as a result of body-contact recreation or animal defecation, including both wild and domestic animals.

Cryptosporidium is currently regulated through the IESWTR and the Long Term 1 ESWTR (LT1ESWTR), which require 2-log reduction, and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) which potentially requires additional log action based on source water monitoring results for *Cryptosporidium*. Under the IESWTR (applicable to public water systems serving at least 10,000 population) and LT1ESWTR (applicable to public water systems serving fewer than 10,000 population) well-operated conventional and direct water treatment plants are granted a 2-log removal credit for *Cryptosporidium* if they meet all treated water turbidity standards. The LT2ESWTR (applicable to all public water systems) further regulates *Cryptosporidium* and requires additional action (treatment or protection) if the source water quality is determined to be impaired based on the required direct *Cryptosporidium* monitoring of the source, if running annual average presumed levels are greater than 0.075 oocysts per liter.

Evaluations

Cryptosporidium

As a small system, both the NBRID and LBRID WTPs are allowed to sample for *E. coli* every two weeks for one year, in lieu of *Cryptosporidium* monitoring for compliance with the LT2ESWTR. *E. coli* data for the LBRID and NBRID WTPs were submitted and it was determined that the WTPs qualified for a Bin 1 classification. The second round of source water monitoring for LT2ESWTR was conducted from October 2017 through September 2018 and was classified again for Bin 1 classification.

E. coli

Table 3-3 provides a summary of *E. coli* data. **Figures 3-2** and **3-3** shows results for *E. coli* over the reporting period at LBRID and NBRID, respectively. To calculate the statistics in **Table 3-3**, it should be noted that non-detectable results were set to zero and results that were reported as greater than an upper limit were set at the upper limit. However, for the graphs, results that were reported as non-detectable were set at the reporting limit, as the log scale y-axis doesn't allow for zero values

Table 3-3. *E. coli* Summary Table, January 2018 to December 2022

WTP	Range	Average	Median	90th
LBRID	0 – >2419	53.6	5.2	62.3
NBRID	0 – 8.5	0.6	ND	2.0

Figure 3-2. LBRID WTP Influent *E. coli* January 2018 to December 2022

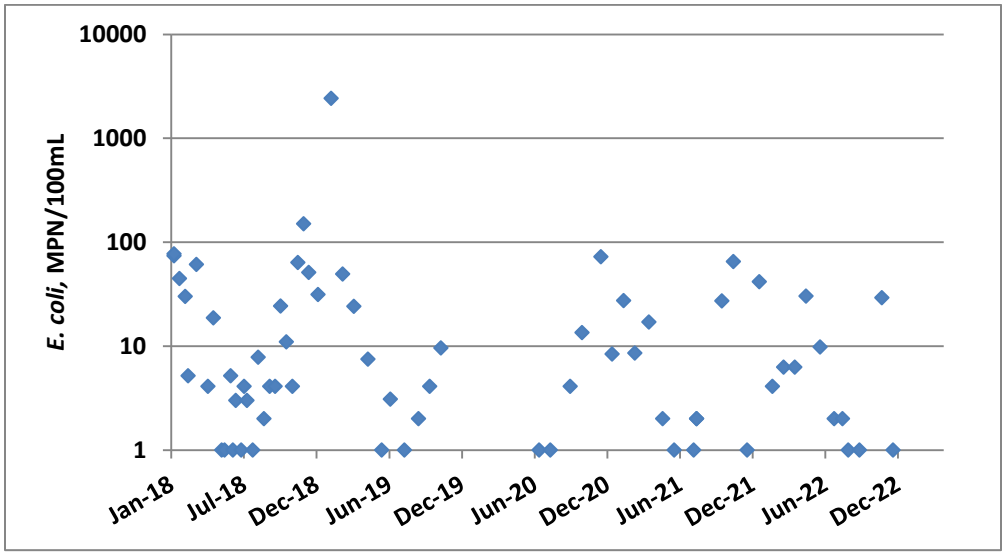
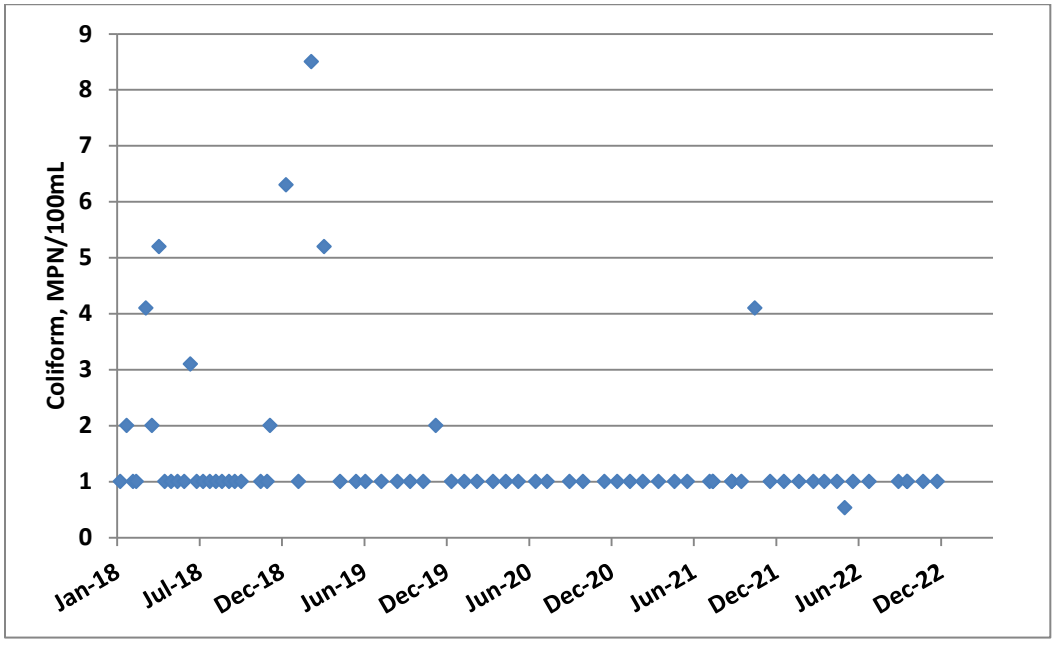


Figure 3-3. NBRID WTP Influent *E. coli* January 2018 December 2022



LBRID WTP

E. coli data were collected twice a month from January 2018 through December 2018, and then monthly from January 2019 to December 2022. *E. coli* densities ranged from ND to greater than 2,419 MPN/100mL, with an overall median of 5.2 MPN/100mL. There was only one individual *E. coli* sample which was greater than 1,000 MPN/100mL. It occurred in February 2019 and was greater than 2,419.6 MPN/100mL, elevated due to heavy precipitation. The drinking water permit for LBRID indicates that in the event that the *E. coli* level in the raw water exceeds 1,000 MPN/100mL, the water system shall notify the Department within 24-hours and increase *Giardia* disinfection activation by a minimum of 1-log. Napa County Dept. of Public Works verified that an additional log disinfection inactivation was achieved during this time. With the exception of the February 2019 sample, all other data indicate that 2-log *Cryptosporidium*, 3-log *Giardia,* and 4-log virus removal and inactivation is the appropriate level of treatment.

NBRID WTP

E. coli data were collected twice a month from January 2018 through December 2018, and then monthly from January 2019 to December 2022. *E. coli* densities ranged from ND to 8.5 MPN/100mL, with an overall median of ND. All *E. coli* individual values were well below the 200 MPN/100 mL threshold.

These data indicate that 2-log *Cryptosporidium*, 3-log *Giardia,* and 4-log virus removal and inactivation is the appropriate level of treatment. Overall, the NBRID WTP has lower *E. coli* levels than the LBRID WTP.

Total Coliform

Table 3-4 provides a summary of total coliform data. **Figures 3-4** and **3-5** shows results for total coliform data over the reporting period at LBRID and NBRID, respectively. It should be noted that results that were reported as non-detectable were set to zero and those results that were reported as greater than an upper limit were set at the upper limit.

Table 3-4. Total Coliform Summary Table, 2018 to 2022

WTP	Range	Average	Median	90th
LBRID	9.8 – > 2,419	1,342	1300	2,419
NBRID	1 – > 2,419	599	202	2,376

Figure 3-4. LBRID WTP Influent Total Coliform, 2018 to 2022

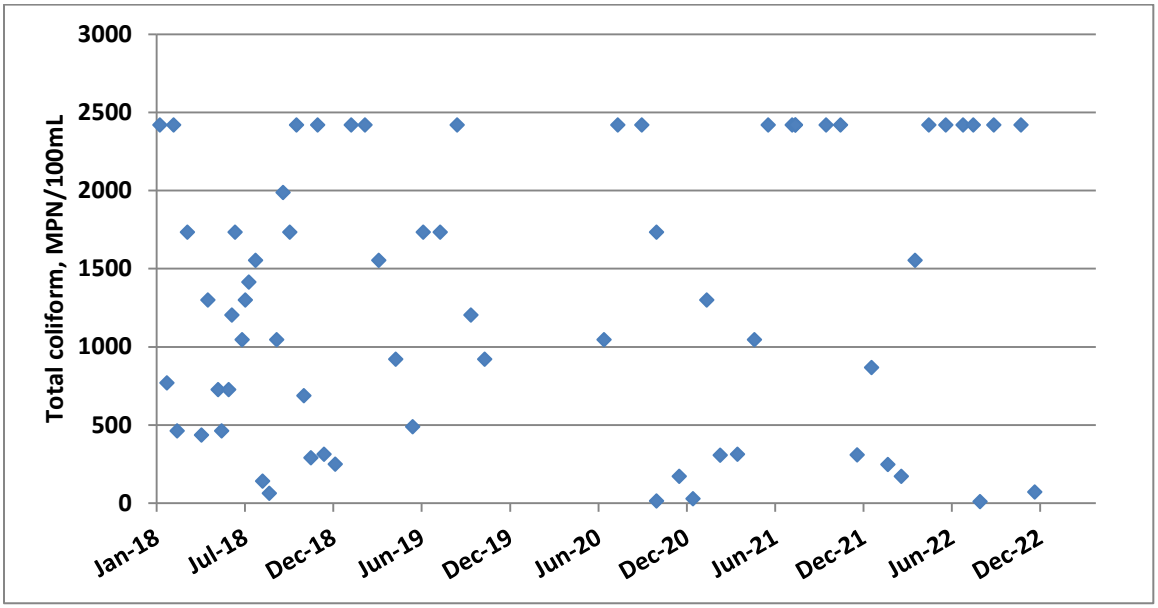
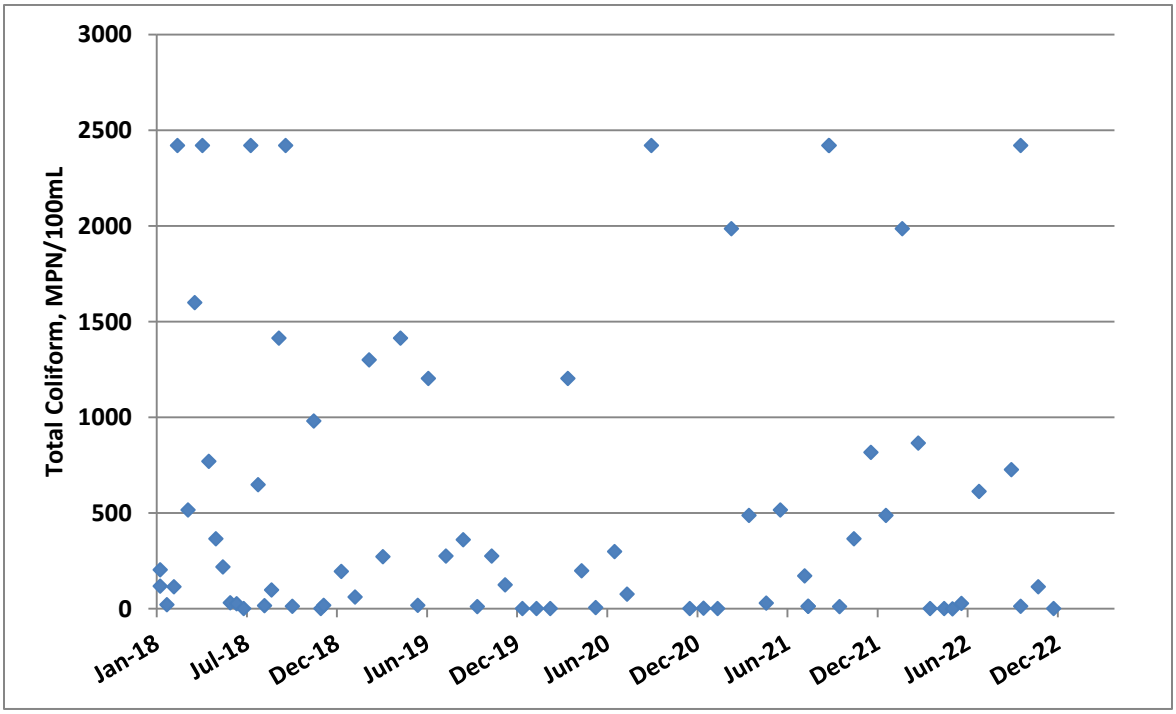


Figure 3-5. NBRID WTP Influent Total Coliform, 2018 to 2022



LBRID WTP

Total coliform were collected twice a month from January 2018 through December 2018, and then monthly from January 2019 to December 2022. Total coliform densities

ranged from 9.8 to greater than 2,419 MPN/100mL, with an overall median of 1300 MPN/100mL.

NBRID WTP

Total coliform were collected twice a month from January 2018 through December 2018, and then monthly from January 2019 to December 2022. Total coliform densities ranged from 1 to greater than 2,419 MPN/100mL, with an overall median of 202 MPN/100mL.

Overall, the NBRID WTP has lower total coliform levels than the LBRID WTP. It is unclear as to why total coliform levels are high in the summer/fall, but most likely due to algal blooms in both Putah Creek above LBRID WTP and Lake Berryessa. However, *E. coli* levels are very low, indicating no fecal contamination.

Summary of Results

- Source water *E. coli* levels are low, with medians at 5.2 MPN/100mL or less.
- Overall, the NBRID WTP has lower *E. coli* and total coliform levels than the LBRID WTP.
- Over the reporting period, all individual *E. coli* samples at the NBRID WTP were well below the 200 MPN/100 mL threshold.
- Over the reporting period, all individual *E. coli* samples at the LBRID WTP were below the 1,000 MPN/100 mL threshold, except for one sample in February 2019, which was greater than 2,419 MPN/100mL.
- Therefore, 2-log *Cryptosporidium*, 3-log *Giardia,* and 4-log virus removal and inactivation is the appropriate level of treatment for both WTPs.
- The second round of LT2ESTWR monitoring was completed in September 2018 and was a Bin 1 classification for LBRID and NBRID.

Total Organic Carbon

General Characteristics and Background

Disinfection By-Products (DBPs) are formed when disinfectants added to water react with naturally occurring organic matter or other constituents, such as bromide. The most common DBPs are total trihalomethanes (TTHMs), which are suspected carcinogens. Other DBPs, including haloacetic acids (HAA5), are suspected mutagens and teratogens. Potential sources of organic carbon are plant matter, animal matter, and soil, which can be contributed by general watershed runoff and fires.

The Stage 1 Disinfectants/Disinfection By-Products (D/DBP) Rule requires varying levels of total organic carbon (TOC) removal if the source water TOC concentrations exceed 2 milligrams per liter (mg/L) and a utility implements conventional filtration. TOC was a selected constituent for further evaluation due to its importance in the formation

of DBPs and also as a general indicator of organic contamination in water. All conventional water treatment plants have the ability to remove some TOC.

