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San Lorenzo River and North Coast Watersheds Sanitary Survey Update

FINAL

Photo courtesy of San Lorenzo Valley Water District

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San Lorenzo River and North Coast Watersheds Sanitary Survey Update

March 6, 2023

Prepared for

City of Santa Cruz
715 Graham Hill Road
Santa Cruz, California 95060
In association with
San Lorenzo Valley Water District

K/J Project No. 2268009*00

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Table of Contents

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

Table of Contents (cont'd)

List of Tables

Table of Contents (cont'd)

List of Figures

Table of Contents (cont'd)

List of Appendices

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Executive Summary

Watershed sanitary surveys are required by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW), formerly the California Department of Public Health, to be completed for each watershed that is a drinking water source. Updates are required every five years per the State of California Surface Water Treatment regulations (Chapter 17, Title 22). These requirements incorporate the Surface Water Treatment Rule (SWTR) mandated by the United States Environmental Protection Agency (EPA) and enforced by DDW as a primacy agency for federal regulations.

This sanitary survey includes the San Lorenzo River and North Coast watersheds, all within Santa Cruz County, California. This update reflects changes that have occurred since the 2018 update was prepared.

Watersheds and Water Supply Systems: - The City of Santa Cruz (City) owns 3,880 acres, and San Lorenzo Valley Water District (SLVWD) owns 2,291 acres of the estimated 76,400 total acres within the San Lorenzo River watershed upstream of the Tait Street Diversion. While the City and SLVWD can influence water quality management activities within the lands they control, protection of the majority of other lands requires outside entities, including Santa Cruz County (County), California State Parks, and non-profit organizations to protect watershed lands for water quality benefit through ownership or regulation. Almost one-quarter of the lands in the San Lorenzo River watershed are under ownership by entities that retain them as preserves. However, private landowners, especially residential landowners, can be the source of pollutants such as those from septic systems, from road erosion, and from domestic animals such as horses.

The North Coast watershed sources fall under a range of public and private ownership with associated benefits and challenges, such as public access and associated water quality risks. The 7,600 acres of the North Coast watershed sources are mostly under private ownership. In 2011, a large swath of the CEMEX properties was acquired by a group of private organizations, resulting in the protection of an additional 8,532 acres of land. Called the San Vicente Redwoods, some of the area drains into the upper reaches of Laguna Creek and potentially into Liddell Spring via the interconnected Laguna-Liddell karst system. A portion of this land is upstream of the City's diversion. The land is owned by the Sempervirens Fund and Peninsula Open Space Trust (POST) with funding support from Save the Redwoods League, the Nature Conservancy, the Santa Cruz County Land Trust, and a number of foundations. The San Vicente Redwoods land is currently under the management of the Land Trust of Santa Cruz County with plans for a park ranger program. Access to the San Vicente Redwoods may be provided through the adjacent federally owned Cotoni Coast Dairies National Monument which will be managed by the US Bureau of Land Management. The quarry in the Liddell Springs watershed, which is one of the City's North Coast sources, is also privately owned. As discussed in Section 2.2.2, the karst limestone provides subterranean connectivity between the Laguna and Liddell watersheds.

Potential Contaminant Sources: As discussed in Section 3, Section 6.2 and summarized in Table 6-2, a number of contaminant sources can contribute sediments, pathogens, and chemicals with the potential to significantly impair drinking water quality. These sources include:

- Wastewater and Urban Runoff
- Unauthorized Activity such as homeless encampments, illegal grading, and unauthorized waste dumping.
- Wildfire
- Roads including rural unpaved roads
- Confined Animal Facilities
- Mining/Quarry Activities
- Agriculture
- Geologic Hazards including landslides after significant rains/fires
- Chemical Spills
- Pesticides and Herbicides

In 2020, the CZU Lightning Complex fires resulted in tens of thousands of acres of watershed lands in Santa Cruz County being burned. With over 900 structures and hundreds of vehicles, propane tanks, septic systems, and water and wastewater pipes and other infrastructure burned in the fires, there is a real threat that contaminants such as benzene, toluene, ethylbenzene and xylene, as well as plastics and other common household materials will exist well into the future. However, data through 2021 (the period covered for this update) show that SLVWD and City drinking water source waters are so far uncontaminated, in large part due to a proactive initial cleanup and erosion control response by the EPA, the County, the Santa Cruz County Resource Conservation District, SLVWD and the City, combined with a lack of and substantial storm events and associated landslides in 2021.

Watershed Management Activities: As discussed in Section 4, watershed management jurisdiction in the San Lorenzo and North Coast watersheds is distributed; the majority of the watershed is governed by Santa Cruz County and/or regulated by Federal and state agencies such as US Army Corps of Engineers, California Regional Water Quality Control Board (RWQCB), California State Parks, California Department of Forestry and Fire Protection (CalFire), and California Department of Fish and Wildlife (CDFW) with the water purveyors jurisdiction limited mostly to those areas that they have land ownership as summarized earlier. In addition, local non-governmental organizations (NGOs) can play a role in watershed protection and water quality improvement as partners as well as individually.

Watershed management includes regulatory activities and management/planning activities which are detailed in Section 4. Regulatory activities include the County's ordinances on cannabis cultivation, wastewater management, water quality, riparian, and sensitive habitats; State regulations on beneficial use and permitting of stormwater, urban runoff, riparian zone construction, and timber harvest; and federal water quality regulations for waste discharge and wetland filling. In addition, state, and federal regulation to protect threatened and endangered species provide ancillary water quality benefits. Specific discussion regarding the non-drinking water quality regulatory activities is discussed further below.

Management and planning activities also occur at the local, state, and federal levels. At the local level, watershed lands management activities by the City and SLVWD can include patrol of agency-owned lands and riparian areas, restoration efforts and implementation of the various planning documents including Habitat Conservation Plans. At the County level, activities include implementation of the County's General Plan, San Lorenzo River Watershed Management Plan, San Lorenzo Nitrate Management Plan, sewer system management plans, and ordinances such as those related to cannabis cultivation and general environmental protection ordinances. In addition, the Resource Conservation District of Santa Cruz County (RCD) has a suite of programs geared towards educating and supporting land owners with tools and resources to assist with projects such as road management, horse stable management, fire protection, fish passage and water quality improvement. Further, State fire and fuel management plans within the State Parks provide management of other watershed lands . Collectively, these management and planning tools generally provide a high level of oversight of activities that impact and improve water quality, which is supported by the long-term water quality data trends. However, improving coordination efforts between the entities and their activities is an ongoing effort.

In addition, City and SLVWD staff has been creative in implementing measures that have the potential to directly improve water quality. Measures include coordinating efforts for habitat restoration and watershed protection; wildfire planning; establishing conservation agreements on private lands to allow staff to patrol upstream of drinking water diversions; and funding for patrols relating to homeless encampments. On a broader basis, the City and SLVWD have partnered with NGOs such as the RCD to educate San Lorenzo River watershed users by installing watershed identification signs and signs at creek crossings and watershed divides. Watershed interpretive and outreach programming has increased in recent years, with the City and SLVWD partnering with the County, the RCD and the Coastal Watershed Council to produce the annual State of the Sn Lorenzo River Symposium. The City and SLVWD have also been involved in significant fire preparedness work on their watershed lands surrounding critical water infrastructure and the City's Loch Lomond Reservoir. Other water quality improvement activities significantly benefit drinking quality, such as participating in a county-wide Fire Safe Council, continuing to support efforts by organizations such as Sempervirens Fund, and POST's efforts to acquire and protect watershed lands.

Non- Drinking Water Regulation: While various local, state, and federal plans and regulations can provide protection of water quality beneficial uses, weak enforcement of those plans and regulations within the watersheds continue to challenge the City and SLVWD. For example, while implementation of TMDLs for pathogens and nutrients can provide benefits to water quality, water purveyors must rely on others to remove these constituents. In addition, while implementation of instream flow targets related to various water rights and the City's existing and pending Habitat Conservation Plans(described in greater detail in Section 2.7.4) have the benefit of improving water quality in source water streams, they limit the City's use of their high-quality North Coast water sources, increasing reliance on other sources with higher total organic carbon, resulting in disinfection challenges that require the City to balance many factors when managing their water supply portfolio.

Water Quality Data Summary: Water quality data for the period from 2017—2021 (found in Figures and Tables in Section 5) indicate seasonally appropriate changes in total coliform, turbidity, or nitrate concentrations in the City's North Coast or the San Lorenzo River watershed sources for the City or SLVWD; expected seasonal and dry/wet year variations have occurred. Nitrates are well below maximum contaminant levels but are showing gradual long-term increases. The North Coast sources, in particular Liddell Spring, continue to have lower total coliform levels when compared to the San Lorenzo River sources. While acute water quality impacts from the CZU Fire were largely averted due to the coordinated agency response, the threat of long-term impacts due to remaining contamination from burned homes, cars, and other infrastructure remains.

Conclusions and Recommendations: The San Lorenzo and North Coast watersheds are generally providing high water quality, with some expected variability during the wet season. The water utilities closely manage the high turbidity events by bypassing stormflows, using stored water and/or alternative sources, that, when combined with the water treatment processes at the WTPs, are delivering a consistently safe drinking water to the residents. However, the City and SLVWD faces future regulatory challenges and interest in wintertime flows for regional water supply reliability. The City is undertaking improvements at the Graham Hill Water Treatment Plant (GHWTP) to continue to meet the drinking water regulations while using higher turbidity waters.

More specific conclusions and recommendations are discussed in Section 6 and include activities such as continuing:

- Coordination of acquisition and review of water quality monitoring data (including increased winter water quality testing), particularly as it relates to wastewater constituents, fire-related retardant (particularly after significant fire events), and to a lesser extent, cannabis cultivation, which is now regulated
- Implementation of County wastewater management, including consolidation efforts of small wastewater plants, other management plans, cannabis regulations, road maintenance practices, and ordinances as well as coordinating with County agencies such as emergency response for toxic spills
- Review of developments in the watersheds including accessory dwelling units and associated wastewater treatment impacts in rural areas, especially near diversions, overlying sandy soils or karst areas
- Support of local NGOs in public education, riparian protection/restoration, homeless camp cleanups, implementation of best management practices for roads and confined animals, as well as land acquisition for preserves
- Improving collaboration with state regulatory agencies with regard to forest fuel management and fisheries habitat improvement; NGOs like the Fire Safe Council of Santa Cruz County; and local fire agencies and with private landowners.