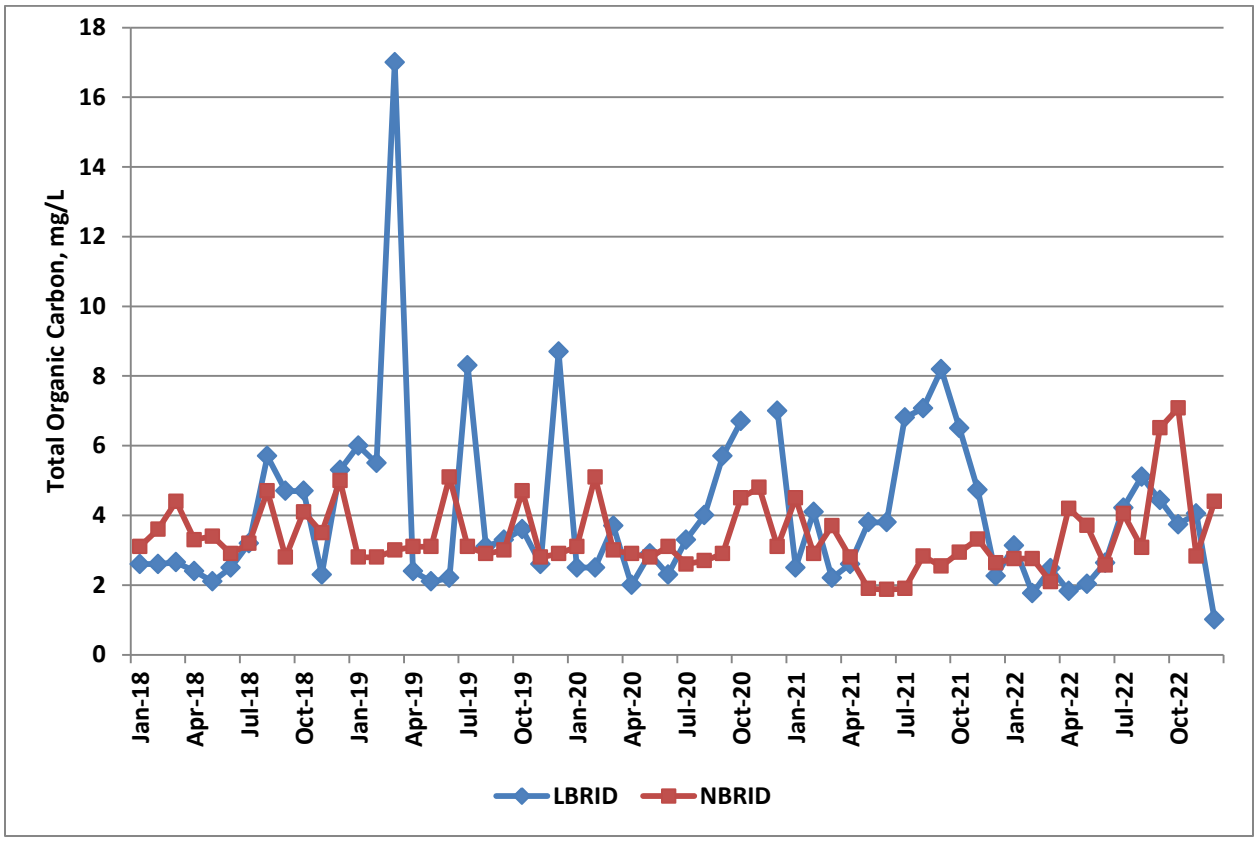
Evaluation

Table 3-5 shows the range, average, median and 90th percentile for TOC over the reporting period. Median TOC concentrations were 3.3 mg/L for LBRID and 3.1 mg/L for NBRID. As shown in **Figure 3-6,** the LBRID WTP experienced a very high TOC level of 17 mg/L in March 2019. This was likely attributed to over 10 inches of rainfall in the months of January and February 2019. TOC can also be elevated in the summer to early fall time period, particularly in dry years such as 2020 and 2021, due to algal blooms. Source water TOC concentrations at the NBRID WTP do not fluctuate as much compared to LBRID; the highest peak was 7.1 mg/L in October 2022.

Table 3-5. TOC Summary Table, 2018 to 2022

WTP	Range	Average	Median	90th
LBRID	1.0 - 17	4.1	3.3	6.8
NBRID	1.8 – 7.2	3.4	3.1	4.7

Figure 3-6. Raw Water TOC at NBRID AND LBRID Influent, 2018 to 2022



Enhanced coagulation is required for the WTPs that treat Lake Berryessa water because the source water TOC is routinely above 2 mg/L and they implement conventional treatment processes. Specifically, 93 percent of source water samples at the LBRID WTP were above 2 mg/L and 94 percent of the source water samples at the NBRID WTP were above 2 mg/L during the reporting period.

Summary of Results

- Median TOC concentrations were 3.3 mg/L for LBRID and 3.1 mg/L for NBRID.
- Source water TOC peak of 17 mg/Lin March 2019 at LBRID is likely attributed to heavy rainfall in both January and February 2019.
- TOC can also be elevated in the summer to early fall time period, particularly in dry years such as 2020 and 2021, due to algal blooms.
- Enhanced coagulation is required for the plants that treat Lake Berryessa water because the source water TOC is routinely above 2 mg/L and they implement conventional treatment processes.

Cyanotoxins

General Characteristics and Background

Freshwater cyanobacteria, or “blue-green algae” can produce cyanotoxins. It is important to note that experiencing a cyanobacteria bloom does not always result in a cyanotoxin problem in the water source. This is because multiple species of cyanobacteria can exist in a single bloom, and not all species are capable of producing cyanotoxins. Furthermore, even when toxin-producing cyanobacteria are present, they may not produce toxins. The conditions that cause cyanobacteria to produce cyanotoxins are not well understood. Both non-toxic and toxic strains of the most common toxin-producing cyanobacteria species exist, and it is impossible to tell if a strain is toxic or nontoxic by looking at it. Additionally, the occurrence of unpleasant tastes and odors are not a reliable sign of a toxin-producing bloom.

Cyanobacteria are photosynthetic bacteria that share some properties with algae and are found naturally in lakes, streams, ponds and other surface waters. Similar to algae, when conditions are favorable, cyanobacteria can rapidly multiply in surface water and cause blooms. A bloom may be dominated by a single species or composed of a variety of toxic and non-toxic producing species. It may take only three to ten days for the population of cyanobacteria to double. Conditions contributing to blooms include light intensity, total sunlight duration, nutrient availability (especially phosphorus), water clarity, water temperature, pH, precipitation events, water flow (whether water is calm or fast-flowing), and water column stability. Warm, slow moving waters that are rich in nutrients can lead to algal growth.

In June 2015 the USEPA established a 10-day health advisory (HA) level for microcystin at 0.3 µg/L for children younger than school age and 1.6 µg/L for all other age groups. A 10-day HA for cylindrospermopsin was also established at 0.7 µg/L for

children younger than school age and 3.0 µg/L for all other age groups. It should be noted that the HA levels for microcystin and cylindrospermopsin apply to finished or treated drinking water. Additionally, compliance with the HA levels are not based on a single sample, but calculated as a 10-day average.

Evaluation

The State Water Resources Control Board sampled four locations in Lake Berryessa on June 22, 2022. The four locations were 1) East of Markley Cove Marina, 2) Spanish Flat Campground, 3) Spanish Flat Day-Use Area, and 4) Oaks Day Use Area Acorn Beach. The samples were analyzed for Anatoxin-a and Microcystin using the ELISA method. All samples were nondetectable for both cyanotoxins.

All samples were also analyzed for toxic cyanobacteria; however, no cyanobacteria were observed. All samples contained low amounts of eukaryotic algae.

Summary of Results

- There is no routine monitoring for cyanotoxins in Lake Berryessa. The State Water Resources Control Board sampled four locations in June 2022. No cyanotoxins were detected.

SECTION 4 – WATERSHED CONTAMINANT SOURCES REVIEW

This section contains an evaluation of the seven potential contaminant sources selected for review for the current Update. Seven potential contaminating activities (PCAs) were selected for review as part of the current Update: (1) spills, (2) recreation, (3) agriculture, (4) wastewater, (5) leaking underground storage tanks, (6) fires, and (7) abandoned/inactive mines. These PCAs were selected based on their presence in the watershed and their potential to impact Putah Creek and Lake Berryessa water quality.

The 1993, 2001, and 2006 watershed sanitary surveys provide a comprehensive description of the watershed and potential contaminant sources along Putah Creek above Monticello Dam and Lake Berryessa. An agreement was reached with the State Water Resources Control Board Department of Drinking Water (DDW) that the 2013 Update would focus on a few of the more significant contaminant sources, and a similar approach was taken for the 2017 and this current 2023 Update.

SPILLS

Background

A hazardous material spill or leak into a surface water body could occur as the result of a vehicular traffic accident, pipeline leak or spill, wastewater treatment plant spill, 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.

Related Constituents

The most common spills are related to oil and petroleum products or sewage. Therefore, typical constituents of concern range from volatile organic compounds (VOCs) and hydrocarbons to microbial constituents (i.e. viruses, pathogens, *Giardia, Cryptosporidium*). However, hazardous materials emergencies can involve a virtually infinite number of chemicals or chemical combinations.

Occurrence in Watershed

The main transportation route through the watershed is Highway 128.

Information on spills was queried from two sources: 1) the Office of Emergency Services (OES) Response Information Management System (RIMS) archived database, and 2) the State Water Resources Control Board's (SWRCB) California Integrated Water Quality System (CIWQS) database on sanitary sewer overflows (SSOs). Information on SSOs will be discussed in the Wastewater Section.

Excluding SSOs and other wastewater related spills, there were 24 spills occurring over the reporting time period and within the watershed, as shown in **Table 4-1. Table 4-1** shows that about half of the spills occurred on land and were typically due to failures with pole mounted transformers, and vehicle accidents. Direct spills to Lake Berryessa

were caused by airplane crash, or sunken boats in the lake. There were six incidents of sunken boats and one sunken aircraft in Lake Berryessa over the reporting period.

The largest non-wastewater spill occurred on April 27, 2019 when 200 gallons of ammonium nitrate was released due to a vehicular accident. However, the chemical did not reach any waterway.

Regulation and Management

When a hazardous materials spill or leak of a reportable quantity occurs, notification to an emergency response agency 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 materials 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 materials 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 Certified Unified Program Agency (CUPA), as well as the OES.

California Emergency Management Agency

OES developed the RIMS as part of the development of the State's Standardized Emergency Management System (SEMS). 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 archived cases, including those from 2010 through 2024, can be accessed at: https://www.caloes.ca.gov/office-of-the-director/operations/response-operations/fire-rescue/hazardous-materials/spill-release-reporting/

Summary of Findings for Spills

- There were seven non-sewage related spills which occurred directly into Lake Berryessa, due to six sunken boats and one aircraft.
- About 50 percent of the spills occurred on land, and 50 percent impacted a waterway.
- Although spills have the potential to contaminate the lake, there was none of significance during reporting period. Please see Wastewater section for information on sewage-related spills.

Table 4-1. Non Wastewater Related Spills occurring in Lake Berryessa Watershed, 2018 - 2022

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
NRC	11/14/2018	100 BLOCK OF BERRYESSA ROAD	PETROLEUM - Unknown Oil	Oil Spill on Road	Unknown	None
Bureau of Reclamation	7/30/2018	5520 Knoxville Rd, Napa	PETROLEUM- Fuel	Sunken Boat	10 gallons	Lake Berryessa
Bureau of Reclamation	4/2/2018	.5 mile south of 5520 Knoxville Rd	PETROLEUM - Unknown Fuel	Aircraft in Lake	Unknown	Lake Berryessa
Calpine Corporation	12/18/2019	10350 Socrates Mine Rd, Middletown	VAPOR - Non Anhydrous Ammonia	Drilling geothermal well	102.6 lbs.	None
NRC	9/11/2019	19355 S STATE HIGHWAY 29, Middletown	PETROLEUM - Unknown Oil	Release of Oil from Scrap Yard	Unknown	Yes, unnamed waterway
NRC	8/22/2019	10350 Socrates Mine Rd, Middletown	CHEMICAL - Non Anhydrous Ammon	Release from permitted geothermal well	100.7 gallons	None
CHP	4/27/2019	Butts Canyon Road // MM 9.38, Middletown	CHEMICAL -Ammonium Nitrate	Vehicle Accident	200 lbs.	None
Bureau of Reclamation	7/26/2019	West of 7780 Knoxville Road , Napa	PETROLEUM - Gasoline	Sunken Boat	10 gallons	Lake Berryessa
Bureau of Reclamation	7/2/2019	Lat / 38 31.215 N Lon / 122 11.803 W, Napa	PETROLEUM - Gasoline	Sunken Boat	Unknown	Lake Berryessa
Bureau of Reclamation	1/9/2019	5520 Knoxville Rd, Napa	PETROLEUM - Sheen	Sunken Boat	20 x 20 Ft.	Lake Berryessa
Spill Center	4/27/2019	Butts Canyon Rd x Guenoc Rd, Pope Valley	CHEMICAL - Ammonium Nitrate	Vehicle Accident	200 gallons	None
Calfire St Helena	9/21/2020	Hwy 29 at Hartmann Rd, Middletown	PETROLEUM - Diesel	Vehicle Accident	Unknown	Yes, unnamed waterway
PG&E	8/25/2020	Hartman Rd and Bowcher Ln, Middletown	PETROLEUM - Mineral Oil	Vehicle struck transformer	15 gallons	None
PG&E	7/1/2020	18570 HWY 175, Middletown	PETROLEUM - Mineral Oil	Vehicle Accident	10 gallons	None
PG&E	9/4/2020	5600 Monticello Rd, Napa	PETROLEUM - Mineral Oil	Damage from LNU Fire	50 gallons	None
PG&E	9/2/2020	4312 Spanish Flat Loop Rd. , Napa	PETROLEUM- Mineral Oil	Damage from LNU Fire	3 gallons	None
CVC	8/25/2020	6850 HWY 128, Napa	RADIOLOGICAL - Neutron Probe	Probe burned in fire	1	None
PG&E	11/18/2021	16407 Butts Canyon Rd. , Middletown	PETROLEUM - Mineral Oil	Vehicle Accident	7 gallons	None
Calpine	10/24/2021	10350 Socrates Mine Rd, Middletown	UNSPECIFIED - Rain water	Storm Surge	Unknown	Squaw Creek
NRC	2/17/2021	10350 Socrates Mine Rd, Middletown	VAPOR - Non Anhydrous Ammonia	Release from permitted geothermal well	248 lbs.	None
Bureau of Reclamation	9/5/2021	Lat 38.514530, Long -122.209966, Napa	PETROLEUM - Gasoline	Sunken Personal Watercraft	5 gallons	Lake Berryessa
NRC	7/5/2021	1547 BERRYESSA KNOXVILLE RD (100 YARDS FROM THE LAUNCH RAMP), Napa	PETROLEUM	Sunken Boat	Unknown	Lake Berryessa
CHP Napa	10/15/2021	In Butts Canyon Rd near Snell Valley, Unincorporated County	PETROLEUM - Motor Oil	Vehicle Accident	3 qts.	Yes, unnamed waterway
PG&E	5/19/2022	Behind 6005 Wragg Canyon Road at the Pleasure Cove Marina , Napa	PETROLEUM - Mineral Oil	Vehicle struck transformer	44 gallons	None

RECREATION

Background

The 2013 Watershed Sanitary Survey provides a historical background of recreational at Lake Berryessa from its opening in 1958 to 2013.

As discussed in the 2018 Watershed Sanitary Survey, all of the recreational areas have reopened with concession contractors, except for Monticello Shores and Berryessa Point. Currently, the U.S. Bureau of Reclamation (Reclamation) manages concession contracts at Putah Canyon, Pleasure Cove, and Markley Cove. In June 2020, Napa County and Reclamation signed a Managing Agreement to allow Napa County to obtain control and management of the concession areas over an agreed timeframe beginning November 1, 2020 with three initial areas (Monticello Shores, Spanish Flat, and Steele Canyon). The agreement states that the management of Pleasure Cove and Markley Cove could be transferred to Napa County by January 1, 2030 if certain prerequisites were met. These prerequisites include a successful agreement between Napa County and the current concessionaire, approval of the agreement by Reclamation, and termination of the existing contact between Reclamation and the current concessionaire. The 2020 management agreement also states that Putah Canyon and Berryessa Point may be managed by Napa County in the future, with no specific date mentioned. In 2022, the Managing Agreement was amended to transfer Berryessa Point to Napa County.

In 2020, Napa County released a Request for Proposals (RFP) for concessionaires at Monticello Shores, Spanish Flat, and Steele Canyon. Although a concessionaire (Sun Communities) was selected, the concessionaire decided to forgo the opportunity, after studying the sites for two years in 2022 and 2023, due to the costs it would take to redevelop the three sites. After this occurred, Napa County entered into a contract with Camp Margaritaville in late 2023 for development of Steele Canyon. Napa County entered into a contract with Suntex in 2022 for development of a marina at Berryessa Point. Each concessionaire will have roughly 30 months to complete studies, site design and environmental review such as NEPA/CEQA. Therefore, Steele Canyon and Berryessa Point are currently in development. To date, there is not a long-term developer for Monticello Shores, but it will be developed eventually. Napa County indicated that there would be an RFP for development at Spanish Flat in the future as well.