Section 1 Introduction

Sanitary surveys are required by the State Water Resources Control Board, Division of Drinking Water (DDW), formerly the California Department of Public Health to be completed for each watershed that is a drinking water source. Updates are required every five years per the State of California Surface Water Treatment regulations (Chapter 17, Title 22). These requirements incorporate the Surface Water Treatment Rule (SWTR) mandated by the United States Environmental Protection Agency (EPA) and enforced by DDW as a primacy agency for federal regulations.

This sanitary survey includes the San Lorenzo River and North Coast watersheds (as shown on Figure 1-1) all within Santa Cruz County, California. The first sanitary survey for this area was completed in 1996 by Camp Dresser & McKee. It was updated in 2001 by the City of Santa Cruz Water Department (SCWD or City), and subsequently updated in 2007, 2013, and 2018 in collaboration with the San Lorenzo Valley Water District (SLVWD)[1], whose source water diversions are contained within portions of the San Lorenzo River watershed. This sanitary survey update is based on numerous discussions with utility and agency staff, review of various reports, an evaluation of historic and recent water quality monitoring results, and analyses of the ongoing management practices within the watershed area.

1.1 Study Area

Figure 1-1 illustrates the approximate watershed boundaries of the San Lorenzo River and North Coast watersheds, all within Santa Cruz County. The San Lorenzo River is the watershed for numerous water purveyors including City and SLVWD. The North Coast watersheds included in this study provide water to the City as well as some private diverters. Figure 1-1 also shows the key sub watersheds, location of the raw water intakes, primary roadways, and streams within the study area.

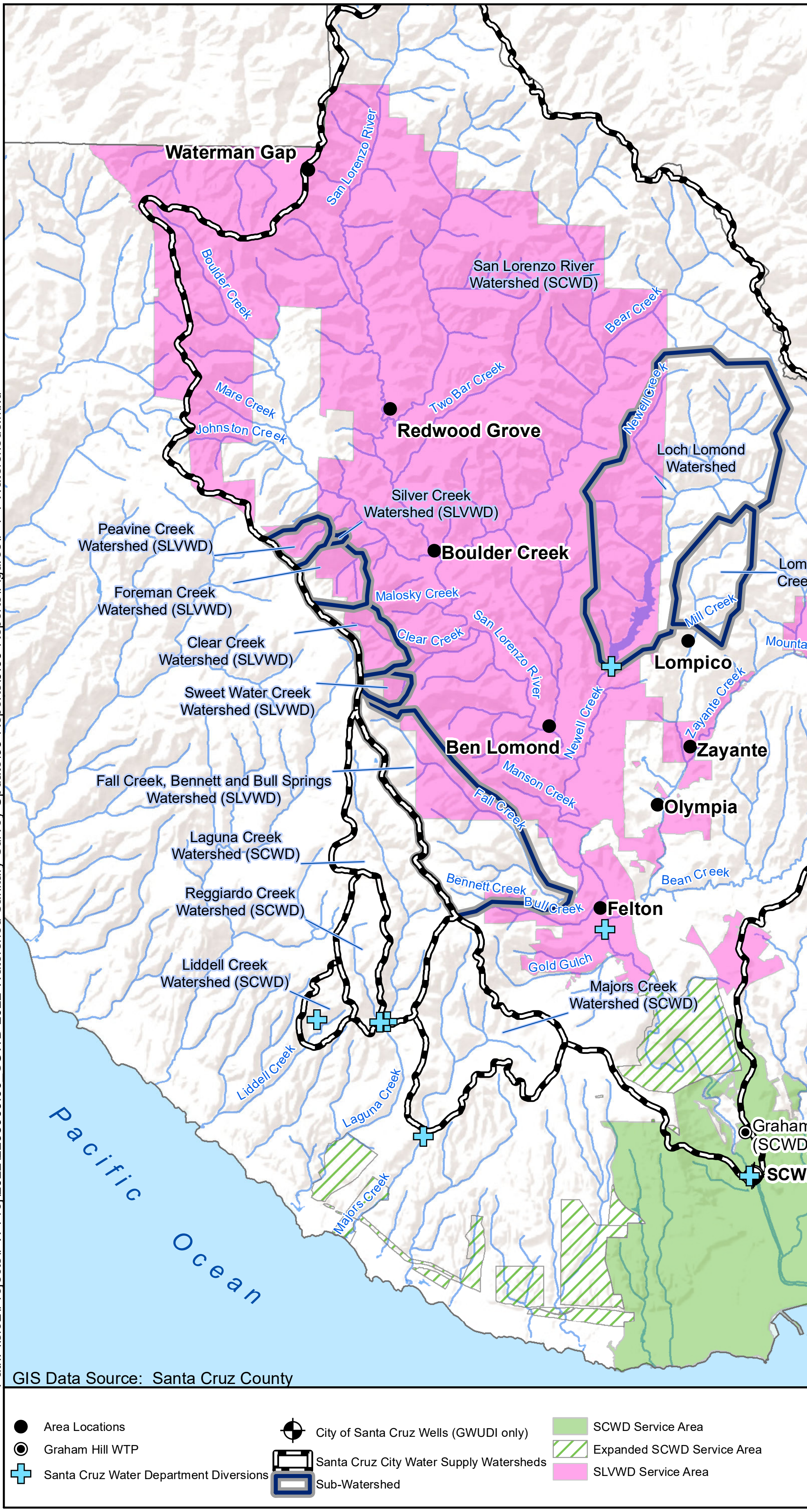
1.2 Watershed Sanitary Survey Requirements

A watershed sanitary survey is a detailed evaluation of surface water sources and their vulnerability to contamination. It is more comprehensive than a Source Water Assessment (SWA) and can be used in place of a SWA to fulfill the requirements of California's 1996 Drinking Water Source Assessment and Protection (DWSAP) Program. Whereas a SWA ranks, and inventories possible contaminating activities (PCAs) located within the source area, a sanitary survey provides more background, descriptive information, and review of all relevant monitoring data.

Specific sanitary survey requirements are:

1. Conduct a sanitary survey of the watershed(s) at least every five years.

[1] Reference to SLVWD includes the areas previously known as Lompico County Water District, which merged with SLVWD in 2016.



Santa Cruz Water Department
WSS Update

Figure 1-1: San Lorenzo Valley and North Coast Watersheds

2. Describe the hydrological conditions of the watershed, summarize source water quality data, describe activities and possible contamination sources, and identify any significant changes since a previous survey was conducted.
3. Describe watershed control and management practices.
4. Evaluate compliance with the SWTR with a focus on disinfection requirements.
5. Recommend corrective actions to maintain or improve water quality.

1.3 Objectives

The objectives of this project are to:

- Prepare a stand-alone document that complies with the DDW requirements to update the 2018 Watershed Sanitary Survey.
- Identify potential sources where chemical and microbiological contaminants may enter the water supply.
- Establish the baseline information needed for a watershed management program.
- Recommend actions to enhance water quality protection and watershed management.

The drinking water purveyors involved in this project should use this report to compare existing water quality conditions with future monitoring data, implement practices to improve water quality, and reduce the risk of source water contamination.

1.4 Participating Drinking Water Utilities

The two water purveyors that participated in this update are the City of Santa Cruz Water Department and the San Lorenzo Valley Water District, both of whom draw from the San Lorenzo River watershed. The City also draws water from the North Coast watersheds.

1.5 Report Organization

This report follows the format in the *Watershed Sanitary Survey Guidance Manual* as required by DDW so that it conforms with reports developed by other suppliers for their watershed areas. Specific sections are:

Section 1: Introduction

Section 2: Watershed and Water Supply System

Section 3: Potential Contaminant Sources in the Watersheds

Section 4: Watershed Management and Control Practices

Section 5: Water Quality Regulations and Evaluation

Section 6: Conclusions and Recommendations

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Section 2 Watersheds and Water Supply Systems

2.1 Watershed Description

The San Lorenzo River and North Coast watersheds and water purveyors which use surface water are described in this section. The watershed area, sub watersheds within the San Lorenzo Valley, and approximate land areas are listed in Table 2-1.

Table 2-1: Watershed Areas and Drinking Water Purveyors Served[1]

Watershed Area	*Utilities Served*	*Watershed Area[3]*	
		Acres	*Square Miles*
San Lorenzo River (upstream of the City intake in Santa Cruz)	City, SLVWD [2]	74,000	115
Subwatersheds			
Loch Lomond Reservoir on Newell Creek	City and SLVWD	5,728	8.95
Fall Creek, Bennett, and Bull Springs	SLVWD	2,600	4.1
Sweetwater Creek	SLVWD	180	0.3
Clear Creek	SLVWD	460	0.7
Foreman Creek	SLVWD	500	0.8
Silver Creek	SLVWD	20	0.03
Peavine Creek	SLVWD	230	0.4
North Coast Watersheds			
Liddell Spring	City	3,994	6.24
Laguna Creek	City	2,560	4.0
Reggiardo Diversion	City	3,584	5.60
Majors Creek	City	2,500	3.9

(1) Figure 1-1 shows the study area primary watersheds and subwatersheds within the San Lorenzo River, the North Coast watersheds, and the general locations for each utility.

(2) Numerous other drinking water purveyors with less than 200 service connections use surface water from this watershed.

(3) The watershed area is the drainage area above the intakes and not the full watershed for the water body

2.1.1 Regional Hydrologic Setting

The project area includes the San Lorenzo River watershed and the North Coast watersheds, all located in north central Santa Cruz County. The San Lorenzo River watershed is the largest contiguous watershed area in the study area with an overall area of about 74,000 acres. The North Coast watersheds have a total area of about 7,000 acres.

City's primary diversion is located on the San Lorenzo River towards the south end of the watershed (Figure 1-1). City's North Coast watershed diversions are located on Majors Creek, Reggiardo Creek, Laguna Creek, and Liddell Spring. The flow from Reggiardo Creek, which is typically minimal, is diverted into Laguna Creek just upstream of the Laguna Diversion. City maintains the Loch Lomond Reservoir on Newell Creek, a tributary to the San Lorenzo River, which provides water to both City and SLVWD.

SLVWD diverts water from Fall Creek, Bull Creek, and Bennett Springs within the town of Felton, and from Sweetwater Creek, Clear Creek, Foreman Creek, Silver Creek, and Peavine Creek watersheds, which are located on the east side of Ben Lomond Mountain. Diversions on Fall and Bull creeks and Bennett Spring supply the SLVWD Felton System. The Fall Creek diversion has a watershed area of approximately 2,770 acres (4.3 square miles), including the 225-acre watershed above the Bennett Spring diversion. The two Bull Creek diversions have a combined watershed area of 175 acres. Bennett Spring and the springs supplying the Bull Creek diversions may have contributing groundwater recharge areas that differ from their respective drainage areas. Together, the Felton System diversion watersheds comprise 4.3 percent of the San Lorenzo River watershed above the Big Trees gage. Surface diversions make up the entire supply for the Felton System, while a combination of groundwater and surface water supply the San Lorenzo Valley System.

2.1.2 Prior Studies

The City, SLVWD, and the County of Santa Cruz, have conducted evaluations of watershed management, water supply, and water quality protection. Key existing information sources include hydrologic and water quality studies conducted by the County of Santa Cruz, U.S. Geological Survey (USGS), U.S. Army Corps of Engineers, Central Coast RWQCB, California Department of Water Resources (DWR), local water purveyors, and consulting specialists. Much of this work is considered and cited in several summary reports (Ricker, 1994; Hecht and others, 1991; Camp Dresser & McKee, 1994; Swanson, 2001; and the San Lorenzo River Watershed Plan Update, 2001). Recent studies reviewed for the development of the 2023 WSS include, but are not limited to, a USGS study of sedimentation in the San Lorenzo River (East et al, 2018), a USGS study on storage capacity of Loch Lomond Reservoir, City's annual source water monitoring study report, and various documentation on the impacts of the CZU Lightning Complex Fire on water quality and other watershed conditions.

Streamflow in the area has been measured by several resource agencies throughout the last several decades. On the San Lorenzo River, the USGS operates long-term stream gages at Big Trees (at the Henry Cowell State Park entrance road) and at Santa Cruz (near the City San Lorenzo River intake in Santa Cruz) as shown on Figure 1-1.

In the past, USGS operated gages for multi-year periods at: San Lorenzo River near Boulder Creek, Boulder and Bear Creeks near Boulder Creek, Newell Creek (prior to the construction of Loch Lomond Reservoir), Zayante Creek at Zayante, Bean and Carbonera Creeks in Scotts Valley, and Branciforte Creek in Santa Cruz. In the North Coast watersheds, the USGS operated gages for multi-year periods at: Majors Creek, Laguna Creek, and San Vincente Creek, an adjoining watershed of similar size immediately to the west of Laguna Creek.

From 2000 to the present, the City established ten gaging stations within the study area to help manage the water resource and in-stream habitat, some of which occupy former USGS gaging stations. Two gages are located within the San Lorenzo River watershed: on Newell Creek, above and below Loch Lomond. Eight gages are located in the North Coast watersheds: three gages are on Laguna Creek; three gages are located on Majors Creek; and two gages are located on Liddell Creek. Some of these stations are equipped with specific conductance and temperature sensors or have had such measurements made routinely over the past several years. Historically, Scotts Valley Water District had two gaging stations on Bean Creek near Scotts Valley: one at Mount Hermon Camp, and the other upstream at Mount Hermon Road (former USGS site); these gages may restart soon.[2]

Water quality stations were operated for several years at the San Lorenzo River gages by the USGS or the DWR.[3] Water quality and instantaneous flow were monitored intermittently in Kings, Two Bar, Love, Fall, and Lompico Creeks, and on lower Zayante Creek below Bean Creek, although no daily records were developed. Much of the USGS water-quality information has been summarized in a report by Sylvester and Covay (1978). Santa Cruz County has routinely sampled an array of other stations in the San Lorenzo River watershed. The City regularly samples water quality from San Lorenzo River sources (Loch Lomond, the Felton Diversion, and the intakes in Santa Cruz) and from North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). The City measures turbidity, with varying frequency, for each of its water sources.

Since 2013, SLVWD has worked with Balance Hydrologics, Inc. to gage flows in channels that serve as SLVWD water sources, with the goal being to utilize data to better understand how diversions affect flow and habitat values in the San Lorenzo River and its tributaries. In 2019, SLVWD and Balance Hydrologics began a parallel project to monitor Fall and Clear Creek flows for operational purposes.

SLVWD also regularly samples water quality at each point of diversion: Clear Creek, Peavine Creek, Sweetwater Creek and Foreman Creek. Meters have been installed on all diversions to measure diverted water. Up until 2020, SLVWD measured bypass flows on Clear Creek; however, this gage was destroyed in the 2020 CZU fire, and the Clear Creek diversion is offline awaiting repairs.

While streamflow gaging has diminished in the San Lorenzo Valley over the past 25 years, the number of stations at which water-quality sampling is conducted generally remained consistent. Periodic changes to frequency of sampling and the number of constituents tested can occur, particularly for special studies in response to events like significant fires and/or to evaluate seasonal water quality changes.

2.1.3 Significance of Storms, Droughts, Geology, and Baseflow

Streamflow in the Santa Cruz Mountains varies seasonally. About 85 percent of annual rainfall occurs in the six months from December through May. Winter precipitation generally does not increase and sustain streamflow until after soil saturation occurs, following the initial rains of the season, with the highest flows typically occurring from late December through March. Peak streamflow resulting from storm events declines rapidly, while elevated baseflow declines gradually after the winter rains cease. Snows are relatively rare in the Santa Cruz Mountains and do not create a snowmelt-runoff season.

[2] Bean Creek at Mount Hermon is a continuous turbidity monitoring station, while upstream Bean Creek at Mount Hermon Road is a continuous specific conductance monitoring station.
[3] DWR also sampled the coastal streams for water quality on a monthly, and then on an intermittent basis, during the 1960s and 1970s.

California and the western states have been affected by a multi-year drought with below average rainfall starting in 2012 and continuing into the fall of 2016. The drought was followed by an extremely wet winter with precipitation from October 2016 to March 2017 at 162 percent of average. Since then, 2018 was a dry water year, 2019 was a normal water year, and 2020 was a dry water year. Due to extreme heat and lack of rain and snow, 2021 was the second driest water year on record. Currently, all 58 counties in California have been placed under an emergency drought proclamation.

2.1.4 Streamflow Summary

The longest continuous period of record for streamflow in the area is the USGS gage on the San Lorenzo River at Big Trees, located downstream of the Fall Creek intake just south of Felton (USGS Station No. 11160500). This gage has operated since 1937 and measures discharge from about 85 percent of the watershed. . The maximum recorded discharge was 30,400 cubic feet per second (cfs) (19,600 million gallons per day or 'mgd') on December 23, 1955. The minimum instantaneous daily discharge was 5.6 cfs (3.6 mgd) on July 27 and 28, 1977, during an intense drought. The annual mean runoff for the period of water year 1937 to water year 2021 is 128 cfs (83 mgd). Recent water years have experienced a similar range of variability with very high stream flows in the San Lorenzo River in January—March 2017 where ten distinct, major storm systems produced very significant peak flows, five of which registered higher than 10,000 cfs. The highest events (January 10 and February 7, 2017) resulted in flooding and some damage of critical water system infrastructure as well as increased potential for septic systems to overflow and impact groundwater. The lowest daily flows in the recent years occurred in September 2021, when flows dropped as low as 9.16 cfs. Low flows can result in warm, stagnant waters, and conditions favorable to harmful algal blooms (HAB), the rapid growth of algae or cyanobacteria that can cause harm to people, animals, or the local ecology.

2.1.5 Geology and Surface Water Quality

Surface water quality in the San Lorenzo River watershed fluctuates seasonally in relation to streamflow. During periods of high runoff, sediment and organic debris, urban runoff, animal wastes and wastewater from septic systems enter the surface water system. High levels of turbidity and pollutants during these events can limit the source water available for treatment. During dry periods and droughts, groundwater sustains baseflow to the area streams. The groundwater quality varies widely because of both geologic and human influences. As groundwater contributes to streamflow, it may carry dissolved constituents from bedrock formations, discharges from septic systems, and other constituents that have percolated into the aquifer.

In general, water quality in the San Lorenzo River watershed is primarily influenced by the three geologic subareas bounded by the Zayante and Ben Lomond faults (c.f., Battleson, 1966; Ricker and others, 1977; Sylvester and Covay, 1978). North of the Zayante fault, streams draining the older sedimentary formations contain relatively high concentrations of dissolved solids (c.f., Philips and Rojstaczer, 2001). The upper watersheds of the San Lorenzo River, and Kings, Two Bar, Bear, Zayante and Newell Creeks are all underlain mainly by erosive sedimentary formations, principally the Butano sandstone, Two Bar shale, Rices mudstone, Vaqueros sandstone, and Lambert shale.

South of the Zayante Fault and east of the Ben Lomond fault, streams originate in the younger sedimentary formations and contain water of intermediate quality. Rainfall runoff tends to occur slowly because of the higher permeability soils that have developed on parts of the Santa Margarita sandstone, Lompico sandstone and Purisima formation (most commonly a water-bearing sandy shale, but locally quite sandy). These geologic formations are shown on Figure 2-5 and discussed further in Section 2.3. Less permeable geologic formations in these eastside streams include the Monterey formation and the Santa Cruz mudstone. The high rates of recharge and relatively large available groundwater volumes within the Santa Margarita sandstone have resulted in extensive development of its water resources. Use of wells has lowered groundwater levels and diminished streamflow, altered the direction of groundwater flow, and helped to induce increases in the dissolved solids ('salts') and nitrate levels in this aquifer, originating (respectively) from groundwater inflow from deeper aquifers and from partial recharge from leach fields or other sources that contribute human or livestock wastes. The larger streams with seasonal baseflows from these formations include Bean, Zayante, Lompico, and Love Creeks.