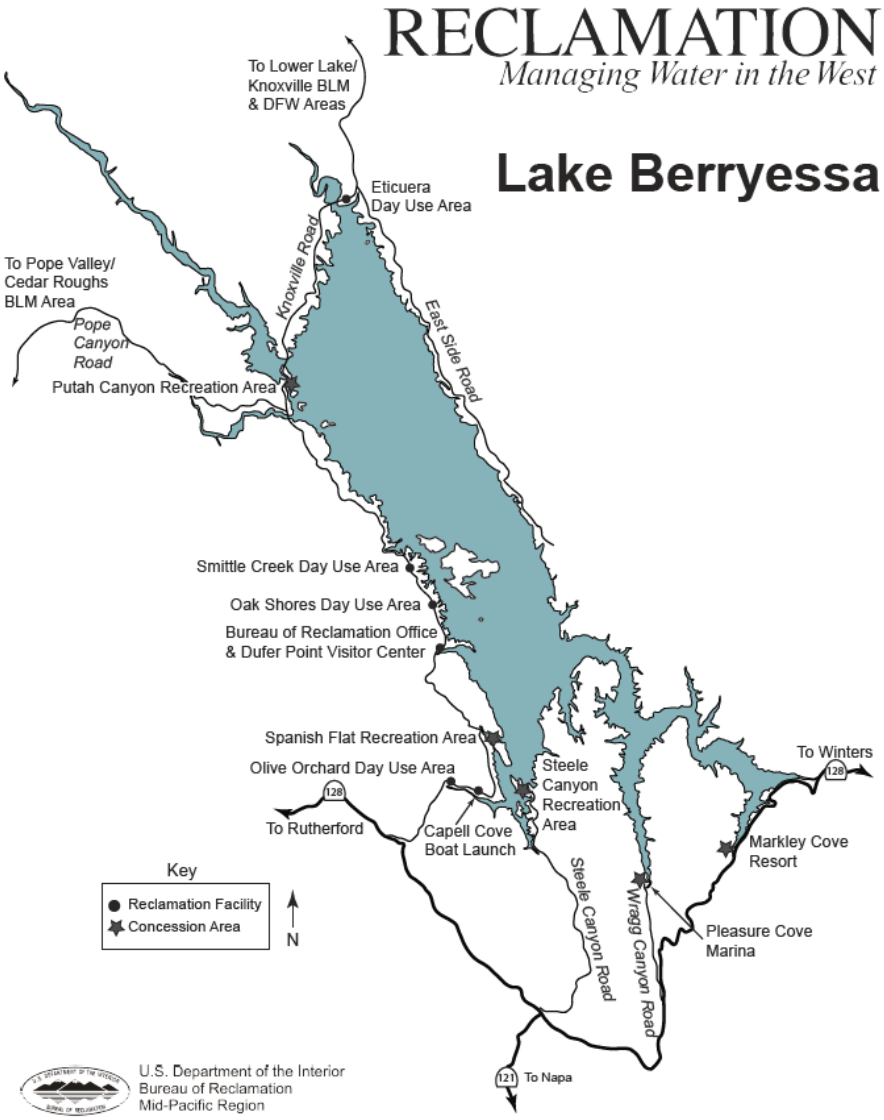
Related Constituents

Body contact recreation in general has long been known to be 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 transmittable to other humans.

Occurrence in Watershed

According to Reclamation, annual visitation to Lake Berryessa varies considerably. High water years usually correspond to higher visitation numbers. A conservative estimate of visitation is 500,000 visitors per year. (Email communication, Jennifer Onufer, June 2024). SCWA estimates that the average number of boats launching into Lake Berryessa is about 30,000 boats annually. The current recreational facilities at Lake Berryessa are shown in **Figure 4-1** and described in this section.

Figure 4-1. Recreational Areas at Lake Berryessa



Putah Canyon Recreation Area (https://royalelkparkmanagement.com/putah-canyon)

The Putah Canyon Recreation Area is located 29 road miles from Monticello Dam. Currently, Putah Canyon is being operated by Royal Elk Park Management through December 2031. The area is available for day use as well as RV and tent camping. There are 98 campground sites, both tent and RV. There is also a boat launch and RV dump station. In 2014, Reclamation installed two vault toilets, RV dump station and two spigots for potable water. In 2016, a well for potable water was installed by Reclamation. There are no showers or flush toilets. Wastewater collection and facilities were demolished in 2011 by Reclamation. There are plans to develop an operational fuel source on site.

Monticello Shores Recreation Area

The Monticello Shores Recreation Area is 27 road miles from Monticello Dam. Currently, Monticello Shores is closed to the public. Its reopening is contingent upon Napa County securing a long-term concession contract for its management and operation and upon significant improvements being made to infrastructure at the site. As mentioned earlier, there is not currently a long-term developer for Monticello Shores, but it will be developed eventually. Wastewater collection and facilities were demolished in 2011 by Reclamation.

Berryessa Point Recreation Area

The Berryessa Point Reclamation Area is 26 road miles from Monticello Dam. Currently, the recreation area is closed to the public. Napa County entered into a contract with SunTex in 2022 for development of Berryessa Point. Initial plans for Berryessa Point are to develop a marina. It is expected that the environmental assessment will be completed in July 2025, with construction complete in 2026. Wastewater collection and facilities were demolished in 2011 by Reclamation.

Spanish Flat Recreation Area

The Spanish Flat Recreation Area is located 19 road miles from Monticello Dam. Currently, Spanish Flat is being operated by an interim concessionaire on a yearly contract with Napa County. Napa County indicated that there would be an RFP for development at Spanish Flat in the future. The area is available for day use as well as RV and tent camping. There are 55 campground sites, both tent and RV. There is also a boat launch and RV dump station. In 2015, Reclamation installed two vault toilets, RV dump station and two spigots for potable water. Wastewater collection and facilities were demolished in 2011 by Reclamation.

Steele Canyon Recreation Area (https://campsteelecanyon.com/)

The Steele Canyon Recreation Area is located 17 road miles from Monticello Dam. Currently, Steele Canyon is being operated by an interim concessionaire on a yearly

contract with Napa County. The area is available for day use as well as RV and tent camping. There are 85 campground sites, both tent and RV. There is also a boat launch and RV dump station. In 2014, Reclamation installed two vault toilets, RV dump station and two spigots for potable water. Potable water comes from a water tank which is purchased from the NBRID WTP. Wastewater collection and facilities were demolished in 2011 by Reclamation. Napa County entered into a contract with Camp Margaritaville in late 2023 for the development of Steele Canyon. Plans for development of Steele Canyon are on the Napa County website, but currently it is unknown what phases will be selected first for environmental assessment, which will hopefully be completed in 2026. Improvements to the NBRID water treatment plant will likely include additional treatment capacity and potable water storage capacity, and will be dependent on the final development plans at Steele Canyon.

Pleasure Cove Marina (https://goberryessa.com/)

Pleasure Cove Marina, located at the lake shore at the end of Wragg Canyon, 9 road miles from Monticello Dam, is currently being operated under a long-term contract with Suntex through December 2047. There is a full marina with gas dock and pump out for sewage. There are also houseboat rentals, boat slips, rental cabins, and 140 overnight campsites (both tent and RV hookups). The recreational area is served by both flush and chemical toilets, with wastewater handled through septic tanks. Suntex plans to expand docks and improve RV and camping sites pending the completion of an Environmental Assessment in 2024. As of November 4, 2024, Reclamation indicated that the Environment Assessment was still in draft form, but might be finalized in December 2024 (email communication, Jennifer Onufer, Reclamation, November 2024).

Markley Cove Resort (https://markleycove.com/)

Markley Cove Resort is located 3 road miles from Monticello Dam. It is being managed by FX10 through December 2047. It has a full marina with gas dock and pump out for sewage. The resort has a general store, boat launching facilities, a boat storage area, rental cabins, boat and jet-ski rentals, boat slips, and fueling services. The marina accommodates approximately 200 boats, including 30 houseboats. Wastewater is handled by septic tanks and evaporation and percolation ponds. FX10 is currently building a water treatment facility which will be complete by the end of 2024.

Day-Use Areas

Reclamation also operates 5 day use areas. The facilities are operated by Reclamation with the exception of Camp Berryessa, now renamed as EcoCamp Berryessa operated by the Napa County Regional Park and Open Space District. These facilities, all located along Berryessa Knoxville Road on the western shoreline of Lake Berryessa are described in this section. It is important to note that all five day use areas were burned in the 2020 LNU Lightning Complex Fire. According to Reclamation, although only one structure burned, the sites experience intermittent plumbing and electrical outages (email communication, Jennifer Onufer, June 7, 2024).

Eticuera Day Use Area

Located on the far north shoreline of Lake Berryessa at Eticuera Creek and 33 road miles from Monticello Dam, Eticuera Day Use Area consists of a parking lot, a comfort station with pit toilets located in the lot, a trash bin, and a short walkway down to the lake shore. While picnicking and shoreline fishing can take place at Eticuera Day Use Area, there are no tables or other facilities to support these activities. While East Side Road extends further south along the lake's eastern shoreline, Eticuera Day Use Area is the recreation facility most distant from Monticello Dam developed and operated for visitors to Lake Berryessa.

Smittle Creek Day Use Area

Smittle Creek Day Use Area, located on the lake's western shore, 25 road miles from Monticello Dam is open to visitors from sunrise to sunset. The day use area consists of a parking lot, picnic tables, barbeque grills, a water fountain, a comfort station with flush toilets and a 5.2-mile out and back nature trail. Wastewater from the Smittle Creek Day Use Area is handled by the wastewater treatment plant operated by Reclamation.

Oak Shores Day Use Area

By far the largest and most-visited recreation facility operated by Reclamation at Lake Berryessa, Oak Shores Day Use Area, located on the lake's western shoreline, 23 road miles from Monticello Dam, offers day visitors a variety of recreational opportunities, including fishing, wildlife viewing, beach activities, swimming, hiking, and picnicking. Open from 7:00 am to 8:00 pm daily and spread out over eight distinct areas (from north to south: Coyote Knolls, Coyote Beach, Patwin Grove, Twin Oaks, McKenzie Ridge, Shale Point, Foxtail Flat, and Acorn Beach), Oak Shores is equipped with over 100 individual and group picnic sites equipped with barbeque grills, two hand launches for kayaks and canoes (at Foxtail Flat and Coyote Knolls), shoreline fishing areas, and protected swimming areas at Coyote Beach and Acorn Beach. In 2019, Reclamation was approved to charge a $5 day use fee. A short trail leads from the southern end of Oak Shores just beyond the Acorn Beach area to the Reclamation Field Office and the Dufer Point Visitor Center.

The areas just offshore of the two beaches are off-limits to motorized boating and there is a 5 mile per hour speed limit for motorized boating areas between Oak Shores and Big Island. Oak Shores provides several comfort stations with flush and pit toilets, supplemented by portable toilets, along with trash and recycling receptacles. Wastewater from the Oak Shores Day Use Area is handled by the wastewater treatment plant operated by Reclamation.

Dufer Point Visitor Center

Located 22 road miles from Monticello Dam, the Dufer Point Visitor Center offers visitors exhibits on the lake's natural resources and provides printed information and

literature. The center is open to the public on Saturdays and Sundays only. The center's restrooms are equipped with flush toilets. Wastewater from the visitor center is handled by the wastewater treatment plant operated by Reclamation.

Capell Cove Boat Launch

Located 18 road miles from Monticello Dam, the Capell Cove Boat Launch is a day use facility consisting of a boat launch ramp, an adjacent dock, a parking lot with a comfort station connected to a septic tank system, an oil absorbent bilge pad dispensing and receiving station and an access gate that is closed during non-operating hours. In 2019, Reclamation was approved to charge a $5 day use fee and a $10 boat launch fee.

Olive Orchard Day Use Area

Located 17 road miles from Monticello Dam, the Olive Orchard Day Use Area is a small facility with a few parking spaces, a comfort station equipped with a pit toilet and a single picnic table.

EcoCamp Berryessa

Located on 15 acres on the northern shore of Putah Cove on the lake's western shoreline and 29 road miles from Monticello Dam, Camp Berryessa is a former Boy Scout camp that closed in 2004. Camp Berryessa, now EcoCamp Berryessa, has undergone a $1.7 million transformation and reopened in October 2016.

EcoCamp Berryessa is a 64-bed group environmental education camp and features solar power, showers feeding into a graywater system, environmentally friendly composting toilets, permanent tent cabins, a stone amphitheater, a canoe/kayak launch, a beach, and paths and trails. EcoCamp Berryessa is operated by the Napa County Regional Park and Open Space District and is home to the Napa Open Space District's outdoor education program.

Regulation and Management

As described in the Background section, management of recreation areas is handled by both Reclamation and Napa County.

Source Water Protection Activities

The Solano County Boater Outreach Program focuses on educational outreach and invasive species prevention at Lake Berryessa. Since 2018, the program is jointly administered by Solano Resource Conservation District (RCD) and SCWA. Solano RCD conducts dockwalker surveys in partnership with the California State Parks Division of Boating and Waterways and California Coastal Commission, issuing oil absorbent pillows (bilge pads), supporting a bilge pad exchange program, and providing one-on-one education as well as informational brochures.

SCWA interns administered visual watercraft screening for invasive zebra and quagga mussels and the boater is asked a set of questions to determine risk of transmitting quagga and zebra mussels. **Table 4-2** summarizes the Program's totals over the past ten years for boater surveys and education. **Table 4-3** summarizes the vessel inspections for quagga and zebra mussels. The number of vessel screenings in 2022 was low due to the low water level in Lake Berryessa and reduced staffing over the course of the summer season.

Table 4-2. Summary of Solano County Boater Outreach Program, 2013-2023

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
# of Interns	6	6	14	12	16	3	2	3	3	3	4
Total Boater Surveys	1568	1670	1195	1210	1115	825	878	391	970	703	756
Total Recreator Surveys	325	300	392	265	224	107	86	-	-	-	64
Bilge Pad Additions	646	521	653	1100	606	822	778	257	499	267	151
Install Rates	51%	50%	57%	50%	41%	48%	58%	28%	37%	23%	20%

Table 4-3. Summary of Lake Berryessa Vessel Screenings, 2018-2022

	2018	2019	2020	2021	2022
# of Interns		17	13	10	11
Total Boater Surveys		13,557	15,000	11,489	6,779

Summary of Findings for Recreation

- Currently, all recreational areas are open except for Monticello Shores and Berryessa Point. Steele Canyon and Berryessa Point are currently in development with a long-term private concessionaire. Improvements to the NBRID water treatment plant will likely include additional treatment capacity and potable water storage capacity, and will be dependent on the final development plans at Steele Canyon.

- All of the recreation areas are downstream of the LBRID WTP. Therefore, only the NBRID WTP is directly impacted. *E. coli* and fecal coliform levels at the NBRID WTP are very low, with an average non-detect and a median of <1 MPN/100mL from 2018 to 2022, indicating no impact from recreation.

- The Solano County Boater Outreach Program is a very effective program to screen for invasive mussels, but also promote clean and safe boating practices.

- There were no spills reported in regards to the gas docks or sewage pumpout located at the marinas.

AGRICULTURE

Background

Agricultural-related activities within the watershed are vineyards, crops, and nurseries.

Related Constituents

Agricultural crops can impact water quality through their use of fertilizers and pesticides. Drip irrigation is most common within the watershed for irrigation in summer and early fall. Since drip irrigated lands do not generate runoff during the growing season when most fertilizers and pesticides are applied, it is highly unlikely that pesticides or fertilizers are being transported to Lake Berryessa due to irrigation.

Occurrence in Watershed

Overall, there is limited agricultural use in the watershed. For the portion of the watershed which is within Napa County, 99.7 percent of the irrigated lands are wine grape vineyards, with olives as the remainder. It is important to note that wine grapes are irrigated using drip irrigation. Due to the nature of drip irrigation, drip irrigated lands do not generate runoff during the growing season when most fertilizers and pesticides are applied. Therefore, irrigation related pesticide or fertilizer transport is highly unlikely to occur in this watershed.

The Napa County Agricultural Commissioner's Office reports that the most typical pesticides used are elemental sulfur to control mildew on grapes, mineral oil to control insects, and glyphosate to control weeds. Sulfur and mineral oil is used between April and July, and glyphosate is used between November and February. However, it is not applied ahead of forecasted rainfall.