West of the Ben Lomond fault, San Lorenzo tributary streams drain the igneous and/or metamorphic rocks, have relatively lower concentrations of dissolved solids and tend to provide high quality water at reasonably constant rates. The weathered upper zone of the rocks (principally granodiorite, quartz diorite, schist, and limestone/marble karst) exposed on Ben Lomond Mountain serves to recharge precipitation and provide dry-season baseflow to the streams that drain the east side of Ben Lomond Mountain. These include Jamison, Peavine, Foreman, Malosky, Clear, Fall, and Shingle Mill Creeks, and Hubbard and Gold Gulches, as well as Bennett Corvin, and Pogonip Springs. Flows in Boulder Creek during dry seasons or drought years are also sustained primarily by flows emanating from these crystalline rocks. Hare Creek and upper Boulder Creek drain similar watersheds from Ben Lomond Mountain but are underlain by sedimentary rocks generally yielding much lower rates of summer baseflow (Hecht, 1977).

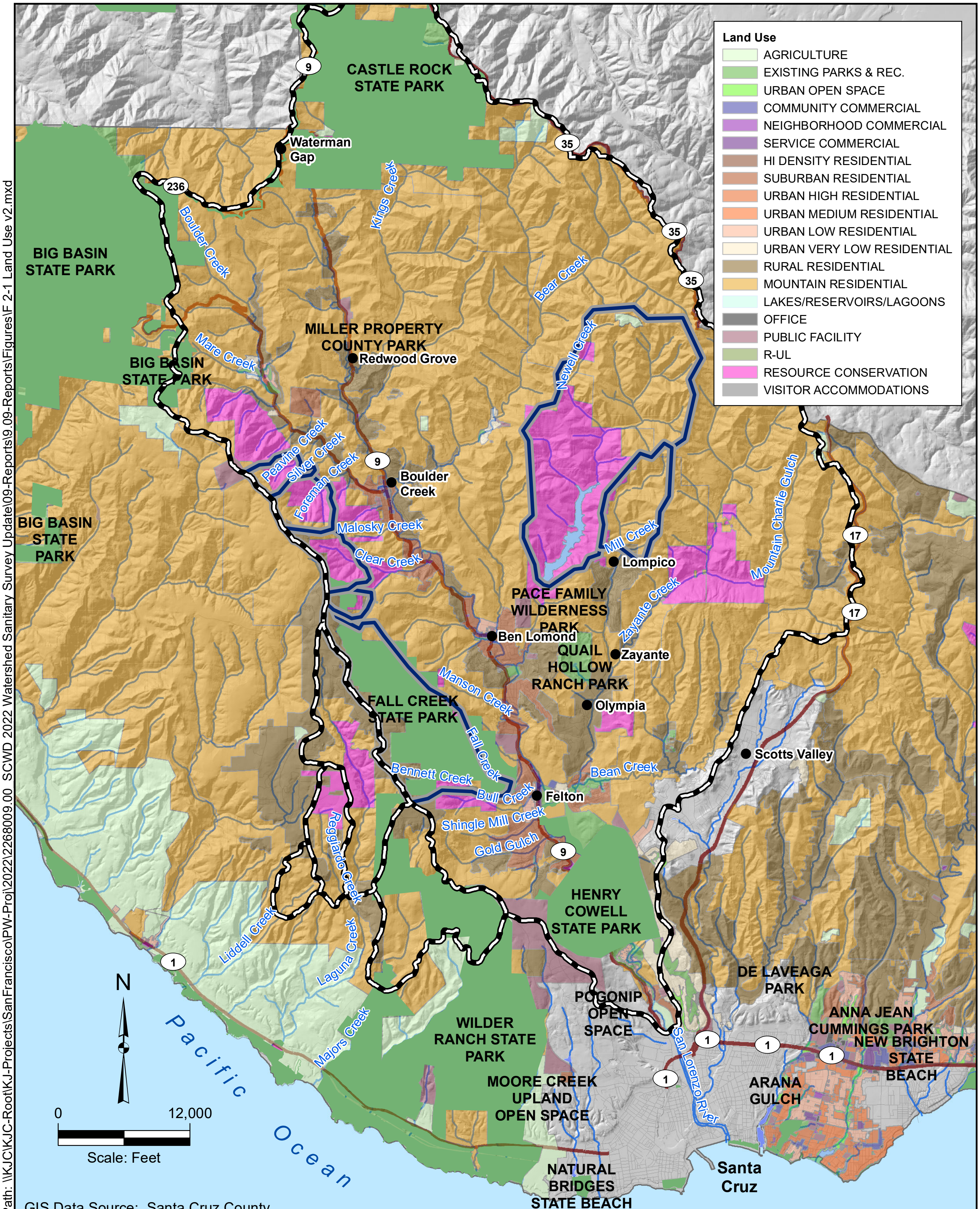
In the North Coast watersheds, surface water in the streams is also influenced by the same crystalline rocks of Ben Lomond Mountain. In addition, the Lompico sandstone, Monterey formation, and Santa Margarita sandstone overlay the crystalline rocks of Ben Lomond Mountain and provide groundwater storage and baseflow to the streams. Sinkholes and cavernous fractures (i.e. karst formations) occur throughout the County and also in several parts of the Laguna and Majors Creek watersheds and at Liddell Spring, which serves as the most distant and reliable North Coast source of water for the City. These karst formations provide subterranean connectivity between the Laguna and Liddell watersheds, essentially increasing the Liddell Spring drainage area by up to 2,000 acres (P.E. LaMoreaux & Associates Inc., 2005). The karst connectivity both increases drainage area and potentially supply at City diversions as well as rapidly transporting contaminants, if any were to occur. Upstream of the City's diversion, Majors Creek has been generally and actively incising into the underlying alluvium and weathered sedimentary rocks since at least the 1960s (Hecht and others, 1968; Hecht, 1978), contributing waters that are typically more turbid than in Laguna Creek or at Liddell Spring (Camp Dresser McKee, 1996). Water derived from Liddell Spring plays an important role in the City's water portfolio due to its relatively high alkalinity compared to other City source waters. The high alkalinity increases the ability to use alum in the treatment process and enhance clarification.

2.2 Land Use and Water Quality

This subsection describes land use and aspects of the natural setting that may affect potential contaminant sources. In general, there have been limited changes to land uses in the watershed since the 2018 Watershed Sanitary Survey.

2.2.1 Land Use

There are a variety of land uses in the watersheds including: timber production, quarrying, agriculture, ranching, rural residential and unincorporated communities with urban densities as found on Figure 2-1. Almost one-quarter of the San Lorenzo River watershed lands are in public or private ownership for natural resource conservation. In the 1960s and 1970s, Santa Cruz County experienced rapid growth in both population and development.



- Area Locations
- Santa Cruz City Water Supply Watersheds
- Sub-Watershed
- Lakes
- Stream
- Streets

Santa Cruz Water Department
WSS Update

Figure 2-1: Land Use

The San Lorenzo Valley entered a period of transition from primarily seasonal vacation homes to full-time residences.

During the period of rapid growth, year-round residential occupancy of properties that were originally developed for summer use increased, which resulted in stress on onsite sewage disposal systems in the San Lorenzo River watershed that were inadequately sized, improperly maintained or poorly sited. Systems designed for seasonal use struggle with both the added load and the issue of higher groundwater during the winter months that has been found to communicate undesirably with the disposal systems. At the same time, new residential development occurred which added more onsite disposal systems at increased density.

Existing and new development activity occurring in steep and remote areas of the watersheds increases runoff and erosion, leading to increases in sedimentation and persistent turbidity in water supply streams. The resulting water quality issues also impact riparian corridors and can thus be attributed both to decisions made at the level of individual lots with respect to grading and land clearing as well as cumulative impacts of widespread development. Similarly, activities and development in the riparian areas can also impact water quality in a manner similar to those in steep and remote areas.

Furthermore, continuous use of unpaved roads to access residences, especially in wet periods, contributes both sediment and turbidity to receiving waters. Partially offsetting these trends is growing acreage of lands no longer open to logging, most significantly in the headwaters of the San Lorenzo River and on lands of the San Lorenzo Valley Water District and the City of Santa Cruz Water Department. In addition, additional effort related to riparian area enhancement is envisioned as discussed in Section 4.9.

Many of the same dynamics have affected land use in the North Coast watersheds, although the initial proportion of seasonal homes was much lower. Historically, this area has seen steady residential growth that has flattened out in recent years. As in the San Lorenzo River watershed, virtually all wastewater disposal is through leach fields, so the volume and areas of watershed affected are growing albeit at a lower rate than historically.

Figure 2-1 shows the general developed areas within the watersheds as well as the protected public park lands within the San Lorenzo River watershed. As detailed in the following sections, regulations related to Accessory Dwelling Units (2.3.2 Residential), the impacts of cannabis cultivation in the San Lorenzo River watershed (2.3.3 Agricultural), and potential public access of additional lands (2.3.6 Recreation) are land use changes with water quality impacts.

2.2.2 Residential

Within the survey area, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz County. As a result, the county is rural in character, heavily forested, and visually dominated by open space.

The 2020 American Community Survey (ACS) estimated a population of 42,932 people in the San Lorenzo Valley (Census Tracts 1203.01 through 1209.02, shown on Figure 2-2). This is 2.6 percent higher than the estimated population of the San Lorenzo Valley in the 2010 ACS.

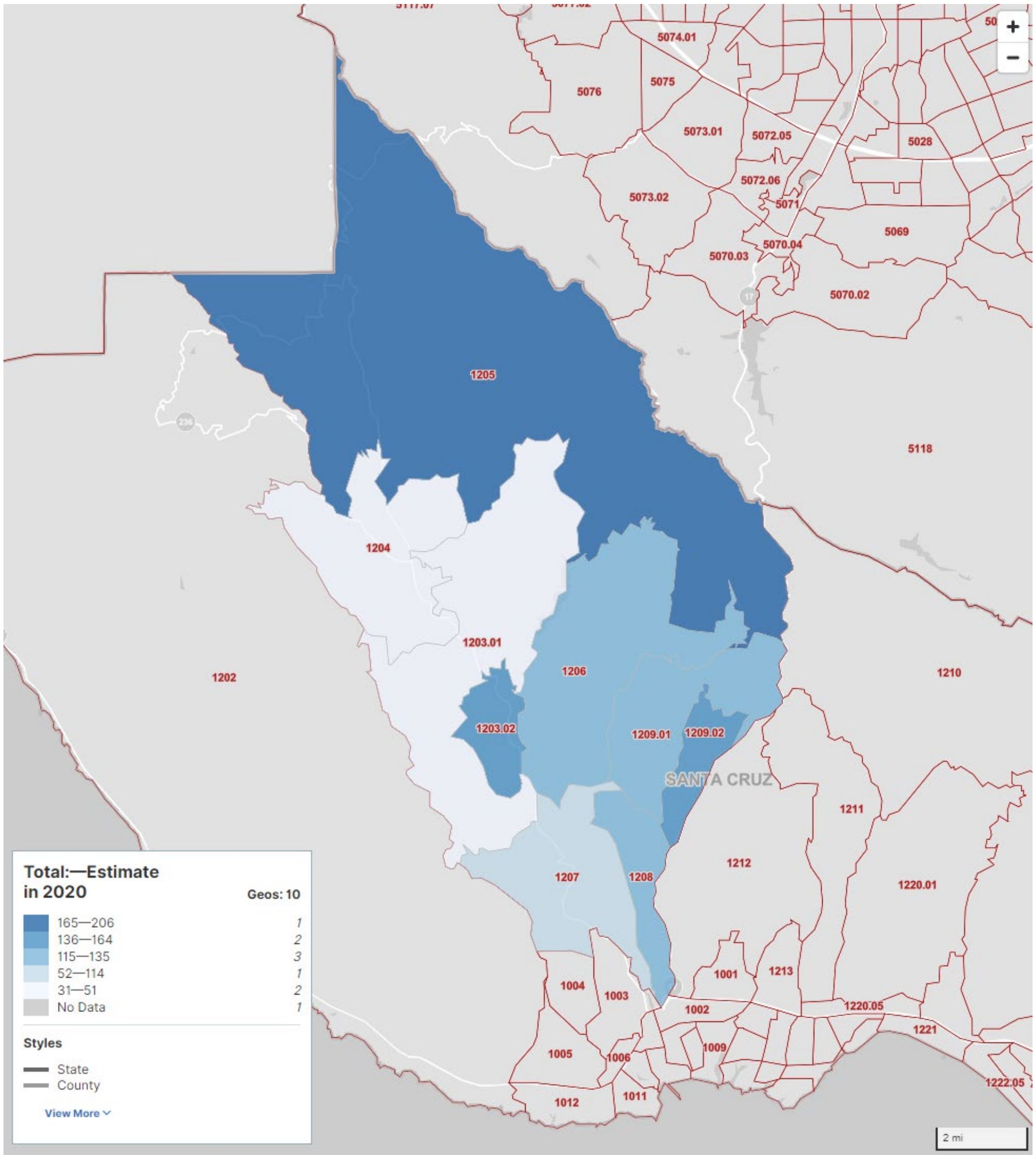


Figure 2-2: San Lorenzo Valley Census Tracts

The population of the North Coast watersheds lies in Census Tract 1202; however, population estimates for CT 1202 overestimate the population of the North Coast watersheds as they also include residents of Davenport, Swanton, and disperse residences along Highway 1 that are downstream of the City intakes. The 2020 ACS estimated population for the North Coast watershed to be approximately 2,630 people, which is a 2.7 percent decrease from the 2010 ACS estimate of 4,757.

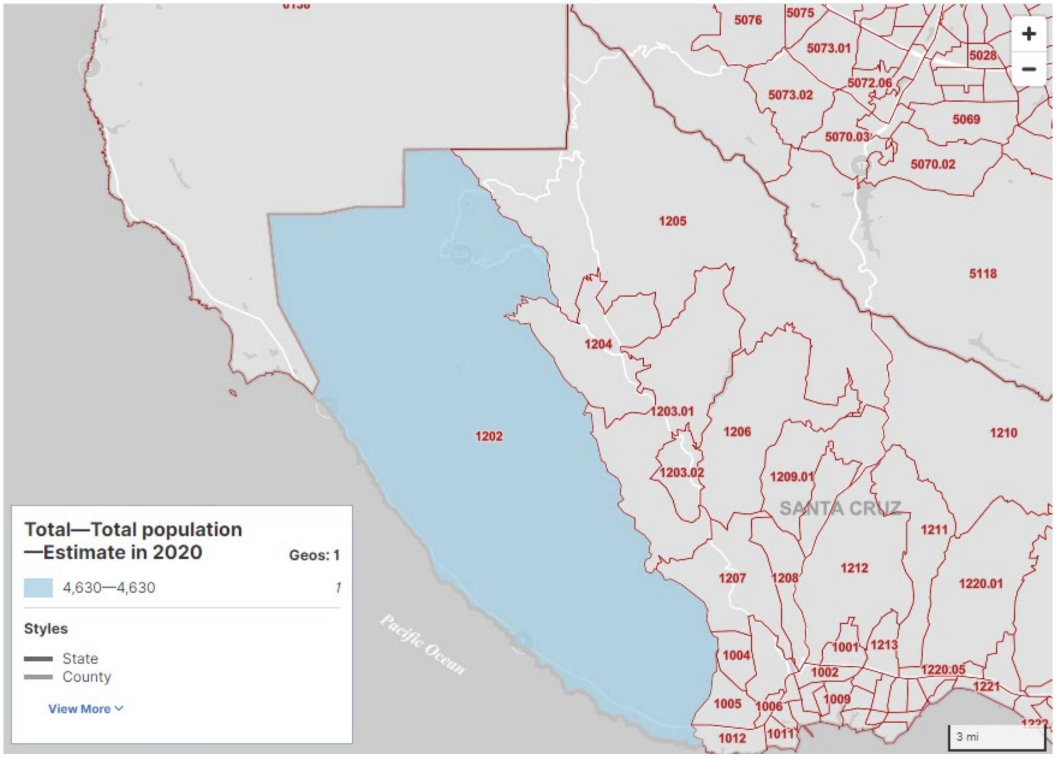


Figure 2-3: North Coast Watershed Census Tracts

Within the San Lorenzo Valley, the majority of the population lives in unincorporated communities located along the San Lorenzo River. Felton, Ben Lomond, Brookdale, and Boulder Creek stretch out along State Highway 9. Other communities have developed along major tributaries to the San Lorenzo, including the areas along Zayante Creek and Lompico Creek. Several closely-packed residential communities which originated as summer ‘encampments’ also exist in the area. These include the Paradise Park, Forest Lakes, Mount Hermon, Riverside Grove, and San Lorenzo Park subdivisions. Conventional 1960s and 1970s subdivision communities established throughout the Valley include: the Boulder Creek Golf and Country Club, Galleon Heights, Bear Creek Estates, Quail Hollow and Glen Arbor, and the portions of Rollingwood and Pasatiempo which lie within the San Lorenzo watershed. There are, in fact, relatively few valleys without a few clusters of homes, now typically occupied year-round. More recently, stand-alone mountain residences have been arrayed along most ridgelines.

The population in the North Coast drainages is far less than that of the San Lorenzo Valley. The largest area in the North Coast drainage with a concentrated population is known as Bonny Doon. Most of the population lives in rural and mountainous areas, mainly along the major roads: Empire Grade, Smith Grade, and Bonny Doon and Martin Roads.

The 2020 population of Scotts Valley was estimated at 10,582 people in its 2020 Urban Water Management Plan (UWMP). Scotts Valley is an incorporated city within the San Lorenzo watershed but most of the city lies beyond the eastern edge of the sanitary survey area, within the Carbonera Creek and Branciforte Creek subwatersheds. However, key commercial and industrial centers of Scotts Valley drain to Bean Creek, which is within the study area.

Individual onsite wastewater disposal systems are the primary means of wastewater treatment and disposal due to the remote nature and dispersed population of much of the watershed. Community onsite disposal systems serve Bear Creek Estates, Boulder Creek Golf and Country Club, the Mt. Hermon Association, and Big Basin State Park. Institutional disposal systems are in service at the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell, and other camps and conference centers in the San Lorenzo Valley. Residential wastewater disposal is discussed in further detail in Section 3.2.

Zoning and land development standards for the unincorporated portions of the county reflect an area-wide awareness of the potential adverse effects of wastewater disposal and other development-related impacts on water supply. Within the area, mountain residential is the lowest density range, where minimal services are available. These areas include various open space and natural resource conservation areas unsuitable for more intense development. Rural residential areas are the next highest density range, requiring access from roads maintained to rural road standards. Suburban residential areas require service from a public water system to develop at the highest allowed density. The most densely populated areas along Highway 9 — Felton, Paradise Park, and Boulder Creek — have been developed at density levels typical of many urban areas despite their rural surroundings. County policies designate that these communities be limited to urban low density development unless community disposal systems are available. Santa Cruz County established CSA 12 in 1989 to promote better septic system management and maintenance and imposes an annual fee to fund the onsite wastewater management program.