As shown in **Figure 4-2**, there are eleven sections (1 mile X 1 mile) located in the Lake Berryessa watershed which had over 8,434 pounds/year of pesticides applied in 2018. Sections which fell into this high category of usage are shaded in red. Pesticide data was sourced from Tracking California, Public Health Institute Agricultural Pesticide Mapping Tool. (Accessed September 2024 from www.trackingcalifornia.org/pesticides/pesticide-mapping-toll). Chemical usage and crop type is summarized in **Table 4-4.**

Figure 4-2. Top Eleven Parcels Identified for Pesticide Usage in 2018 in Lake Berryessa Watershed, Napa County

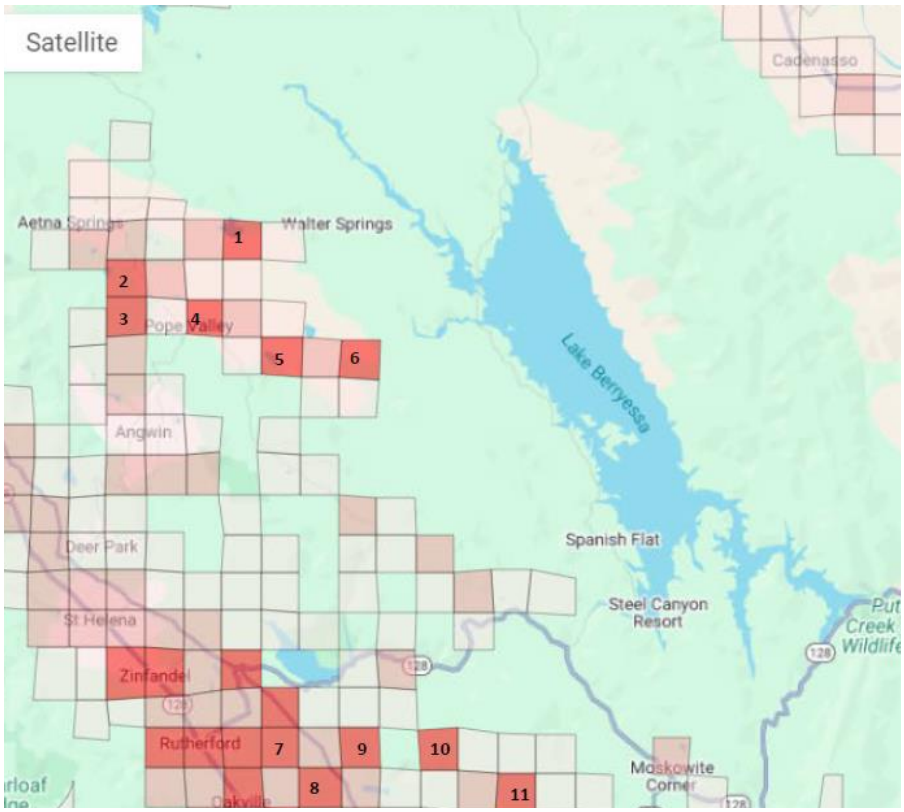


Table 4-4. 2018 Chemical Usage for Top Eleven MRTS in Lake Berryessa Watershed, Napa County

	Meridian Township Range Section (MRTS)	2018 Chemical Usage, lbs.	Crops Grown	Chemicals Used
1	M09N05W10	18,874	Wine Grapes	Sulfur, Glyphosate, Pendimethalin
2	M09N05W18	8,905	Wine Grapes	Sulfur, Kaolin
3	M09N05W19	Not reported	Wine Grapes, Plum, Peach, Pear,Tomato, Olive, Vegetable Leaf	Kaolin, Sulfur, Potassium bicarbonate, Lime-Sulfur
4	M09N05W21	8,582	Wine Grapes	Sulfur, Glyphosate
5	M09N05W26	9,712	Wine Grapes	Sulfur, Glyphosate, Mineral Oil
6	M09N04W30	25,800	Wine Grapes, Olives	Sulfur, Copper Oxide, Glyphosate

	Meridian Township Range Section (MRTS)	2018 Chemical Usage, lbs.	Crops Grown	Chemicals Used
7	M07N05W14	18,980	Wine Grapes	Sulfur, Mineral Oil, Glyphosate
8	M07N05W24	10,609	Wine Grapes, Olives	Sulfur, Glyphosate
9	M07N04W18	9,543	Wine Grapes	Sulfur, Mineral Oil
10	M07N04W16	10,232	Wine Grapes	Sulfur, Mineral Oil, Cyprodinil
11	M07N04W23	10,528	Wine Grapes, Olives	Petroleum Distillates, Sulfur, Simazine, Glyphosate

As the Tracking California, Public Health Institute Agricultural Pesticide Mapping Tool only contained 2018 data, additional analysis was conducted to obtain a fuller picture of pesticide use in the watershed. The Napa County Agricultural Commissioner's Office provided 2018 to 2022 chemical usage for all MRTS in Napa County. The data was sorted by product name and units applied. After sorting the data, the sum of the highest 5 products applied over the 2018 to 2022 reporting period were identified. **Table 4-5** shows the highest 5 products by weight (pounds) and **Table 4-6** shows the highest 5 products by volume (quarts).

The caveat to drawing conclusions from this data is that not all of the chemicals have necessarily been applied within the Lake Berryessa watershed. However, this evaluation shows that the majority of products with the highest chemical usage are not of concern to drinking water. The highest five products in **Table 4-5** are sulfur products, which are used to address mildew. The only product in **Table 4-6** of concern to drinking water is glyphosate.

Table 4-5. Highest Five Products Applied from 2018 to 2022 in Napa County by weight (pounds)

Product Name	Pounds Applied 2018- 2022
Special Electric	1,067,186
Sulfur DF	456,501
Sulfur Dry Flowable	410,802
Dusting Sulfur	262,285
Mar Vista Dusting	213,171

Table 4-6. Highest Five Products Applied from 2018 to 2022 in Napa County by Volume (Quarts)

Product Name	Quarts Applied 2018- 2022	Active Ingredient
Sonata	24,750	Strain of *Bacillus pumilus*
Vintre	16,130	Constituents Ineffective as Spray Adjuvants
Regalia	15,390	Extract of *Reynoatria sachalinensis*
PureSpray Green	14,358	Mineral Oil
Roundup	11,591	Glyphosate

Related Water Quality Issues and Data Review

Copper, simazine and glyphosate are the only pesticides listed in **Table 4-4** for which drinking water standards has been established. No VOCs or SOCs were detected at the LBRID or NBRID intake over the reporting period. There were no detections of glyphosate at the NBRID intake over the reporting period. Glyphosate is not required to be monitored at the LBRID intake.

Regulation and Management

Regional Water Quality Control Board, Central Valley Region

In 2014 the Regional Board finalized and adopted the Irrigated Lands Regulatory Program (ILRP) as the long-term solution for irrigated agricultural discharges. The ILRP addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. These wastes can harm aquatic life or make water unusable for drinking water or agricultural uses. The goal of the ILRP is to protect surface water and groundwater and to reduce impacts of irrigated agricultural discharges to waters of the State. Two orders were adopted by the Regional Board for coalitions in the Sacramento River watershed; R5-2014-0030 – Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed That are Members of a Third-Party Group (Sacramento River Watershed) and R5-2014-0032 – Waste Discharge Requirements General Order for Sacramento Valley Rice Growers (Sacramento Valley Rice Growers).

The Sacramento Valley Water Quality Coalition (SVWQC) was developed to comply with the Discharges from Irrigated Lands Regulatory Program. It consisted of a monitoring program and management practices where the monitoring data indicated the need. The SVWQC covers all non-rice irrigated crops in the Sacramento Valley, including wild rice and pastureland. The Napa County Putah Creek Watershed Group was formed in response to the irrigated lands regulatory program and is a subgroup of the SVWQC. The Napa County Putah Creek Watershed Group is signatory to the SVWQC.

The SVWQC previously conducted water quality monitoring at two sites in the watershed: Capell Creek and Pope Creek. Monitoring was discontinued at Capell Creek in 2008. The monitoring site on Pope Creek, **shown in Figure 4-3**, is downstream of major stormwater runoff and above Lake Berryessa. It is downstream of Weeks Lake. Primary crops in the drainage are vineyards and olive orchards. According to Larry Walker Associates (email communication, Mike Trouchon, June 2024), Pope Creek was approved for reduced monitoring in 2016 due to limited agriculture and limited pesticide use. Normally, the Pope Creek site is dry. Over the reporting period, Pope Creek was sampled once in 2021 as shown in **Table 4-7.** No pesticides or metals were sampled. The monitoring conducted in 2021 does not show anything of concern. The site will likely be monitored in the upcoming 2024-2025 monitoring season (October 2024 to September 2025).

Table 4-7. Water Quality Monitoring in Pope Creek, Putah Creek Watershed Group, 2014 to 2021

Date	Total Coliform MPN/100mL	*E. coli,* MPN/100mL	Nitrate/Nitrite, mg/L	TOC, mg/L	Specific Conductance, uS/cm	TSS, mg/L	Total Copper, ug/L
12/2/2014	NT	2419.6	0.12	8.2	NT	NT	NT
1/20/2015	NT		NT	NT	353.7	NT	NT
2/9/2015	2419.6	410.6	0.2	5.5	131.2	131	NT
3/18/2015	NT	44.1	0.17	2.1	436.6	6	NT
4/21/2015	2419.6	791.5	NT	2.5	568	NT	1.2
5/20/2015	NT	30.1	NT	2.3	667	NT	1
4/22/2021	NT	1	<0.04	3.9	558	2 J	1.7

NT = sample not taken
J= estimated

Figure 4-3 Location of Pope Creek Monitoring Site for Sacramento Valley Water Quality Coalition

Source Water Protection Activities

The 2014 Agricultural Orders require growers to self-inspect, implement best management practices, conduct water quality monitoring either as a group or individual, and submit farm information to either their coalition or the Central Valley Water Board, including farm evaluations and nitrogen management data.

Summary of Findings for Agriculture

- There is limited agriculture use in the watershed, of which, 99.7 percent are wine grapes.

- As wine grapes are drip irrigated, irrigation related pesticide or fertilizer transport is highly unlikely to occur in this watershed.

- Based on the 2018 to 2022 chemical use data from Napa County Agricultural Commissioner's Office, the highest chemical usage in pounds are all sulfur-based products and do not have an associated MCL in drinking water. Glyphosate is the only product applied in high amounts and also of concern to drinking water due to its MCL of 700 µg/L.

- Commercial growers are required to be enrolled in the Central Valley Regional Water Quality Control Board's Irrigated Lands Program, and most growers are likely participating in the Sacramento Valley Water Quality Coalition, through the Napa County Putah Creek Watershed Group.

- Copper, simazine and glyphosate are the only pesticides used in the watershed draining to Lake Berryessa for which drinking water standards have been established. Monitoring data collected at the LBRID and NBRID WTPs water show low levels of copper (less than 50 µg/L), no detections of simazine, and no detections of glyphosate at the NBRID WTP.

WASTEWATER

Background

Wastewater is known to contain pathogenic microorganisms. Wastewater treatment plants remove and/or inactivate some, though not all, of these organisms through various treatment processes. Secondary treatment of domestic sewage is expected to remove 75 to 99 percent of enteric viruses[1], 85 to 99 percent of heterotrophic bacteria[2], and 92[2] percent of *Giardia* cysts.

Lake Berryessa is designated as a no discharge basin by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), meaning, no direct discharges of wastewater to surface waters is allowed in the watershed.

The upper portions of the watershed are served primarily by onsite wastewater treatment systems and several small wastewater treatment facilities that discharge to ponds or to the Southeast Geysers Effluent Pipeline (SEGEP). The small communities and resorts around Lake Berryessa are served primarily by systems that discharge to evaporation and percolation ponds. Individual home owners and businesses near the lake have onsite wastewater treatment systems.

Seasonal Patterns

Sewer spills typically occur in during heavy precipitation events when infiltration occurs into the collection system. Mostly recently, this occurred in January/February 2019 at three wastewater treatment plants in the watershed.

Related Constituents

Wastewater is a blend of sewage, washwater from showers, kitchens, etc., and any effluent from industrial facilities within the sewer collection system. Potential contaminants of concern in wastewater include microbial pathogens (such as bacteria, viruses, and protozoa), total organic carbon (TOC), volatile organic compounds (VOCs), and synthetic organic compounds (SOCs).

Occurrence in Watershed

Middletown

The community of Anderson Springs and accompanying septic systems surrounds Anderson Creek, a small stream that flows into Putah Creek. The Valley Fire of 2015

[1] National Research Council, 1998. Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies with Reclaimed Water. National Academy Press.

[2] Chauret, C. et al., 1999. Fate of *Cryptosporidum oocysts*, *Giardia cysts*, and microbial indicators during wastewater treatment and anaerobic sludge digestion. Canadian Journal of Microbiology, 45: 257-262.

destroyed 193 of the 212 homes in Anderson Springs. Due to more stringent requirements associated with the siting and construction of new septic tanks, a new sewer collection and conveyance system was installed and operational in December 2019. The Anderson Springs subdivision is now connected to the Middletown Wastewater Treatment Facility (WWTF). Approximately seven miles of force main piping was installed for a project buildout of 300 single family homes.

Lake County Sanitation District (LACOSAN) provides wastewater collection and treatment to the community of Anderson Springs, Middletown and the Harbin Springs Resort. The Middletown WWTF operates under Waste Discharge Requirement (WDR) Order 97-249, issued by the Central Valley Water Board. The WWTF was constructed in 1992 and has an average dry weather flow of 0.15 million gallons per day (mgd) and a peak wet weather flow of 0.5 mgd. The WWTF consists of a facultative pond system consisting of a primary pond, three secondary ponds, a sodium hypochlorite feed system and contact basin, an effluent storage reservoir, an effluent pump station, and a spray irrigation system that may be used as a back-up disposal. The influent flows are measured using magnetic flow meters, which are all calibrated on an annual basis. The ponds are all lined. The wastewater is chlorinated prior to discharge into the effluent pipeline for disposal into the Southeast Geyser Pipeline, where it is injected into the Geysers steamfield for power production. The back-up disposal system consists of a 240 acre-foot storage pond. Water from the storage pond is used to spray irrigate fodder crops. The plant was last inspected on August 21, 2019 and April 27, 2022. The 2019 inspection report noted that biochemical oxygen demand (BOD) and pH in the effluent, which is discharged to the effluent storage reservoir, exceeded permit levels. However, this does not directly affect water quality to Lake Berryessa. In addition, total coliform levels in groundwater monitoring wells exceeded permit levels. The 2022 inspection report noted total coliform levels in groundwater monitoring wells exceeding permit levels. According to the Regional Board, LACOSAN was asked to submit a well disinfection plan to disinfect wells and reduce coliform levels (Personal Communication, Guy Childs, Regional Board, June 19, 2024).

As shown in **Table 4-8**, there were two spills over the reporting period. It is important to note that these did not reach surface waters.

Table 4-8. Sanitary Sewer Overflows from Middletown WWTF or Collection System

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
Lake County Special Districts	7/24/2018	Butts Canyon Rd, mile marker 266, Middletown	Treated Effluent	Broken Pipe	3000 gallons	None
Lake County Special Districts	1/23/2020	LAT: 38.77673 LONG: -122.68696, Middletown	Sewage	Leaking Air Vacuum	10 gallons	None

Hidden Valley Lake Community Services District

The Hidden Valley Lake Community Services District provides wastewater collection and wastewater treatment services to 1,500 connections in the community of Hidden Valley Lake and some commercial parcels in the Coyote Valley. A number of residences in the Hidden Valley Lake community are on engineered onsite wastewater treatment facilities.

The wastewater collection system consists of eight sewage booster pump stations. The Hidden Valley Lake Water Reclamation Facility operates under Waste Discharge Order R5-00-019, issued by the Central Valley Water Board. The facility became operational in 1996 and includes an activated sludge-extended aeration plant with an average dry weather flow of 0.350 mgd and a peak wet weather flow of 0.894 mgd. The facility processes include primary screening, secondary treatment by extended aeration activated sludge, secondary clarification, direct tertiary filtration, and chlorination. Treated effluent is stored in the 412 acre-feet, clay-lined, effluent storage basin, and is then pumped into two irrigation ponds located on the Hidden Valley Lake golf course. Treated effluent is used to spray irrigate the Hidden Valley Lake golf course and an 80-acre supplemental spray irrigation field adjacent to the water reclamation facility.2 The plant was last inspected on October 20, 2021. The inspection report noted that total coliform and pH in the effluent exceeded permit levels. However, this does not directly affect water quality to Lake Berryessa.

Although discharge to surface waters is not allowed, any spills from the collection system or plant would flow into Crazy Creek and then into Putah Creek. As shown in **Table 4-9,** there were nine spills, with one 12,600 gallon spill reaching Hidden Valley Lake. The majority of the spills occurred in 2019, due to heavy rainfall that year.

Table 4-9. Sanitary Sewer Overflows from Hidden Valley Lake Water Reclamation Facility or Collection System

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
Hidden Valley Lake CSD	2/14/2019	Equalization Basin at WWTP	Sewage	Rainfall exceeded design	158,400	Equalization Basin spilled to Tertiary Pond
Hidden Valley Lake CSD	2/26/2019	Equalization Basin at WWTP	Sewage	Rainfall exceeded design	353,100	Equalization Basin spilled to Storage Pond
Hidden Valley Lake CSD	2/26/2019	Hidden Valley Lake, WWTP manhole	Sewage	Rainfall exceeded manhole capacity	18,000	Crazy Creek

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
Hidden Valley Lake CSD	3/4/2019	18896 Grange Road, Middletown	Sewage	Overflow from Cleaning Sludge Beds	200 gallons	Crazy Creek
Hidden Valley Lake CSD	3/14/2019	18734 East Ridge View Dr., Unincorporated Lake County	Sewage	Contractor Discharged lateral line	12,600 gallons	Hidden Valley Lake
Hidden Valley Lake CSD	4/15/2019	Equalization Basin at WWTP	Sewage	Rainfall exceeded design	33,300	Equalization Basin spilled to Tertiary Pond
Hidden Valley Lake CSD	10/30/2019	16746 Hawks Hill	Sewage	Pump Station Failure	75	None
Hidden Valley Lake CSD	1/16/2020	Harman Rd and Mountain Meadow North, 38.796417 - 122.554242, (Hidden Valley Lake), Unincorporated Lake Count	Sewage	Release from District Vacuum truck	75 gallons	None
Hidden Valley Lake CSD	10/30/2022	19210 Hartman Road	Sewage	Other	6,840	None

Lake Berryessa Resort Improvement District, Lake Berryessa Estates

LBRID was established in 1965 to provide potable water and sewer services to the Lake Berryessa Estates Unit 2 subdivision, an unincorporated community located along Putah Creek. The LBRID WWTF currently serves 180 single-family residences. At full build-out, LBRID will provide water and wastewater services to 339 lots.

The disposal of wastewater is allowed under WDR Order R5-2017-9002, issued by the Central Valley Water Board. The order allows LBRID to treat and dispose of an average dry weather flow of 42,000 gallons of treated water per day with a peak flow of 123,000 gallons per day.

Wastewater from the community flows via gravity to three lift stations where it is pumped to a 91,000 gallon aboveground holding tank. The steel equalization tank will be replaced by a cast-in-place reinforced concrete at the end of 2024. From the tank, wastewater is pumped approximately 1.2 miles into a manhole. From the manhole, wastewater gravity flows to facultative treatment ponds. LBRID completed repairs to the sewage collection system in the fall of 2011 to reduce infiltration and inflow to the system.