In addition, regulation related to Accessory Dwelling Units (ADU) have undergone major updates at both the state and county level in an effort to address affordable housing challenges in the region. On January 1, 2020, new state ADU laws went into effect that required updates to the County's ADU ordinance. These laws include AB 68, AB 587, AB 881, and SB 13. Key provisions contained in these laws include streamlined ADU review, reduced or waived fees, more lenient development standards, lower parking requirements, Junior ADUs (JADUs), multifamily dwelling ADUs, owner occupancy requirements, short-term rentals, nonconformities, code enforcement, and separate sale of ADUs. In January 2020 and again in March 2022 the local Santa Cruz County Code was updated in alignment with state law requirements.

An increase in ADU development could pose future challenges especially in rural areas since the adequacy of aging, existing septic systems may be insufficient to meet both health and environmental needs. However, the County's Local Agency Management Program (LAMP), which was updated in November 2020 to stay consistent with evolving environmental health regulations, includes provisions for upgrade of existing Onsite Wastewater Treatment Systems (OWTS), or installation of an additional OWTS to serve an ADU on a developed parcel. In addition, rural unpaved roads continue to be a likely contributor of sediments and adding ADU can increase traffic and impacts of roads on water quality which should be addressed during the approval process.

2.2.3 Agricultural Uses and Animal Grazing

Agricultural acreage in the San Lorenzo River and North Coast watersheds is limited because of the steep topography and limited tillable land. Following the widespread initial logging of the late 1800s and early 1900s, apples and other orchard fruits were, however, planted on the flatter newly opened slopes throughout the subject watersheds. Much of this acreage has been abandoned and now supports chaparral, second growth redwood forests, and residential development.

Vineyards and Christmas tree farms occupy the largest amount of agricultural acreage in the watersheds of interest tracked by the agricultural commissioner. There is one licensed commercial cannabis cultivation site in the watershed, and it is under strict regulation by Santa Cruz County. There are an unknown number of discretionary use permits for cultivation for personal use. Santa Cruz County is diligent about prohibiting unlicensed cannabis cultivation. Cannabis cultivation is subject to regulation from the US Fish and Wildlife Service, California Department of Fish and Wildlife, California Department of Cannabis Control, California Regional Water Quality Control Board, and Santa Cruz County. These regulations include limitations on impacts to water bodies, pesticide use, sedimentation and runoff, and water usage. Due to the strict regulations around cannabis cultivation, t future expansion of cannabis cultivation is not expected to have a substantial impact to water quality in the watersheds. Additional discussion regarding cannabis is in Section 3.4.2.

Majors Creek has the most significant agricultural land use of the tributary watersheds as shown on Figure 2-1. The lowest coastal terraces, downstream of the City supply intakes in the North Coast watersheds, are used for pasture or are cultivated for brussels sprouts and other row crops. Agricultural activity along the coast does not extend into the watersheds of the supply intakes. Agricultural or animal grazing is limited to that associated with residential uses in the SLVWD subwatersheds. Limited cattle grazing occurs in the North Coast drainages. Grazing leases are held on private lands and vary from year to year. Horses, on the other hand, are commonly kept by rural residents, and by several commercial stables. Confined animals are considered to be a potential source of nitrogen and pathogens (c.f., Hecht and others, 1991; White and Hecht, 1993, Ricker 1995, Ivanetich, 2006) and can also contribute to persistent turbidity in the area's streams.

2.2.4 Timber Harvests

Both City and SLVWD have ceased timber harvesting in their respective watershed lands. City manages timber on their watershed properties for fire resiliency except in the context of fire protection, restoration, and overall forest health needs, and prioritizes management of their watershed lands for source water protection and open-space uses. Given the increased awareness of redwood forest fire dynamics subsequent to the CZU Lightning Complex fire and ongoing drought, City is currently considering more active forest management on their watershed lands. City and SLVWD actively reviews timber harvests on private lands in their source watersheds to ensure source protection as well.

2.2.5 Mining

The survey area previously had many active mining operations. Currently, only Felton, Wilder, Quail Hollow, and Olive Springs Quarries are active.

Mining activities have been discontinued since 2004 at the Olympia and Hanson ('Kaiser') Quarries although reclamation and monitoring activities continue. A landslide in the vicinity of Conference Drive below the Hanson Quarry had significant movement in winter 2017 which resulted in sand erosion into Bean Creek and downstream. Most recently the CEMEX Bonny Doon marble (locally called 'limestone') and shale mine closed as discussed further in Section

3.9. There are no commercial or informal instream gravel mining operations in the subject watersheds.

Exploratory drilling for oil and gas has historically been conducted throughout the survey area, principally during the 1950s and 1960s. No current or shut-in (potentially re-activatable) production is reported. The principal water-effects of drilling have been unquantified increases in the salinity of the local stream system associated with deep, highly saline waters emanating from several abandoned boreholes (c.f., Hecht, 1975). Naturally-occurring asphaltum or bituminous sandstone outcrops at the edges of the Majors Creek watershed, where it was mined about 100 years ago. No effects on waters of Majors Creek have been reported.

2.2.6 Recreation

Santa Cruz and its surroundings have served as a center of recreation for more than 150 years. In the San Lorenzo River Valley, much of the recreation is focused on summer use of the streams and riparian corridors. Use of the San Lorenzo River and its tributaries includes swimming in natural pools, canoeing, fishing, hiking, and equestrian activities. Visitor use – especially the traditional river-based, water-contact recreation – is both a motivation for cleaner streams and a secondary contributor to bacteria, nitrate, and possibly turbidity levels.

The California Department of Parks and Recreation manages about 15 percent of the watershed, including Henry Cowell (including Fall Creek), Castle Rock and portion of Big Basin Redwood State Parks. See Figure 2-1 for locations of parks and open space within the Santa Cruz City water supply watersheds.

City-operated recreation facilities at Loch Lomond Recreation Area will continue to emphasize boating, picnicking, and trail uses. However, the high priority emphasis on source water protection and concerns by first responders at the city and state levels regarding fire risk and access for emergency response are likely to limit additional public access beyond that which is already available.

Recreational use of the Majors and Laguna Creek watersheds covered by the survey are diffuse and typical of rural residential areas, concentrated along the roads and trails. Significant portions of the southeastern side of the Majors Creek watershed are within the sectors of the Grey Whale Ranch and Wilder Ranch State Park which is now open to visitor use, with some restrictions. Public access and recreation are limited in the SLVWD watersheds. Hiking and equestrian trails can be found in Fall Creek State Park (within the Fall Creek watershed), and in some areas within the Olympia watershed. Additional discussion regarding the potential water quality threats from recreation occurs in Section 3.12.

Off road vehicles and mountain-bike use can be occur in localized areas common. Trail (bike, horse, and hiker) and off-road vehicle use can be sources of erosion, adding to background levels, and can contribute to increased risk of fire during the fire season. The Santa Cruz Mountains Trail Stewardship works closely with local land managers to incorporate new trails and mountain bike pump tracks into parks and open spaces throughout the Santa Cruz Mountains. Recently, their work includes the development of multi-use trails through the Cotoni-Coast Dairies and San Vincente Redwoods and fire relief efforts in response to the CZU Fire (including trail clearing and reconstruction, and bridge and culvert repairs and replacements).

In 2016, 5,800 acres of land surrounding the coastal City of Davenport were designated as the Cotoni-Coast Dairies National Monument. Relatively few people have seen this land since public access has been limited for more than a century. The Bureau of Land Management (BLM) has developed a public access plan and the National Monument is currently open for volunteer events. Although much of these lands are downstream of the City intake, concerns remain that public access can result in increased fire danger, and other risks that could impact water quality.

The SLVWD currently does not actively manage any of its lands for recreational purposes The SLVWD has had a written agreement with the Santa Cruz County Horseman's Association (SCCHA) for limited use of the District's Olympia watershed property, on marked trails.

2.2.7 Reservoir Sedimentation

Sedimentation rates in Loch Lomond Reservoir are small relative to its capacity, perhaps because the watershed of the reservoir is maintained primarily in open space, and are not expected to constrain the water supply functions of the reservoir for many years to come. The City has commissioned five separate sedimentation surveys of Loch Lomond by USGS in 1971 (Brown, 1973), 1982 (Fogelman and Johnson, 1986), 1998 (McPherson and Harmon, 2000), 2009 (McPherson et al, 2009), and most recently in 2019 (Whealdon-Haught et al, 2021).

The 2019 sedimentation survey by Whealdon-Haught et al. measured a storage capacity of Loch Lomond Reservoir of approximately 8,770 acre-feet. Whealdon-Haught et al. measured a loss of approximately 68 acre-feet since 2009 in shallow areas (such as the upstream end of the reservoir), suggesting sediment deposition. In areas deeper than 30 feet, small storage gains totaled 82 acre-feet since 2009. These changes in storage were consistent with loss patterns from past surveys. In total, it is estimated that Loch Lomond has lost about 500 acre-feet of total storage over its lifetime (on average, 8-9 acre-feet/year over its 60-year history).

2.3 Natural Conditions and Water Quality

The San Lorenzo River watershed and the North Coast water supply drainages are located in north central Santa Cruz County, California. These watersheds drain runoff from the Santa Cruz Mountains into the Pacific Ocean at or near the north end of Monterey Bay (see Figure 1-1).

The Santa Cruz Mountains extend south to southwest for about 100 miles from San Francisco to the Pajaro River. The ridge of the Santa Cruz Mountains rises between San Francisco Bay and the Santa Clara Valley on the east and the Pacific Ocean on the west. The topography of the area is moderately rugged, with elevations ranging from sea level to over 2,600 feet along the crest of Ben Lomond Mountain, and over 3,300 feet at several locations along the northeastern edge of the watershed. Steep slopes of over 30 percent are common, and most of the streams discussed in this report flow through deep canyons cut into bedrock. This is particularly true in the San Lorenzo River watershed, whose many streams are deeply shaded by a dense growth of redwood and Douglas fir trees.

The region has a Mediterranean climate with cool, dry summers and moderate-to-heavy rainfall in the winter months from November through March. Average annual rainfall ranges from about 30 inches along the coast to about 50 inches along the ridge of Ben Lomond Mountain. Coastal fog is common during the summer months and tends to spread inland at night.

The crest of Ben Lomond Mountain forms the topographic divide between the San Lorenzo River watershed to the east and the North Coast watersheds (Majors and Laguna Creeks) to the west. Coastal terraces, in the North Coast drainages, are a mosaic of grasslands, oak woodlands, steep forested canyons, and chaparral.

2.3.1 Soils and Geology

The area is underlain by a complex mosaic of alluvial and terrace deposits of Quaternary age; mudstone, shales, and sandstones of tertiary age; and fractured granitic rocks, schists, and metamorphosed limestones. Soils are highly variable, with a dense mosaic, depending on the underlying parent materials, and other factors such as climate, aspect, vegetation cover, and local relief. Alluvial and terrace soils of varying ages have formed on the alluvial and terrace deposits along nearly all of the major streams. Some of these soils have well-developed clay subsoils, inhibiting use of leach fields.

In the most general terms, soils underlain by permeable sandstones, as well as igneous and metamorphic rocks, are deep and well-drained. These loamy and sandy loam soils are found throughout the heavily forested reaches of the survey area. Soils formed from the Santa Margarita and several other sandstone formations are also sandy, deep, and well drained as shown on Figure 2-4. In the sandy soils, organic-matter content and cation exchange capacities are often about 15 to 25 percent of those found in many forest soils in coastal California. Sandy soils can infiltrate quickly which can pose a threat to groundwater and/or base flow if septic systems are located on sandy soils.

Santa Cruz County has been providing training and information on approaches and technologies to control erosion in these soils, and to improve nitrogen and pathogen removal in discharges from septic systems. In addition, the RCD has supported training to reduce road erosion as well as landowner support after the CZU fire to prevent fire-related runoff. Soils formed from mudstones and shales also tend to be deep, yet somewhat less well-drained. Overall, soil depth is often limited by shallow bedrock, steep slopes, and the gradual loss of topsoil to erosion.

In the alluvial areas of the San Lorenzo and North Coast watersheds, soils are also deep and well drained, although soil depth may be limited by low-permeability layers of fines. In the marine terraces of the North Coast, soils are characterized as deep to very deep and range from well-drained to somewhat poorly drained where claypans have developed. As in the San Lorenzo Valley, depths vary with slope and aspect.

Naturally-occurring cadmium occurs in portions of the Monterey shale and (to a much lesser extent) Santa Cruz mudstone geologic units. Because cadmium is tightly bound to minerals and clays in the local soils, elevated levels of cadmium are seldom if ever encountered in the water diverted from either the San Lorenzo River or North Coast watersheds. Higher levels are found in stream sediments and vegetation, and cadmium can be bioconcentrated by organisms living in the sediments and soils. The distribution of cadmium in western Santa Cruz County is explained in Golling (1983). Zinc and other trace elements often co-occurring with cadmium are not reported to be elevated in the local soils and sediment derived from the Monterey formation. The same formations tend to be rich in phosphorus, which is widespread in the streams of all surveyed watersheds. With organic carbon also abundant, the ecosystems of these streams are nearly always nitrogen-limited (Aston and Ricker, 1979 Butler, 1978).

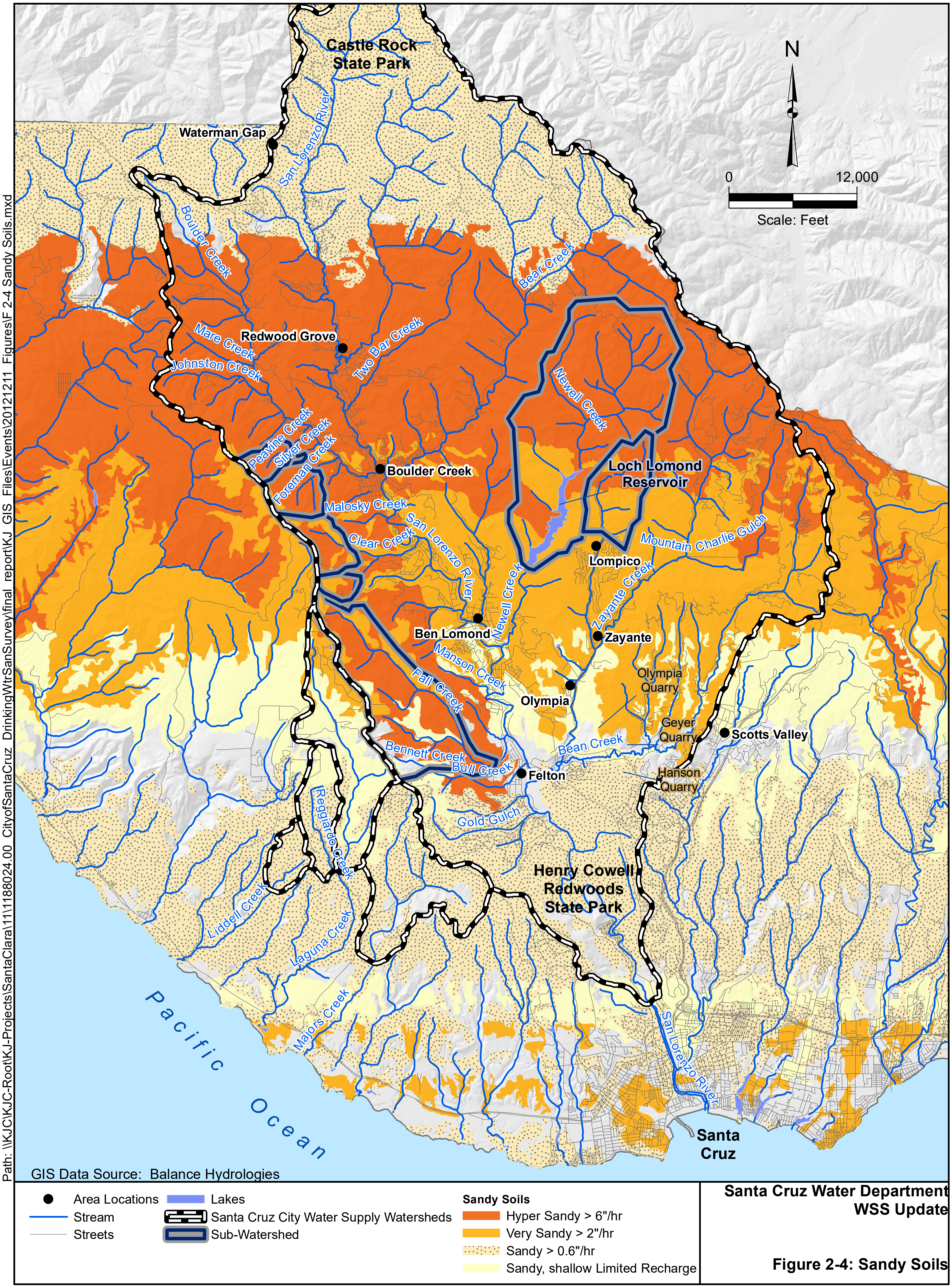


Figure 2-4: Sandy Soils

Portions of the watershed areas are underlain by karst geology which poses a different type of risk to water quality because the large voids in karst allow for direct connection of contaminants to drinking water. Recent work by the City to map karst springs and marble outcrops associated with karst are overlain on Figure 2-4 which indicates that the Liddell Creek, Laguna Creek and portions of the Fall Creek, Bennett and Bull Springs watersheds exhibit these features. Karst geology, especially in the lower San Lorenzo River watershed, is an important means of providing base flow during the dry season which can reduce the need for Loch Lomond water in the summer and fall with resulting water quality benefits.