The LBRID wastewater treatment and disposal facilities consist of three facultative treatment ponds (Ponds 1-3) in series followed by a polishing pond (Pond 4) and non-aerated storage ponds (Ponds 5-8). Wastewater is disinfected with sodium

hypochlorite, pumped through a chlorine contact basin, and then applied via spray irrigation to four separate land application areas totaling approximately 15.5 acres. Runoff from the spray fields is collected within a tail water collection ditch which flows via gravity or is pumped back into the pond system for reapplication.

The LBRID WWTF was inspected on January 29, 2019, January 19, 2022, and March 7, 2024. Over this time period, the violations were pH above 8.4 in the groundwater monitoring wells in the first and third quarter in 2018, and one total coliform bacteria sample in the effluent was above the 240 MPN/100mL maximum daily limit on March 23, 2023.

Over the reporting period, there was one spill which occurred on January 16, 2019 at 2446 Stage Coach Canyon Road. This was due to a power failure at a sewage lift station and 20,000 gallons of raw sewage entered Putah Creek, which is tributary to Lake Berryessa. It should be noted that this one SSO over the reporting period of 2018 to 2022 is a significant decrease from the previous reporting period of 2013 to 2017 when 20 SSOs occurred. Please refer to Source Water Protection Activities at the end of this section for more information.

Spanish Flat Water District

The Spanish Flat Water District provides water and sewer services to approximately 50 mobile homes in the Spanish Flat Mobile Villa, and 60 homes in the Spanish Flat Woodlands Subdivision. The Spanish Flat Water District owns the Spanish Flat WWTF and Napa County owns the land on which the treatment plant and main storage/disposal ponds have been constructed. Due to the August 2020 LNU Lightning Complex fire which destroyed the mobile homes in the Spanish Flat Mobile Villa, the effluent flows have been greatly reduced.

The disposal of wastewater is allowed under WDR Order 93-236, issued by the Central Valley Water Board. The WDRs allow the discharge of a monthly average dry weather flow of 25,000 gallons per day, with peak daily flows up to 53,000 gallons per day. Wastewater from the Spanish Flat Mobile Villa flows via gravity to a lift station where it is pumped to a package treatment plant and then into a wastewater storage and disposal pond. Wastewater from Woodland Subdivision flows via gravity into a dosing sump where it is pumped to the package treatment plant and then into the pond. Wastewater is then discharged to the 3.7 acre Monticello cemetery sprayfield, or the 2.5 acre Woodlands sprayfield.

The plant was last inspected on January 29, 2019 and November 1, 2022. The 2022 inspection report noted that total coliform in groundwater monitoring wells exceeded permit levels. According to the Regional Board, the Spanish Flat Water District was asked to submit a well disinfection plan to disinfect wells and reduce coliform levels (Personal Communication, Guy Childs, Regional Board, June 19, 2024). There was one spill reported by a Spanish Flat resident on February 11, 2020 at 4312 Spanish Flat

Loop Road. The cause of the spill was noted as lateral line blockage. The amount of sewage spilled into Lake Berryessa was listed as unknown.

Napa Berryessa Resort Improvement District, Berryessa Highlands

NBRID was created in 1965 for the purpose of providing water and wastewater service to residential customers and the Steele Park Resort. The WWTF is located on land owned by Reclamation under a permanent easement to NBRID. The WWTF currently serves only the Berryessa Highlands subdivision.

Wastewater is conveyed to the WWTF by gravity sewers, lift stations, and force mains. The disposal of wastewater from the NBRID WWTF is currently allowed under WDR Order R5-2013-0065, adopted by the Central Valley Water Board on May 31, 2013. The current order allows NBRID to treat and dispose of a monthly average flow of 50,000 gallons of treated water per day to four sprayfields. The plant which was constructed in November 2013, is a membrane bioreactor package (MBR) treatment plant system. Wastewater from the MBR system is disinfected using sodium hypochlorite and one of the effluent storage ponds as the chlorine contact basin. The disinfected wastewater is then pumped to a 50,000 gallon above ground storage tank prior to being discharged to one of four land application areas, totaling 60 acres. A construction project is underway to revamp the sprayfield transmission and lateral system with new irrigation guns. Wastewater runoff from each of the sprayfields is collected and returned to the above ground tank. Sludge is dewatered and disposed of in a landfill.

As shown in **Table 4-10**, there were two spills from the NBRID system, with both spills reaching Lake Berryessa.

Table 4-10. Sanitary Sewer Overflows from NBRID Facility or Collection System

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
Napa Berryessa Resort Improvement District	1/17/2019	1465 Steele Canyon Rd, Napa	Sewage	Spill on Ground	5,000 gallons	Lake Berryessa
Napa Berryessa Resort Improvement District	2/14/2019	Approximate Lat/Long of 38.51531, -122.19134, Napa	Raw Sewage	Malfunction at Lift Station	2,500 gallons	Lake Berryessa

Turtle Rock Motel and Boat Storage WWTF

The Turtle Rock WWTF is a privately owned facility that serves 15 connections, which includes the motel/storage facility and the restaurant/bar located across Highway 128, near the intersection of Highway 28 and Berryessa Knoxville Road.

The disposal of wastewater from the facility is allowed under Water Quality Order 97-010-DWQ, General Waste Discharge Requirements for Discharges to Land by Small Domestic Wastewater Treatment Systems. The facilities consist of two septic tanks and then to a percolation/evaporation pond with a monthly average dry weather flow of

2,500 gallons. The last inspection for this plant was on November 1, 2022. The inspection report did not note any water quality related violations.

Although discharge of wastewater is not allowed, any spills from the WWTF would flow into Soda Creek, a tributary of Capell Creek and Lake Berryessa. No spills were reported from this facility from either the OES database or the State Water Board SSO database.

Capell Valley Mobile Home Park

The Capell Valley Mobile Home Park WWTF is privately owned and serves approximately 59 sewer connections, which include the Capell Valley Mobile Home Park, a few commercial establishments, and domestic wastewater from Moss Creek Winery. The mobile home park is located near the intersection of Highways 128 and 121.

In 1994, the Central Valley Water Board adopted WDRs Order 94-099 to regulate discharges from the Capell Valley Mobile Home Park WWTF. Approximately 9,600 gallons per day of septic tank effluent is discharged to three evaporation/percolation ponds and one emergency overflow pond. In 2006, the Central Valley Water Board adopted a new Monitoring and Reporting Program, requiring the installation of groundwater monitoring wells. The most recent inspection for this plant was on March 7, 2024. The inspection report did note total coliform levels in groundwater monitoring wells exceeding permit levels. According to the Regional Board, Capell Valley Mobile Home Park was asked to submit a well disinfection plan to disinfect wells and reduce coliform levels (Personal Communication, Guy Childs, Regional Board, June 19, 2024). Although discharge to surface waters is not allowed, any spills from the collection system or wastewater ponds would flow into Oak Moss Creek, a tributary of Capell Creek and Lake Berryessa. As shown in **Table 4-11,** there were two spills over the reporting period. These were very small spills which did not reach a waterway.

Table 4-11. Sanitary Sewer Overflows from Capell Valley Mobile Home Park

Discharger or Reporting Agency	Date	Spill Location	Spill Type	Cause	Volume	Receiving Water
Harmony Communities (Capell Valley Estates)	4/10/2019	6004 Monticello Rd, Space 48, Napa	Sewage	Overflow from Septic Tanks	4 gallons	None
Capell Valley Estates	4/30/2019	6004 Monticello Rd. SPC 32, Napa	Sewage	Broken Junction Box near septic tanks	3 gallons	None

Circle Oaks County Water District

The Circle Oaks County Water District serves the Circle Oaks subdivision, located three miles south of the junction of Highways 128 and 121. The WWTF currently serves approximately 300 to 350 homes.

In 1994, the Central Valley Water Board adopted WDR Order 94-097 to regulate discharges from the Circle Oaks County WWTF. The WWTF consists of three stabilization ponds with the capacity to treat a monthly average dry weather flow of 72,000 gallons per day with disposal via three evaporation/percolation ponds. The two most recent inspections for this plant were on November 1, 2022 and May 1, 2024. The May 2024 inspection report noted that 2023 total coliform levels in the groundwater monitoring wells exceeded permit levels. According to the Regional Board, the Circle Oaks County Water District was asked to submit proposed actions to address the total coliform levels, which is typically disinfection of the wells to reduce coliform levels (Personal Communication, Guy Childs, Regional Board, June 19, 2024). Although discharge to surface waters is not allowed, any spills from the collection system or WWTF would flow into Capell Creek. There were no spills over the reporting period.

Reclamation Administrative Center and Day Use Areas

The Eticuera and Olive Orchard Day Use Areas have pit toilets and the Capell Cove Boat Launch has restrooms connected to a septic tank. The Reclamation Administrative Center, Dufer Point Visitor Center, Oak Shores Day Use Area, and Smittle Creek Day Use Area are located on the west shore of Lake Berryessa near the community of Spanish Flat. Reclamation operates its own wastewater collection, treatment, and disposal system.

The discharge of wastewater is authorized by General Waste Discharge Requirements for Small Domestic Wastewater Treatment Systems, Order WQ 2014-0153. Wastewater is collected from the Administration Center, Visitor Center, and eight public restrooms (Oak Shores Day Use Area) in nine septic tanks located near the facilities at each site. Nine lift stations pump the wastewater to two concrete lined oxidation-evaporation ponds. The ponds receive up to 3,000 gallons per day (average dry weather flow) of wastewater. Backwash from a water treatment plant is discharged to a third unlined evaporation/percolation pond. Graywater from the administrative center (except the dormitory) and sinks in the recreation area is discharged to subsurface leachfields.

CIWQS does not contain any information on sanitary sewer overflows or spills of treated wastewater from the system. The last inspection for this plant was in April 2019. The inspection report did not note any water quality related violations.

Pleasure Cove Marina

Pleasure Cove Marina, located on Wragg Canyon, is operated by a private corporation, Suntex, on land owned by Reclamation. The Central Valley Water Board adopted WDRs Order 98-086 to permit the discharge of up to 25,000 gallons per day of domestic wastewater into four percolation/evaporation ponds. The ponds receive wastewater from 23 cabins, 14 RV spaces, 5 modular homes, RV dump station, houseboat dump station, campground restrooms and showers. Wastewater from houseboats is pumped out by Pleasure Cove staff into a septic tank.

Effluent from the septic tanks is discharged to four stabilization ponds at three separate sites. Pond 1 has a capacity of 105,000 gallons. Ponds 2 and 3, near the mid-point of the resort, have a combined capacity of 70,000 gallons. Pond 4, near the north end of the resort, has a capacity of 25,000 gallons. Up to 25,000 gallons per day of wastewater is collected in the ponds, and disposed of by sprayfield irrigation.

CIWQS does not contain any information on sanitary sewer overflows or spills of treated wastewater from the system. The last inspection for this plant was in April 2019. The inspection report did not note any water quality related violations.

Markley Cove Resort

Markley Cove Resort, on Highway 28 about 3 miles west of Monticello Dam, is operated by a private concessionaire FX 10 on land owned by Reclamation.

The Central Valley Water Board adopted WDRs Order No. 98-084 in 1998 authorizing the collection and treatment of up to 11,500 gallons per day (as a monthly maximum) of septic tank, houseboat pump out, and domestic wastewater effluent. Order No. 98-084 has been rescinded and Markey Cove is now covered under State Water resources Control Board Order WQ 2014-0153-DWQ, General Waste Discharge Requirements for Small Domestic Wastewater Treatment Systems. Wastewater is discharged to septic tanks and then to two evaporation/percolation ponds.

An inspection of the facility was conducted on April 4, 2019. At that time, the marina accommodated approximately 370 boats, including 40 houseboats. There were also eight overnight rental cabins. According to the Notice of Applicability dated 2022, the wastewater treatment facility was constructed in the 1990's and consists of a gravity sewer collection system, three lift stations, one houseboat pump-out station and two percolation/evaporation ponds.

The Markley Cove Resort was damaged by the 2020 LNU Lightning Complex fire. Specifically, the general store, seven out of eight existing cabins, and multiple lift pumps were destroyed. As a result of the damage from the 2020 fire, the septic tank system is not in use, and the two evaporation ponds have been dry from August 2020 to the present. Reclamation confirmed that during this time wastewater is being pumped by a septic tank hauler for disposal off site. It is expected that the septic tanks and pond system will be operational by the end of 2024.

CIWQS does not contain any information on sanitary sewer overflows or spills of treated wastewater from the system. The last inspection for this plant was in April 2019. The inspection report did not note any water quality related violations.

Other Recreation Areas

The wastewater collection and disposal facilities for the Putah Creek Resort, Monticello Shores, Berryessa Point, and Spanish Flat were all demolished by Reclamation prior to

2011. Currently, there are only wastewater treatment plants (WWTP)s at Markley Cove, Pleasure Cove and the Oak Shores Day Use Area.

Regulation and Management

Septic Systems

The rural areas of the Putah Creek watershed and the small communities of Loch Lomond, Adams, and Whispering Pines are served by onsite waste treatment systems. Installation of new systems is subject to review and approval by the Lake County Environmental Health Division. Onsite systems must be designed to meet the optimal carrying capacity of the individual site's soils, slopes, and water table conditions. While lots with site conditions that are inadequate to support septic systems previously were undevelopable, relatively new technology and regulations permit installation of engineered systems that are self-contained and not reliant on site conditions. Many previously undevelopable lots can now be developed using these systems (Lake County Community Development Department, 2010).

State Water Resources Control Board

Onsite wastewater treatment systems are governed by the SWRCB Onsite Wastewater Treatment Systems Policy which was developed in 2012 and amended in 2023 as well as policy adopted by local agencies.

In Napa County, the Environmental Health Division of the Planning, Building & Environmental Services Department oversees the permitting and inspection of onsite wastewater treatment systems. In Lake County, these services are overseen by the Environmental Health Division of the Health Services Department. The community and resort wastewater systems are governed by the Central Valley Water Board through WDRs issued to each facility.

Wastewater Treatment Plants

The discharge of treated wastewater is regulated by the individual permits for each wastewater treatment plant, as indicated in the write-up for each plant.

State Water Board General Order 2022-0103-DWQ requires enrollees to submit their Sewer System Management Plan and report all sanitary sewer spills to the State Water Board's online California Integrated Water Quality System (CIWQS) Sanitary Sewer System Database.

The State Water Board defines Category 1 spills as discharges of sewage that equal or exceed 1,000 gallons, or result in a discharge to a drainage channel and/or surface water, or discharge to a storm drain that was not fully captured and returned to the sanitary sewer system. Category 2 spills are defined as other discharges of sewage and are generally small discharges that do not reach surface waters. Discharges from

wastewater treatment facilities are governed by the individual WDRs issued to the facilities. Spill information was obtained from the State Water Board's CIWQS database and from Central Valley Water Board records. Operators of sanitary sewers in the Lake Berryessa watershed were required to start reporting spills to CIWQS in November 2007.

Source Water Protection Activities

LBRID completed a number of projects over the reporting period to reduce the occurrence of SSOs. Flow monitoring in the sewer collection system was conducted to identify areas, if any, that are susceptible to inflow/infiltration due to either age, condition, or installation. Additionally, sewer lift stations were upgraded with submersible pumps to respond immediately to rising sewer levels. The flow of wastewater to the District's treatment/storage ponds was reduced by replacing 3,000 feet of sewer force main leading to the wastewater pond system, and installing a filter backwash wastewater recovery system at the LBRID WTP. LBRID currently sends all backwash wastewater to the pond system, and installation of the backwash recovery system will allow the District to recycle approximately one million gallons of backwash wastewater throughout the year.

Another project in progress is called the wastewater Ponds Groundwater Inflow Mitigation Project, and was mandated by the Central Valley Water Board through a Time Schedule Order in response to the discharges during the January to March 2017 storm events. The order requires the District to increase capacity in the treatment/storage ponds to accommodate a 100-year precipitation return period. The project will provide the means to prevent the inflow of groundwater into the pond system, and a construction contract will be finalized in 2024.

Finally, in response to the bank failures near the main wastewater tank that caused pipe supports to fail and ultimately spills into Putah Creek, the District recently completed a Slope Stabilization project to stabilize the bank and replace the pipes and supports that failed during the storms.

Summary of Findings for Wastewater

- All of the WWTPs discharge to evaporation or percolation ponds, so effluent violations do not directly impact the water quality in Lake Berryessa.
- All facilities have been recently inspected by the Regional Board, and no major violations or deficiencies were found.
- Out of all the wastewater facilities, the Hidden Valley CSD experienced the most number of SSOs entering a waterbody, mostly due to heavy rainfall in 2019.
- The LBRID WWTP implemented a number of projects to reduce flow to the pond system, which reduced the occurrence of SSOs over the reporting period.

LEAKING UNDERGROUND STORAGE TANKS

Background

Leaking underground storage tanks (USTs) can be a significant source of petroleum-based products to groundwater and may pose the following potential threats to health and safety:

- Exposure from contaminated soil and/or groundwater;
- Contamination of drinking water aquifers;
- Contamination of public or private drinking water wells;
- Inhalation of vapors.

Although leakage from underground storage tanks primarily affects groundwater, there is potential for surface water contamination if the contaminated groundwater is hydrogeologically connected to surface water. The potential for a leaking underground storage tank to impact surface water is also dependent on the magnitude of the spill, proximity of the spill to a waterway, and fate and transport characteristics of the contaminant.

Related Constituents

Contaminants of concern in underground storage tanks likely include hydrocarbons from gasoline and other petroleum-based products. Benzene is a major concern due to carcinogenic health effects.

Occurrence in Watershed

According to the Regional Board's Geotracker database, there is only one active leaking UST site within the watershed at the former Putah Creek Resort.

The leaking underground tank at the former Putah Creek Resort is located at 7600 Knoxville Road and was a former fueling station and convenience store at Putah Creek Resort. Petroleum hydrocarbons impacted the soil and groundwater beneath the site. From 2002 to 2012, various remedial technologies were implemented, but nothing was effective as a long-term remedy. In 2016, pilot testing for soil vapor extraction and air sparging indicated it would be viable for the remaining contamination. The main constituents of concern at the site are total petroleum hydrocarbons as gasoline, benzene, toluene, ethylbenzene, MTBE and total xylenes.

A corrective action plan was approved by the Central Valley Regional Water Quality Control Board in 2017. From 2017 to 2022, despite many requests from the Regional Board to submit updates on funding and remediation activities, little information was received until April 2022 when a Final Remediation Plan was submitted. The remediation plan proposes 28 sparging wells and 22 soil vapor extraction wells. Startup

of the remediation system was tentatively scheduled for November 2022. However, the air sparging system did not start until March 2024. The soil vapor extraction was briefly started but has not been operated due to high groundwater levels in the SVE wells. According to the remediation plan, an operation period of two to three years is expected for the remediation system.

Related Water Quality Issues and Data Review

Nineteen groundwater samples from nineteen monitoring wells and two surface water samples are collected from the lake every year. Water quality sampling is required in monitoring wells either semi-annually or annually. Lake samples are sampled annually. As shown in **Table 4-12**, no impacts to the lake have been confirmed in monitoring conducted to date.

Table 4-12. Groundwater Performance Monitoring Analytical Results – March 19, 2024, µg/L

Sample Location	TPH-G	Benzene	Toluene	Ethyl Benzene	Total Xylenes	MTBE	TBA	Napthalene	DCA
MW-1	250,000	35,000	3,000	7,000	30,000	1,000	<200	<200	<200
MW-2	<0.50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-3	130,000	15,000	2,300	1,000	5,300	<200	<200	<200	<200
MW-4	16,000	1,900	530	380	1,600	89	<100	<10	<10
MW-5	12,000	1,200	<5.0	180	22	44	<50	<5.0	<5.0
MW-6	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-7	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-8	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-9	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-10	<50	<0.50	<0.50	<0.50	<1.0	3.8	<5.0	<0.50	<0.50
MW-11	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-12	4,800	460	2,4	100	13	13	<5.0	42	<0.50
MW-13	<50	<0.50	<5.0	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
MW-14	Underwater								
MW-16	Underwater								
MW-17	Underwater								
MW-18	3,300	300	<5.0	5.2	15	56	<5.0	<5.0	<5.0
MW-19	Underwater								
MW-20	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
Lake 1	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50
Lake 2	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<5.0	<0.50	<0.50

There were no detects of hydrocarbons, MTBE, benzene, or other VOCs in the NBRID influent over the reporting period related to leaking underground storage tanks.

Regulation and Management

The Regional Board's Underground Storage Tank Section directs environmental cleanup activities at leaking UST sites. Such sites include active and inactive gasoline stations, agricultural sites, brownfield redevelopment sites, airports, bulk petrochemical storage terminals, pipeline facilities, and various chemical and industrial facilities. Local agencies manage the majority of leaking UST sites in the region. The local agencies work cooperatively with the Regional Board to manage cases in their jurisdiction.

Normally, the local agency handles the majority of leaking sites. The Regional Board typically handles the sites where groundwater has been impacted, or if the responsible party is recalcitrant.

The Putah Creek Resort site is regulated by the Regional Board under Cleanup and Abatement Order (CAO) R5-2009-0704. The water quality objectives are shown in **Table 4-13.** It is interesting to note that many of the chemicals with primary drinking water MCL are higher than the water quality objective. For example, toluene has a primary drinking water MCL of 150 µg/L, but it will be cleaned to 42 µg/L. Other chemicals with a higher drinking water MCL than the cleanup objective are ethylbenzene, total xylenes, and 1,2-DCA.

Table 4-13. Clean up (Water Quality Objectives) for Putah Creek Resort

Constituent	Limit, µg/L	Water Quality Objective
Total Petroleum Hydrocarbons as Gasoline	5	Taste and Odor
Benzene	1	California Primary MCL
Toluene	42	Taste and Odor
Ethylbenzene	29	Taste and Odor
Total Xylenes	17	Taste and Odor
MTBE	5	Taste and Odor
TBA (tertiary butyl alcohol)	12	California Drinking Action Level
DIPE (Di isopropyl ether_	0.8	Taste and Odor
1,2,-DCA (1,2-dichloroethane)	0.4	Toxicity
ETBE (ethyl tertiary butyl ether)	13	Toxicity
TAME (tertiary amyl methyl ether)	13	Toxicity

Source Water Protection Activities

This contaminating activity has the potential to impact source water quality, but no data exists to show that Lake Berryessa is currently impacted. Therefore, no source water protection activities are recommended at this time.

Summary of Findings for Leaking Underground Storage Tanks

- The latest remedial action plan for the former Putah Creek Resort has been approved. Air sparging and soil vapor extraction remedial systems have been recently tested in 2024. The full operation with soil vapor extraction wells cannot proceed with current high groundwater levels. .
- There were no detects of hydrocarbons, MTBE, benzene, or other VOCs in the NBRID influent over the reporting period related to leaking underground storage tanks.

FIRES

Background

The aftermath of a wildfire or prescribed burn can alter source water quality. In general, the load of dissolved substances to streams will increase following a wildfire, due to increased runoff. Increased runoff can occur following a fire because the formation of a hydrophobic organic layer in the soil increases the water repellency of soils (DeBano, 2000). A 2004 United States Geological Survey (USGS) study revealed that measurable effects of fires on streamwater quality are most likely to occur if the fire was severe enough to burn large amounts of organic matter, if windy conditions were present during the fire, if heavy rain occurred following the fire, and if the fire occurred in a watershed with steep slopes and soils with little cation-exchange capacity (USGS, 2004).

Related Constituents

The magnitude of the effects of fire on water quality is dependent on how fire characteristics (frequency, intensity, duration, and spatial extent of burning) interact with watershed characteristics (weather, slope, soil type, geology, land use, timing of regrowth of vegetation, and burn history). This interaction is complex and highly variable so that even fires in the same watershed can burn with different characteristics and produce variable effects on water quality. Typically, storm water runoff from burned forested areas contains high concentrations of phosphorus, nitrogen, dissolved organic carbon, sediment, and metals such as mercury, lead, and arsenic.

Occurrence in Watershed

There were two wildfires in over the reporting period. **Table 4-14** contains information about these fires and **Figures 4-4** and **4-5** show the fire burn areas for each fire. Additionally, wildfires occurred upstream of Lake Berryessa during the reporting period, such as Hennessey, Gamble, Green, Aetna, Spanish, Morgan, and Round fires which eventually merged and became the LNU Complex Fire.

SCWA conducted post-fire monitoring for both wildfires, which is presented in the next section.

Although outside of this reporting period, the Markley Cove fire occurred on February 25, 2023. The fire destroyed the dock as well as ten to twenty boats and/or jetskis. The fire was put out within three hours.

Table 4-14. Wildfires in the Lake Berryessa Watershed, 2018 to 2022

Fire Name	Dates or Date Started	Total Acres Burned
County	6/30-7/17/2018	90,288
Hennessey (LNU Complex)	8/17-9/30/2020	305,920

Figure 4-4. Burn Area for the 2018 County Fire

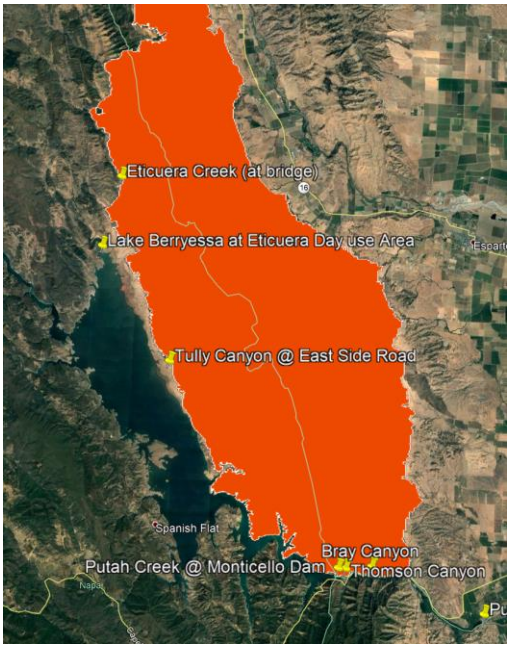
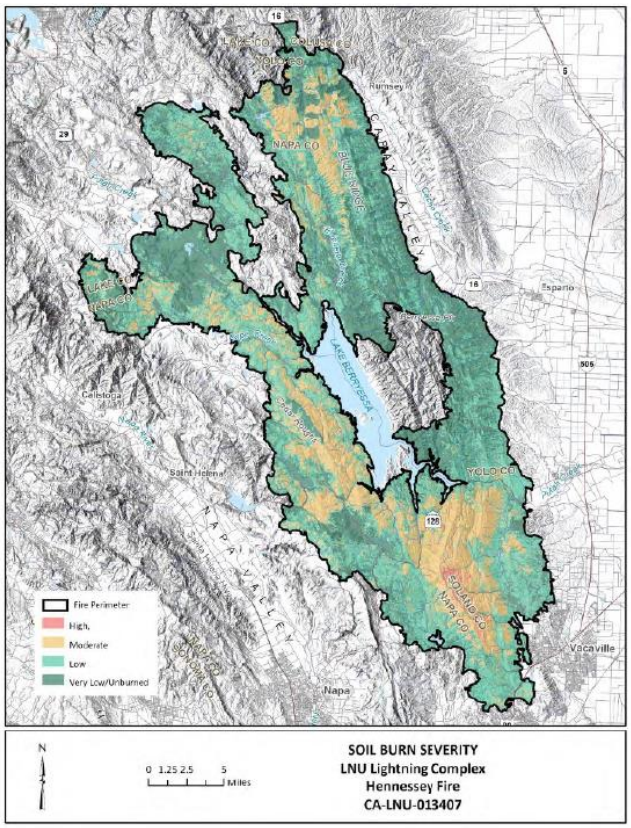


Figure 4-5. Burn Area for the 2020 LNU Complex Fire



Related Water Quality Issues and Data Review

Within the Lake Berryessa watershed, SCWA conducted post-fire monitoring after the 2018 County wildfire at two locations: Eticuera Creek and Lake Berryessa at Eticuera Day Use Area as shown in **Figure 4-3.** Samples were collected on January 7 and February 13, 2019, and results are shown in **Table 4-15.** Results shaded in yellow exceeded a primary MCL and results in orange exceeded a secondary MCL.

Aluminum, iron, manganese, and color were found at levels above their respective primary and secondary MCLs at both locations. These are commonly found in elevated levels in post-fire monitoring. Eticuera Creek had one sample above the MCL for mercury and nickel. Lake Berryessa at Eticuera Day Use Area had one sample above the MCL for lead and selenium. The detections of lead and selenium in the lake are notable, however levels decreased to non-detectable (ND) in the second (February) sampling.

Table 4-15. Post-fire Monitoring after 2018 County Fire – Lake Berryessa Sites

			EC	EC	ECDU	ECDU
Analyte	**Units**	**DL**	**1/7/2019**	**2/13/2019**	**1/7/2019**	**2/13/2019**
			EC	EC	ECDU	ECDU
Aggressive Index	[blank]		12	12	11	12
Aluminum	mg/L	0.023	1.5	16	ND	1.7
Barium	mg/L	0.023	ND	0.5	8.2	0.079
Calcium	mg/L	0.046	25	28	0.17	17
Iron	mg/L	0.014	2.3	25	13	2.8
Magnesium	mg/L	0.046	50	27	14	28
Manganese	mg/L	0.0045	0.04	1.5	24	0.1
Potassium	mg/L	0.91	2.6	3.2	0.38	ND
Sodium	mg/L	0.45	32	8.1	2.6	8.5
Zinc	mg/L	0.023	ND	0.11	5	ND
Antimony	ug/L	0.91	ND	ND	ND	ND
Arsenic	ug/L	1.2	ND	4.6	ND	ND
Beryllium	ug/L	0.45	ND	ND	2.2	ND
Cadmium	ug/L	0.45	ND	ND	ND	ND
Chromium	ug/L	4.5	13	42	ND	ND
Copper	ug/L	2.3	6.1	59	48	6.1
Lead	ug/L	0.45	ND	9.7	16	ND
Nickel	ug/L	4.5	28	120	ND	10
Selenium	ug/L	0.91	ND	ND	130	ND
Silver	ug/L	4.5	ND	ND	ND	ND
Thallium	ug/L	0.45	ND	ND	ND	ND
Mercury	ug/L	0.091	0.21	4.8	ND	ND
Chloride	mg/L	0.51	21	1.9	3	4.5

			EC	EC	ECDU	ECDU
Analyte	**Units**	**DL**	**1/7/2019**	**2/13/2019**	**1/7/2019**	**2/13/2019**
Fluoride	mg/L	0.042	ND	ND	ND	ND
Nitrate + Nitrite as N	mg/L	0.099	0.52	ND	0.57	ND
Nitrate as N	mg/L	0.099	0.52	ND	ND	ND
Nitrite as N	mg/L	0.020	ND	ND	ND	ND
Sulfate as SO4	mg/L	0.40	120	16	10	18
Acenaphthene	ug/L	0.0040	ND	ND	ND	ND
Acenaphthylene	ug/L	0.0023	ND	ND	ND	ND
Anthracene	ug/L	0.0020	ND	ND	0.32	ND
Benzo(a)anthracene	ug/L	0.0023	ND	ND	ND	ND
Benzo(a)pyrene	ug/L	0.0033	ND	ND	ND	ND
Benzo(b)fluoranthene	ug/L	0.0021	ND	ND	ND	ND
Benzo(g,h,i)perylene	ug/L	0.0039	ND	ND	ND	ND
Benzo(k)fluoranthene	ug/L	0.0028	ND	ND	ND	ND
Chrysene	ug/L	0.0011	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ug/L	0.0031	ND	ND	ND	ND
Fluoranthene	ug/L	0.0012	ND	ND	ND	ND
Fluorene	ug/L	0.0043	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ug/L	0.0027	ND	ND	ND	ND
Naphthalene	ug/L	0.0027	ND	ND	ND	ND
Phenanthrene	ug/L	0.0024	ND	ND	ND	ND
Pyrene	ug/L	0.0014	ND	ND	ND	ND
2-Fluorobiphenyl	ug/L		4.2	6.8	ND	6.8
p-Terphenyl-d14	ug/L		4.1	6.8	ND	7.1
Nitrobenzene-d5	ug/L		4.3	7.1	ND	7
Alkalinity as CaCO3	mg/L	3.0	190	70	4.3	140
Bicarbonate as CaCO3	mg/L	3.0	190	70	4.2	140
Carbonate as CaCO3	mg/L	3.0	ND	ND	4.6	ND
Hydroxide as CaCO3	mg/L	3.0	ND	ND	100	ND
Langelier Index	SI Units	-10	0.22	-0.24	110	0.042
Hardness as CaCO3	mg/L	0.19	270	180	1.5	160
Conductivity @ 25C	umhos/cm		660	190	82	310
Total Dissolved Solids	mg/L		420	150	82	170
Cyanide (total)	mg/L	0.0017	ND	ND	ND	ND
Dissolved Organic Carbon	mg/L	0.095	12	7.3	ND	ND
Total Organic Carbon	mg/L	0.085	12	7.1	-0.47	-0.8
MBAS, Calculated as LAS, mol wt 340	mg/L	0.021	0	ND	130	100
Absorbance at	1/cm		0.53	0.14	180	160

UV255nm						
pH (1)	pH Units			8	8.3	8.2
pH Temperature in °C	pH Units			19.6	22.6	19.3
Color, Apparent	CU	250		1000		100
Turbidity	NTU	0.50		1100		34

As a result of the 2020 LNU Complex Fire, SCWA conducted post-fire monitoring in January 2021 which is when the first rains occurred after the fire. Four locations were monitored: Lake Berryessa at Monticello Dam, Pope Creek (upstream of Lake Berryessa), Lake Berryessa at Spanish Flat Creek, and Lake Berryessa at Spanish Flat Creek downstream.

Table 4-16 is a summary of the post-fire monitoring conducted at the four locations in January 2021. Data shaded in yellow are greater than the primary drinking water MCL and data shaded in orange are greater than the secondary drinking water MCL. Overall, the constituents which were greater than their respective MCLs are constituents that have been previously shown at elevated levels such as aluminum, iron, manganese, conductivity and total organic carbon. Pope Creek had elevated levels of aluminum, iron and manganese. Spanish Flat Creek had elevated levels of conductivity, antimony and manganese. Spanish Flat Creek downstream had elevated levels of iron. All locations had a few polycyclic aromatic hydrocarbons detected.

After the January 2021 storm, the next storm did not occur until October 2021. Unfortunately, post fire monitoring did not occur in October 2021, as early heavy rains were not expected at the time and SCWA staff was not able to mobilize quickly. Debris flow from the 2020 LNU fire contributed to build-up of sediment in the creek which feeds the LBRID WTP. Sediment build-up and drought conditions caused creek flow to nearly cease. This required installation of a temporary pumping system to pump water nearly a mile further upstream. Specific water quality impacts at LBRID were taste and odor compounds, turbidity and disinfection by-products.

Impacts to the NBRID WTP were turbidity and sediment from post-fire debris flows, which required adjustment of plant processes. Additionally, the 2021 CCR for LBRID indicated that primary MCL for aluminum was exceeded, as well as the secondary MCLs for iron and manganese. Over the reporting period no other years had elevated concentrations for aluminum, iron, and manganese, except for 2021. Due to this, and the results in **Table 4-16**, it appears that these impacts at NBRID are a result of the LNU Complex Fire.

Table 4-16. Post-fire Monitoring after LNU Complex Fire – Lake Berryessa Sites

METHODCODE	ANALYTE	Units	Lake Berryessa below Monticello Dam	Lake Berryessa at Pope Creek	Lake Berryessa at Spanish Flat Creek	Lake Berryessa at Spanish Flat Creek (downstream)
Aggressive Index	Aggressive Index	AGGR	12.00	13.00	11.00	12.00
S-Title 22 - GM/IO/GP	Hardness as CaCO3	mg/L	170.00	360.00	440.00	180.00
Aluminum, CA DW ICP	Aluminum	mg/L	ND	2.40	0.20	0.23
Aluminum, CA DW ICP Dissolved	Aluminum	mg/L	ND	ND	ND	ND
Barium, CA DW ICP	Barium	mg/L	0.06	0.13	0.17	0.07
Barium, CA DW ICP Dissolved	Barium	mg/L	0.06	0.09	0.17	0.07
Calcium, CA DW ICP	Calcium	mg/L	18.00	30.00	110.00	22.00
Calcium, CA DW ICP Dissolved	Calcium	mg/L	18.00	28.00	110.00	25.00
Iron, CA DW ICP	Iron	mg/L	0.04	3.70	0.18	0.33
Iron, CA DW ICP Dissolved	Iron - Dissolved (1)	mg/L	ND	ND	ND	0.02
Magnesium, CA DW ICP	Magnesium	mg/L	30.00	70.00	40.00	31.00
Magnesium, CA DW ICP Dissolved	Magnesium	mg/L	31.00	67.00	42.00	33.00
Manganese, CA DW ICP	Manganese	mg/L	ND	0.11	0.06	0.05
Manganese, CA DW ICP Dissolved	Manganese - Dissolved (1)	mg/L	ND	ND	0.05	0.03
Potassium, CA DW ICP	Potassium	mg/L	1.30	2.10	4.50	1.50
Potassium, CA DW ICP Dissolved	Potassium	mg/L	1.40	1.80	4.50	1.50
Sodium, CA DW ICP	Sodium	mg/L	9.60	17.00	22.00	12.00
Sodium, CA DW ICP Dissolved	Sodium	mg/L	9.90	17.00	23.00	14.00
Zinc, CA DW ICP	Zinc	mg/L	ND	ND	0.07	ND
Zinc, CA DW ICP Dissolved	Zinc	mg/L	ND	ND	0.06	ND
Antimony, CA DW ICPMS	Antimony	ug/L	ND	ND	6.20	ND
Antimony, CA DW ICPMS Dissolved	Antimony	ug/L	ND	ND	5.50	ND
Arsenic, CA DW ICPMS	Arsenic	ug/L	ND	1.90	6.50	ND
Arsenic, CA DW ICPMS Dissolved	Arsenic	ug/L	ND	ND	5.00	1.20
Beryllium, CA DW ICPMS	Beryllium	ug/L	ND	ND	ND	ND
Beryllium, CA DW ICPMS Dissolved	Beryllium	ug/L	ND	ND	ND	ND
Cadmium, CA DW ICPMS	Cadmium	ug/L	ND	ND	ND	ND
Cadmium, CA DW ICPMS Dissolved	Cadmium	ug/L	ND	ND	ND	ND
Chromium, CA DW ICPMS	Chromium	ug/L	ND	14.00	42.00	ND
Chromium, CA DW ICPMS Dissolved	Chromium	ug/L	ND	ND	36.00	ND
Copper, CA DW ICPMS	Copper	ug/L	ND	31.00	14.00	ND
Copper, CA DW ICPMS Dissolved	Copper	ug/L	ND	7.40	11.00	ND
Lead, CA DW ICPMS	Lead	ug/L	ND	1.70	ND	ND
Lead, CA DW ICPMS Dissolved	Lead	ug/L	ND	ND	ND	ND
Nickel, CA DW ICPMS	Nickel	ug/L	ND	30.00	ND	ND
Nickel, CA DW ICPMS Dissolved	Nickel	ug/L	ND	4.80	ND	ND
Selenium, CA DW ICPMS	Selenium	ug/L	ND	ND	8.40	ND
Selenium, CA DW ICPMS Dissolved	Selenium	ug/L	ND	ND	6.60	1.00
Silver, CA DW ICPMS	Silver	ug/L	ND	ND	ND	ND
Silver, CA DW ICPMS Dissolved	Silver	ug/L	ND	ND	ND	ND
Thallium, CA DW ICPMS	Thallium	ug/L	ND	ND	ND	ND
Thallium, CA DW ICPMS Dissolved	Thallium	ug/L	ND	ND	ND	ND
Mercury, WW CVAA	Mercury	ug/L	ND	ND	0.31	ND
Mercury, WW CVAA Dissolved	Mercury	ug/L	ND	ND	0.15	ND
Ammonia, CFA	Ammonia as N	mg/L	ND	ND	0.20	ND
TKN	Total Kjeldahl Nitrogen	mg/L	ND	0.42	2.10	ND
Phosphorus	Phosphorus	mg/L	ND	0.25	0.53	0.17
Phosphorus as PO4	Phosphorus as PO4	mg/L	ND	0.77	1.60	0.51

Table 4-16. Post-fire Monitoring after LNU Complex Fire – Lake Berryessa Sites Continued

METHODCODE	ANALYTE	Units	Lake Berryessa below Monticello Dam	Lake Berryessa at Pope Creek	Lake Berryessa at Spanish Flat Creek	Lake Berryessa at Spanish Flat Creek (downstream)
Polycyclic Aromatic Hydrocarbons						
EPA 8270C - PAH Low Level	Acenaphthene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Acenaphthylene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Anthracene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Benzo(a)anthracene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Benzo(a)pyrene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Benzo(b)fluoranthene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Benzo(g,h,i)perylene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Benzo(k)fluoranthene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Chrysene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Dibenzo(a,h)anthracene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Fluoranthene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Fluorene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Indeno(1,2,3-cd)pyrene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Naphthalene	ug/L	-	0.01	ND	ND
EPA 8270C - PAH Low Level	Phenanthrene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	Pyrene	ug/L	-	ND	ND	ND
EPA 8270C - PAH Low Level	2-Fluorobiphenyl	ug/L	-	3.8	3.7	3.6
EPA 8270C - PAH Low Level	Nitrobenzene-d5	ug/L	-	3.9	3.9	3.8
EPA 8270C - PAH Low Level	p-Terphenyl-d14	ug/L	-	3.7	3.5	3.5
Alkalinity as CaCO3	Alkalinity as CaCO3	mg/L	150	230	53	160
Alkalinity as CaCO3	Bicarbonate as CaCO3	mg/L	150	230	53	160
Alkalinity as CaCO3	Carbonate as CaCO3	mg/L	ND	ND	ND	ND
Alkalinity as CaCO3	Hydroxide as CaCO3	mg/L	ND	ND	ND	ND
Langelier Index	Langelier Index	LANG	0.096	0.51	-0.66	-0.016
EC, Conductivity	Conductivity @ 25C	umhos/cm	350	670	1000	400
TDS, Total Dissolved Solids	Total Dissolved Solids	mg/L	210	430	860	250
TSS, Total Suspended Solids	Total Suspended Solids	mg/L	ND	67	ND	14
Cyanide, Total	Cyanide (total)	mg/L	ND	0.0023	ND	ND
DOC, Dissolved Organic Carbon	Dissolved Organic Carbon	mg/L	2.4	5.5	10	3.6
TOC, Total Organic Carbon	Total Organic Carbon	mg/L	2.6	6	10	3.8
MBAS	BAS, Calculated as LAS, mol wt 3	mg/L	ND	ND	0.048	ND
S-Total Nitrogen (calc)	Total Nitrogen	mg/L	ND	ND	11	0.56
S-Chloride	Chloride	mg/L	5.9	15	160	8.6
S-Fluoride	Fluoride	mg/L	0.08	0.063	0.091	0.097
S-Nitrate-N	Nitrate as N	mg/L	ND	ND	9	0.56
S-Nitrite	Nitrite as N	mg/L	ND	ND	ND	ND
S-Sulfate	Sulfate as SO4	mg/L	23	110	180	29
S-Color	Color, Apparent	CU	5	75	45	15
S-Turbidity	Turbidity	NTU	1.1	21	2.9	2.5
S-Odor	Threshold Odor	T.O.N.	1.8	4.7	6	3
S-Color pH	Color pH (1)	pH Units	7.8	8.3	7.5	8.3
S-pH, Drinking and Wastewaters	pH (1)	pH Units	8.3	8.3	7.3	8.1
S-pH, Drinking and Wastewaters	pH Temperature in °C	pH Units	21.1	21.4	20.2	20.9

The use of approved long-term retardants in wildland fire suppression is standard in fire management and planning. The retardants are most often delivered in fixed or rotor-wing aircraft. The fire retardant commonly used is Phos-Check. Fire retardant is 88 percent water and 12 percent ammonium phosphate, commonly found in fertilizers, which acts as the fire-retardant component. Other ingredients include gum thickeners to help the retardant stick to vegetation. The use of fire retardants can impact water quality if it was accidentally dropped into a waterbody, or if heavy rains occur before the product has had time to naturally degrade.

The National Interagency Fire Center has developed *Interagency Standards for Fire and Fire Aviation Operations* which are annually revised. The *Interagency Standards for Fire and Fire Aviation Operations* states, references, or supplements policy for U.S. Bureau of Land Management, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the National Park Service. Regarding the use of fire retardants, the Aerial Application Guidelines are to "avoid aerial or ground application of retardant or foam within 300 feet of waterways."

Summary of Findings for Fires

- Post-fire water quality monitoring showed that iron, manganese and aluminum are the most common constituents detected above respective primary or secondary MCLs. Post-fire water quality monitoring data from the County and LNU Complex fire, showed that heavy metals such as antimony, lead, nickel and mercury were also sporadically detected. It is difficult to assess the long-term effects of these fires, as samples were collected only once after the LNU Complex Fire and twice after the County Fire.

- Both the LBRID and NBRID WTPs were impacted after the 2020 LNU Complex fire with elevated turbidities, which necessitated the operators to adjust plant processes. Additionally, the LBRID WTP had to install a temporary pumping system to pump water nearly a mile further upstream, due to the creek becoming nearly dry from sediment buildup and drought. The NBRID WTP also exceeded the MCLs for aluminum, iron and manganese as discussed in the 2021 CCR, which is likely due to post-fire impacts from the LNU Complex fire.

ABANDONDED/INACTIVE MINES

Background

Mining has occurred in the upper regions of the Lake Berryessa/Putah Creek watershed since the 1850s. The vast majority of mines in this region for mercury, gravel and other materials are abandoned. There are a number of databases containing information about mines. The United States Geological Survey (USGS) and the California Department of Conservation both have an online mapping inventory of mine sites which was queried, and the Westside Brownfields Coalition also inventoried abandoned mines in the Lake, Napa, Solano, Colusa, and Yolo Counties. The Westside Brownfields Coalition report was completed in 2016 and discussed extensively in the previous WSS. This Update will only discuss new findings and work conducted by the Westside Brownfields Coalition since the previous WSS.

Related Constituents

Water draining from abandoned mines can be highly acidic. Acidic mine drainage can contain metals such as nickel and mercury. Mercury is toxic after it transforms and magnifies its concentration in fish.

Occurrence in Watershed

Based on the information queried from the USGS, the California Department of Conservation, and the Westside Brownfields Coalition, there are no active mines in the Lake Berryessa watershed. There are inactive mines, which are discussed below and summarized in **Table 4-17** with locational information.

Table 4-17. Abandoned/Inactive Mines in Lake Berryessa Watershed

Name of Mine	Locational Information (Longitude, Latitude)
McLaughlin Mine	-122.35796, 38.83568
Knoxville Mine	-122.3389, 38.8253
Pope Creek/Blue Rock Quarry	APN 18-080-023
Plymouth Mine	-122.5911, 38.6969
Jewess Mine	-122.6875, 38.7357
Red Elephant Mine	-122.405, 38.8346

United States Geological Survey (USGS)

The USGS has a database of mine sites. Within the Lake Berryessa watershed there were two mines: McLaughlin Mine and Knoxville Mine which are both located in the upper watershed, just inside the watershed boundary, close to the McLauglin Reserve. Please see **Figure 4-6** for the locations. The McLaughlin Mine ceased operation in

1996 and was a gold and silver mine. The Knoxville Mine ceased operation in 1948 and was a mercury mine.
https://mrdata.usgs.gov/mrds/map-graded.html

California Department of Conservation

The California Department of Conservation has a Mines Online database. Within the Lake Berryessa watershed there were two mines, the McLaughlin Mine (mentioned above) and the Pope Creek/Blue Rock Quarry. Mining ceased at the Pope Creek/Blue Rock Quarry in 2008, and processing ceased in 2013.
https://maps.conservation.ca.gov/mol/index.html

Westside Brownfields Coalition Assessment

As discussed in the previous Update, the Westside Brownfields Coalition Assessment Project created an interactive database of mine sites, assessed prioritized mine-scarred sites in the area, and evaluated sites for potential cleanup. Brownfields are properties that are difficult sites for expansion, redevelopment, and reuse due to contaminants such as hazardous materials, pollutants, petroleum or mine waste.

In 2016, the project completed a number of maps to identify Brownfield priority sites. These maps were included in the previous Update to give a sense of the locations of historical mines.

A report entitled “Westside Brownfields Coalition Assessment” was completed in October 2019. The targeted communities are within the counties of Colusa, Lake, Napa, Solano and Yolo. The report describes the process of identifying sites and then prioritizing them for site assessment. This project focused on mercury mines for several reasons: 1) there are few mercury mines in this region that have been characterized, and 2) mercury contamination persists in both soil and water.

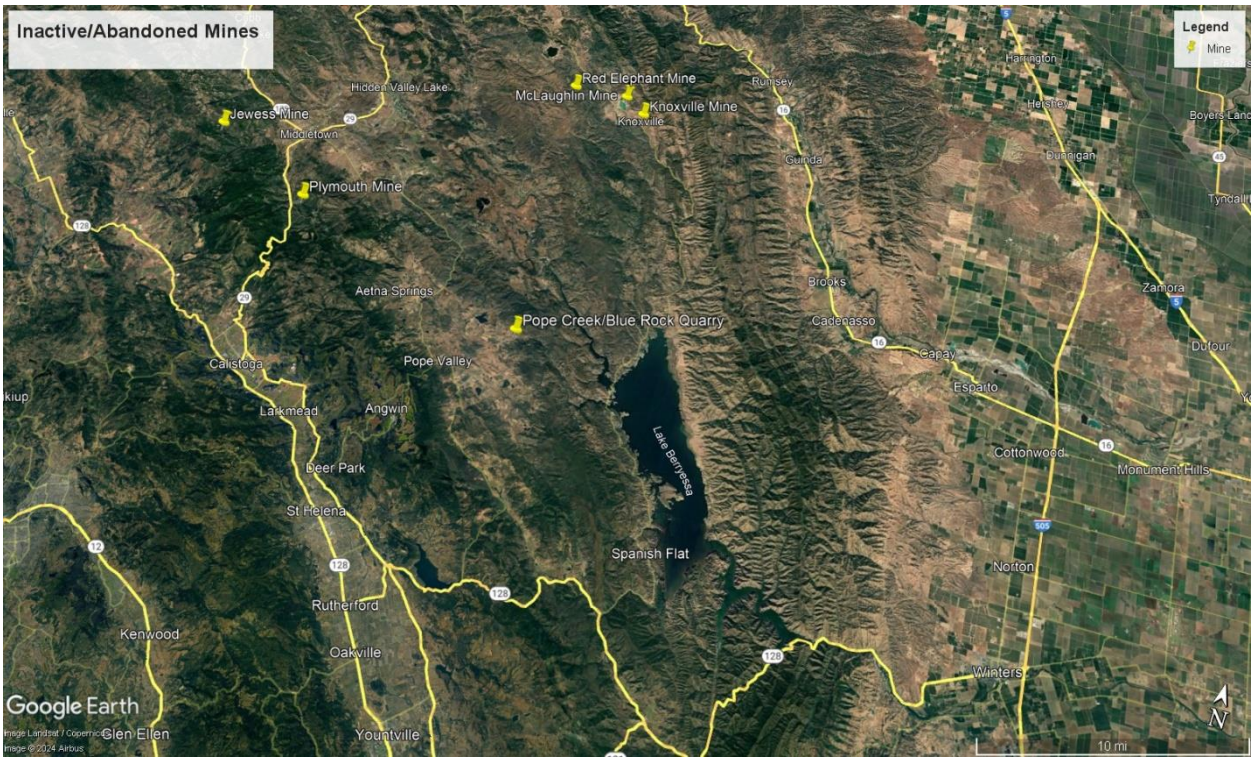
The process revealed that these sites are challenging due to their remote location (far from population centers and on steep terrain) and are not clearly suitable for traditional development and reuse. Additionally, many landowners had concerns that a brownfield assessment on their property could result in regulatory enforcements actions. Without that reassurance, few landowners allowed brownfields assessments of their property.

Due to concerns from landowners, although 50 sites were prioritized, only three properties with abandoned mercury mines received a Phase 1 Environmental Site Assessment (ESA), which were Jewess Mine, Plymouth Mine and Red Elephant Mine. Only two sites received a Phase 2 ESA, which were the Plymouth Mine and Willow Slough informal firing range. Of these sites, all are within the Lake Berryessa watershed, except for the Willow Slough firing range.

According to McCord Environmental, with the exception of the Red Elephant Mine which was inspected by the Regional Board in 2024, none of the other sites mentioned above

have moved forward with additional inspections or physical improvements. The Regional Board did not have any recommendations after their inspection of the Red Elephant Mine.

Figure 4-6. Inactive/Abandoned Mines in the Lake Berryessa Watershed



Related Water Quality Issues and Data Review

Methyl Mercury sources come from legacy gold mining activity, atmospheric deposition, and natural geology. SCWA has not collected water quality samples for mercury at Lake Berryessa in the past, but only at downstream locations from Monticello Dam. The issue of mercury is not a drinking water concern due to the detection levels being drastically low in comparison to drinking water MCLs.

Regulation and Management

Waste discharges from active and inactive mines are primarily regulated by California Code of Regulations Title 27. The Central Valley Regional Water Quality Control Board has a Mining Program which oversees the discharge to land of mining waste from active and inactive mines. The goal of the mining program for inactive mines is to eliminate surface and groundwater impacts from past mining and prevent any further degradation of waters of the State. Discharges from active mines are regulated through the issuance of waste discharge requirements and will usually regulate all of the surface impoundments, tailing ponds, and waste piles.

Source Water Protection Activities

Lake Berryessa Watershed Improvement Program

In order to fund flood control and watershed improvement projects to benefit urban regions and rural unincorporated areas of Napa County, the Napa Flood Protection Sales Act (Measure A) collected revenue from 1999 to 2018.

In total $1.7M of Measure A tax revenue proceeds were set aside for Lake Berryessa Watershed preservation. Three (3) Lake Berryessa Watershed projects were selected for Funding Agreements in the fiscal year 2018 kickoff period. The following projects are mentioned as they will ultimately improve water quality by restoring the Lake Berryessa watershed.

Oat Hill Mine Road Flood and Erosion Control Improvements Project

This project will implement improvements (ditches, inlets, culverts, outlets) to about 25 drainage crossings along Oat Hill Mine Road, which passes by legacy mercury mines. Existing culverts are/were undersized and improperly installed. This project will reduce flooding, improve road access and reduce sediment and heavy metal loads to Bateman, Kidd and James creeks. In 2019, the Napa County Resource Conservation District collected data to identify and quantify road-related erosion and sediment delivery to streams in the James Creek subwatershed, a tributary in the Putah Creek watershed.

Post-Fire Restoration in Hunting Creek Watershed

Due to severe fire damage and associated erosion caused by wildfires in 2015 and 2020, this project will address a number of issues:

- Restoration of 4-mile Cedar Creek Trail in Bureau of Land Management's Knoxville Management Area. The land is charred and denuded, and the trail needs to be reshaped and restored.
- Remove partially failed Aikawa Dam
- Recontour and stabilize banks of a retention pond in McLaughlin Reserve.

This project will construct cost-effective reliable trail and water crossing improvements, providing safe trail access for users, and will rehabilitate a fire-scarred, mineral rich area. It should be noted that there are many abandoned mines in this area.

Erosion Control, Road Remediation and Meadow Restoration in Upper Hunting Creek Watershed

The McLaughlin Reserve has a sensitive and botanically diverse serpentine meadow. Soil loss in this system has been accelerated by abandoned roads and failed drainage structures. Invasive species are also a concern.

This project will (1) arrest erosion--caused mostly by abandoned roads and failed drainage structures, (2) slow runoff and reduce sediment input into Hunting Creek, and (3) finish the eradication of the invasive barbed goatgrass in the upper reaches of the Hunting Creek watershed. Conservation crews will construct water bars and rock structures to restore natural drainage patterns and armor vulnerable erosion points.

Summary of Findings for Abandoned/Inactive Mines

- The California Department of Conservation, USGS, and the Westside Brownfields Coalition Assessment Project provided information on location of historical mines in the watershed. The closest mine to Lake Berryessa is the Pope Creek/Blue Rock Quarry. Mining ceased at the Pope Creek/Blue Rock Quarry in 2008, and processing ceased in 2013.

- Napa County has implemented three watershed improvement projects which will improve water quality to Lake Berryessa as they address fire-scarred areas, reduce erosion and flooding, and reduce sediment and heavy metal loading downstream.

- The issue of mercury is related to fish consumption as it can accumulate in fish tissue. It is not a drinking water concern due to the detection levels being drastically low in comparison to drinking water MCLs.

SECTION 5 – KEY FINDINGS AND RECOMMENDATIONS

This section consists of a discussion of key findings, update on recommendations from the 2018 watershed sanitary survey and a list of current recommendations.

KEY FINDINGS

It is important to understand that the intakes to the LBRID and NBRID WTPs are different as the LBRID WTP intake is located beneath the gravel bed of Putah Creek and the NBRID intake is located in Lake Berryessa. As creek water quality is more susceptible to changes, especially after fires and during/after storms, the LBRID water treatment plant (WTP) typically experiences wider variations in water quality. However, it should be noted that a new intake was installed for LBRID in the fall of 2022, which extended the intake pipe further into the creek alluvium. This should provide some natural filtration of the water prior to the LRBID treatment processes.

Additionally, the different geographical locations of the LBRID and NBRID WTPs may mean that certain potential contaminating activities are less relevant. For example, the leaking underground storage tank at the former Putah Creek Resort is downstream of the LBRID WTP and will not affect the source water quality of the LBRID WTP. Additionally, although swimming and boating may occur in Lake Berryessa, all campgrounds and resorts are located downstream of the LBRID WTP, indicating less impact on the LBRID WTP from recreational activities. However, all seven potential contaminating activities discussed in this report are relevant for the NBRID WTP.

Water Quality

Turbidity

- Median source water turbidity was 4.2 NTU for the LBRID WTP and 1.8 NTU for the NBRID WTP. There can be periods where levels exceed that substantially, up to 100 NTU and higher at the LBRID WTP and 20-70 NTU at the NBRID WTP. These excursions are associated with storm water runoff caused by intense winter storms, particularly evident in March 2019.
- LBRID is more susceptible to changes in water quality due to the diversion location in Putah Creek, versus lake withdrawal at NBRID. Due to the relocation of the LBRID intake pipe deeper into the creek alluvium in the fall of 2022, this should provide additional protection from fluctuation in creek water quality.

Microbial Constituents

- Source water *E. coli* levels are low, with medians at 5.2 MPN/100mL or less.
- Overall, the NBRID WTP has lower *E. coli* and total coliform levels than the LBRID WTP.
- Over the reporting period, all individual *E. coli* samples at the NBRID WTP were well below the 200 MPN/100 mL threshold.

- Over the reporting period, all individual *E. coli* samples at the LBRID WTP were below the 1,000 MPN/100 mL threshold, except for one sample in February 2019, which was greater than 2,419 MPN/100mL.
- Therefore, 2-log *Cryptosporidium*, 3-log *Giardia,* and 4-log virus removal and inactivation is the appropriate level of treatment for both WTPs.
- The second round of LT2 monitoring was completed in September 2018 and was a Bin 1 classification for LBRID and NBRID.

Total Organic Carbon

- Median TOC concentrations were 3.3 mg/L for LBRID and 3.1 mg/L for NBRID.
- Source water TOC peak of 17 mg/Lin March 2019 at LBRID is likely attributed to heavy rainfall in both January and February 2019.
- TOC can also be elevated in the summer to early fall time period, particularly in dry years such as 2020 and 2021, due to algal blooms.
- Enhanced coagulation is required for the plants that treat Lake Berryessa water because the source water TOC is routinely above 2 mg/L and they implement conventional treatment processes.

Cyanotoxins

- There is no routine monitoring for cyanotoxins in Lake Berryessa. The State Water Resources Control Board sampled four locations in June 2022. No cyanotoxins were detected.

Potential Contaminant Sources

Spills

- There were seven non-sewage related spills which occurred directly into Lake Berryessa, all due to sunken boats and one aircraft
- About 50 percent of the spills occurred on land, and 50 percent impacted a waterway.
- Although spills have potential to contaminate lake, there was none of significance during the reporting period. Please see Wastewater section for information on sewage-related spills.

Recreation

- Currently, all recreational areas are open except for Monticello Shores and Berryessa Point. Steele Canyon and Berryessa Point are currently in development with a long-term private concessionaire. Improvements to the NBRID water treatment plant will likely include additional treatment capacity and potable water storage capacity, and will be dependent on the final development plans at Steele Canyon.

- All of the recreation areas are downstream of the LBRID WTP. Therefore, only the NBRID WTP is directly impacted. *E. coli* and fecal coliform levels at the NBRID WTP are very low, with an average non-detect and a median of <1 MPN/100mL from 2018 to 2022, indicating no impact from recreation.
- The Solano County Boater Outreach Program is a very effective program to screen for invasive mussels, but also promote clean and safe boating practices.
- There were no spills reported in regards to the gas docks or sewage pump out located at the marinas.

Agriculture

- There is limited agriculture use in the watershed, of which, 99.7 percent are wine grapes.
- As wine grapes are drip irrigated, irrigation related pesticide or fertilizer transport is highly unlikely to occur in this watershed.
- Based on the 2018 to 2022 chemical use data from Napa County Agricultural Commissioner's Office, the highest chemical usage in pounds are all sulfur-based products and do not have an associated MCL in drinking water. Glyphosate is the only product applied in high amounts and also of concern to drinking water due to its MCL of 700 µg/L.
- Commercial growers are required to be enrolled in the Central Valley Regional Water Quality Control Board's Irrigated Lands Program, and most growers are likely participating in the Sacramento Valley Water Quality Coalition, through the Napa County Putah Creek Watershed Group.
- Copper, simazine and glyphosate are the only pesticides used in the watershed draining to Lake Berryessa for which drinking water standards have been established. Monitoring data collected at the LBRID and NBRID WTPs water show low levels of copper (less than 50 µg/L), no detections of simazine, and no detections of glyphosate at the NBRID WTP.

Wastewater

- All of the wastewater treatment plants (WWTP) s discharge to evaporation or percolation ponds, so effluent violations do not directly impact the water quality in Lake Berryessa.
- All facilities have been recently inspected by the Regional Board, and no major violations or deficiencies were found.
- Out of all the wastewater facilities, the Hidden Valley CSD experienced the most number of SSOs entering a waterbody, mostly due to heavy rainfall in 2019.
- The LBRID WWTP implemented a number of projects to reduce flow to the pond system, which reduced the occurrence of SSOs over the reporting period.

Leaking Underground Storage Tanks

- The latest remedial action plan for the former Putah Creek Resort has been approved. Air sparging and soil vapor extraction remedial systems have been recently tested in 2024. The full operation with soil vapor extraction wells cannot proceed with current high groundwater levels. .
- There were no detects of hydrocarbons, MTBE, benzene, or other volatile organic compounds (VOC)s in the NBRID influent over the reporting period related to leaking underground storage tanks.

Fires

- Post-fire water quality monitoring showed that iron, manganese and aluminum are the most common constituents detected above respective primary or secondary MCLs. Post-fire water quality monitoring data from the County and LNU Complex fire, showed that heavy metals such as antimony, lead, nickel and mercury were also sporadically detected. It is difficult to assess the long-term effects of these fires, as samples were collected only once after the LNU Complex Fire and twice after the County Fire.
- Both the LBRID and NBRID WTPs were impacted after the 2020 LNU Complex fire with elevated turbidities, which necessitated the operators to adjust plant processes. Additionally, the LBRID WTP had to install a temporary pumping system to pump water nearly a mile further upstream, due to the creek becoming nearly dry from sediment buildup and drought. The NBRID WTP also exceeded the MCLs for aluminum, iron and manganese as discussed in the 2021 CCR, which is likely due to post-fire impacts from the LNU Complex fire.

Abandoned/Inactive Mines

- The California Department of Conservation, United States Geological Survey, and the Westside Brownfields Coalition Assessment Project provided information on location of historical mines in the watershed. The closest mine to Lake Berryessa is the Pope Creek/Blue Rock Quarry. Mining ceased at the Pope Creek/Blue Rock Quarry in 2008, and processing ceased in 2013.
- Napa County has implemented three watershed improvement projects which will improve water quality to Lake Berryessa as they address fire-scarred areas, reduce erosion and flooding, and reduce sediment and heavy metal loading downstream.
- The issue of mercury is related to fish consumption as it can accumulate in fish tissue. It is not a drinking water concern due to the detection levels being drastically low in comparison to drinking water MCLs.

UPDATE ON 2018 RECOMMENDATIONS

The 2018 Update recommended several actions that Napa County Flood Control and Water Conservation District and SCWA should take to protect source water quality. These recommendations and the agencies' responses are discussed in **Table 5-1.**

Table 5-1. Recommendations from 2018 Watershed Sanitary Survey

2018 Update Recommendation	Summary of Actions Taken b
1) Continue to optimize treatment during periods of reduced or changing source water quality.	This is an on-going effort at both WTPs.
2) Continue to provide 3/4/2-log reduction for *Giardia*/virus/*Cryptosporidium.*	This is an on-going effort at both WTPs.
3) Napa County to begin submitting *E. coli* data for Round 2 Long Term 2 Enhanced Surface Water Treatment Rule.	Completed in September 2018.
4) Napa County and SCWA should review plans for new wastewater facilities associated with new or redeveloped recreation areas to ensure that adequate pond capacity is provided and that the ponds are located as far from Lake Berryessa as possible.	Napa County is involved with development plans for new recreation areas at Lake Berryessa.
5) SCWA and Napa County should continue to support and participate in the Lake Berryessa Partnership.	This is an on-going effort.

RECOMMENDATIONS

Table 5-2 presents the recommendations developed for this Fifth Update, listed by subject area and not by priority. Development of recommendations for watershed management actions that are economically feasible and within the authority of Napa County and SCWA is critical. Recommendations will be implemented as resources are available.

Table 5-2
Recommendations for 2023 Watershed Sanitary Survey

Recommendation	Basis for Recommendation
1) Consider sampling for glyphosate during rainy season at LBRID due to application in the watershed.	Glyphosate is applied in the watershed and also of concern to drinking water due to its MCL of 700 µg/L. Normally, it is applied to land during the November to February time period. Glyphosate is currently monitored at NBRID.
2) Track *E. coli* levels in source water at NBRID to determine if any long-term increases are occurring.	*E. coli* levels could potentially increase with increased development and visitation to lake.
3) Consider conducting post-fire monitoring for two to-three winters after the fire.	Long-term impacts may not be evident in the first winter after a fire, particularly if it was a dry winter.

APPENDIX A: BIBLIOGRAPHY AND LIST OF CONTACTS

Email Communication, Vera Fischer, Central Valley Water Quality Control Board, (916)464-4792, Vera.Fischer@waterboards.ca.gov (Leaking Underground Storage Tanks)

Email Communication, Jennifer Onufer, US Bureau of Reclamation, Recreation, jonufer@usbr.gov

Email Communication, Kevin Richards, US Bureau of Reclamation, Recreation and Wastewater, krichards@usbr.gov

Phone and Email Communication, Leigh Sears, Napa County, Recreation, leigh.sears@countyofnapa.org

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Email Communication, Guy Childs, Central Valley Water Quality Control Board, (916)464-4648, Guy.Childs@waterboards.ca.gov

Email and Personal Communication, Andre Napolitano, County of Napa Agriculture Commissioners Office, (707) 253-4357, andre.napolitano@countyofnapa.org

Email Communication, Mike Trouchon, Irrigated Lands Monitoring, LWA Associates, michaelt@lwa.com

Email Communication, Dana Schultz, Harmful Algal Blooms, dana.schultz@waterboards.ca.gov

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Email Communication, Stephen McCord, Brownfields Site Assessment, sam@mccenv.com

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CIWQS for Inspection Reports and Permits for Wastewater Treatment Plants
https://www.waterboards.ca.gov/ciwqs/