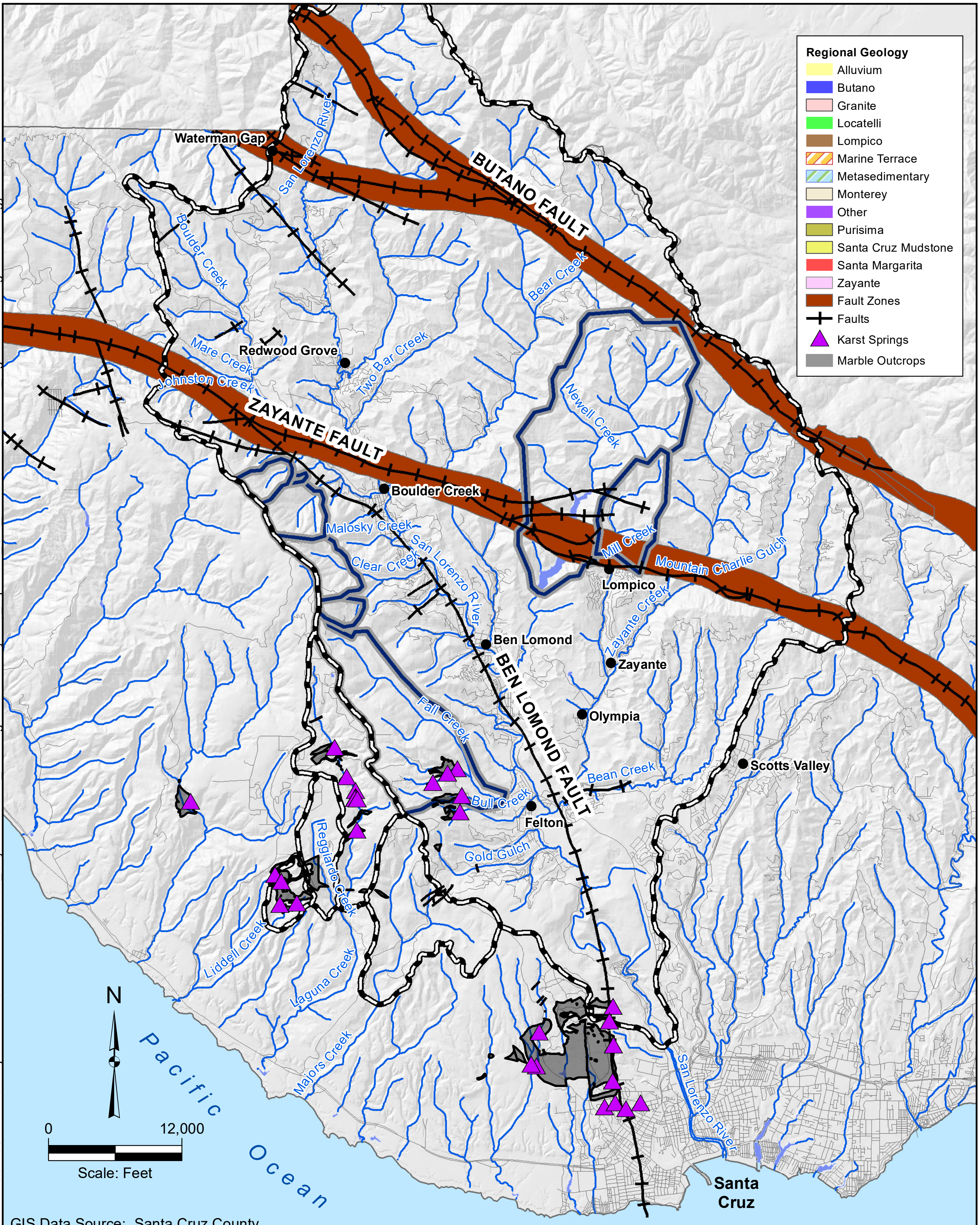
2.3.2 Faults and Seismic Activity

Faulting and seismicity pose a potential geologic hazard in the Santa Cruz Mountains. The San Andreas fault parallels the northern boundary of the project area approximately two miles to the north. Numerous faults cross the project area. In the San Lorenzo Valley, the most notable faults include: the Zayante fault, which runs primarily east-west, crossing Loch Lomond; Ben Lomond fault, with a trace roughly paralleling the San Lorenzo River from Santa Cruz to the Boulder Creek area; and the Butano fault, which crosses the northern, highest portions of the San Lorenzo watershed. No recent movement has been recorded on any of the three faults but these faults, as shown on Figure 2-5, control groundwater flow and quality in the region.

The principal fault in the North Coast area is the San Gregorio fault zone, which trends north-northwestward several miles offshore from the mouths of Laguna and Majors Creeks. It is active and has sustained recurrent activity for several million years.

Santa Cruz County experiences low-level seismic activity on a regular basis. The most significant recent event was the 1989 Loma Prieta earthquake. Significant damage to structures, roadways, and utilities occurred, including damage to water systems occurred following the magnitude 7.1 Loma Prieta earthquake. Landslides, debris flows, and the reconstruction of residences and infrastructure contributed to persistent turbidity in area streams and surface waters for a period thereafter. Future seismic activity should be anticipated, and this expectation should be a major factor in public policy and management of local water supplies.

In the past five years, the closest significant earthquake to the San Lorenzo Valley region occurred in east of Santa Cruz with a magnitude of 3.6. Even a moderate earthquake in this area could result in death, property damage, and economic upset as well as water quality upsets, particularly after a wet winter which resulted in landslides.



Santa Cruz Water Department
WSS Update

Figure 2-5: Regional Geology

2.3.3 Volcanic Activity

While known for their seismic activity, the Santa Cruz Mountains are highly unlikely to experience any volcanic activity in the foreseeable future.

2.3.4 Vegetation

The watershed lands evaluated in this survey area are dominated by dense forests consisting of a mix of deciduous and evergreen trees and hardy shrubs. Second growth coast redwood is the dominant forest species in the steep canyons, particularly where coastal fog can supply summer moisture. Several species of oak, as well as Douglas fir, tanoak, and madrone form mixed stands on drier slopes and aspects. Some ridges are covered by dense chaparral, composed mainly of manzanita and chamise. Ponderosa pine, a forest species not generally found in the Coast Range, forms a distinct community in the locations where the coarse sands of the Santa Margarita formation are exposed.

While scattered grasslands can still be seen in the San Lorenzo River watershed, most have been converted to residential uses or have reverted to chaparral and second growth forests. The coastal terraces, much of which is downstream of City intakes, support larger grasslands, but are also subject to the same sorts of residential development pressures and conversion to chaparral and coastal scrub. Within the area grasslands, few native bunchgrasses are found, having long ago been replaced by the exotic annual grasses introduced by early European settlers.

Riparian plant communities are established along all streams in the surveyed watersheds, although human activity or debris from unstable slopes often encroaches in these areas. Several species of willow and alder, as well as big leaf maple, box elder, sycamore, and cottonwood are the most common tree species. California blackberry, poison oak, stinging nettle, in addition to numerous species of sedge and rush, make up much of the understory streambank vegetation. In disturbed riparian areas, non-native vegetation such as French broom, English or cape ivy, poison hemlock, periwinkle, and acacia have become established and compete with native species. These riparian zones play vital roles in protecting and maintaining water quality in most of the water supply watersheds.

2.3.5 Wildlife

Numerous wildlife species inhabit the California Coastal Ranges. The steep topography, extensive open space, and vegetation communities that range from aquatic and riparian to woodland and chaparral, provide a wide range of habitats for terrestrial and avian species. The area supports such mammalian species as: black-tail deer, mountain lion, bobcat, gray fox, California ground squirrel and a variety of other small terrestrial mammals. A number of non-native species have become established in the Santa Cruz Mountains, including bullfrogs, New Zealand mudsnail, wild pig, Norway rat, common opossum, and feral domestic dogs and cats.

The number of bird species found in the Santa Cruz Mountains reflects the variety of habitats and the location along the Pacific Coast migratory route of waterfowl and songbirds. The riparian habitats fringing the San Lorenzo River and the smaller streams of the region have the highest breeding bird density of all habitat types in the area. Canada geese populations at Loch Lomond resulted in a 2019 study for more active population management to reduce potential water quality impacts. Several species of wading birds live in the area, including great blue heron, green heron, and black crested night heron. Belted kingfishers, Stellar's jays, and wood ducks are also residents. Raptors are common throughout the area and include red-shouldered hawks, red-tailed hawks, and Coopers hawks, while occasionally golden eagles can also be encountered in the watershed. Wild turkey sightings have increased significantly in the last several years since the 2018 Watershed Sanitary Survey Update.

Reptile and amphibians can occur in local riparian habitats. Notable species in the County include the western pond turtle, California red-legged frog, legless lizard, and several species of salamander although specific presence in the watersheds varies.

The San Lorenzo River supports many species of fish. Steelhead trout and coho salmon are considered native to the coastal streams in Santa Cruz County and the San Lorenzo River supports the region's largest steelhead run. While data suggests historically large and viable populations, historical numbers are challenging to interpret due to significant hatchery operations. Since 1981, coho have been intermittently observed in the San Lorenzo River, though local populations are on the verge of extirpation. Both steelhead and coho are federally listed as threatened under the Endangered Species Act, while coho are listed by the State under the more-critical 'endangered' designation. Recent extended drought periods 2012-2015 and 2020-present have further stressed fish populations although fish stocking has somewhat reduced the impacts. The primary threats to these species include: loss of high-quality rearing and spawning habitats due to flow reductions and excessive fine sediment loads; and barriers to migration due to dams, culverts, and flow-depleted critical riffles (Alley and others, 2004; National Marine Fisheries Service. 2012; National Marine Fisheries Service. 2016)

2.4 Water Supply Systems Background

2.4.1 History

The San Lorenzo River and North Coast watersheds provide drinking water for numerous communities in the Santa Cruz area. Table 2-2 lists the water supply sources and general treatment processes used by the purveyors participating in this sanitary survey update (City and SLVWD). These purveyors use surface water and have over 200 total service connections. Table 2-3 lists the same information for non-participating purveyors part of the 1996 Watershed Sanitary Survey many of which have less than 200 service connections. All the purveyors listed in Tables 2-2 and 2-3 use surface water in the San Lorenzo River watershed. The following sections focus on the larger utilities, listed in Table 2-2, which include City and SLVWD. The watershed areas for each participating utility are shown on Figure 1-1.

Table 2-2: Summary of Drinking Water Purveyors Serving Surface Water with More Than 200 Service Connections in the Study Area

Santa Cruz Water Department (City of Santa Cruz)			
Number of Connections:		24,592	
Surface Water Sources:		San Lorenzo River/Loch Lomond Reservoir and North Coast Springs & Creeks	
Treatment Process	***Average Production***	***Primary Disinfectant***	***Last DDW Inspection Report***
Conventional Filtration (Graham Hill WTP)	2,606 MGY (from all sources)	Chlorine	Oct 2019
San Lorenzo Valley Water District			
Number of Connections:		6,523 Service Connections	
Surface Water Sources:		Clear Creek, Foreman Creek, Peavine Creek, and Sweetwater Creek	
Treatment Process	***Average Flow***	***Primary Disinfectant***	***Last DDW Inspection Report***
Trident Microfloc (Lyons WTP)	1.92 mgd, including use of groundwater sources	Chlorine	2021
San Lorenzo Valley Water District – Felton			
Number of Connections:		1,356 Service Connections	
Surface Water Sources:		Fall Creek, Bull Springs, and Bennett Spring	
Treatment Process	***Average Flow***	***Primary Disinfectant***	***Last DDW Inspection Report***
CPC Microfloc-Trimite TM-350 (Kirby WTP)	1.0 MGD (capacity)	Chlorine	2021

Notes:

Data from waterboards.ca.gov and the 2009 SLVWD Water Supply Master Plan.
Big Basin MWC Participated in the 1996 Watershed Sanitary Survey and is included in Table 2-3

Table 2-3: Summary of Small Non-Participating Drinking Water Purveyors in the San Lorenzo River Watershed

Big Basin Water Company		
Number of Connections:	482	
Watershed Location:	Four surface sources; Jamison Springs (No. 1 and 2), Corvin Springs, Well No. 5 (horizontal under the influence of surface water)	
Filtration System/Type	***Disinfection Strategy***	***Comments***
Jamison WTP Conventional Processes with Capacity to Treat 150 gpm (Neptune Microfloc/ Trimite)	Chlorine	--
Brackenbrae Mutual Water Company(1)		
Number of Connections:	24	
Watershed Location:	North of Boulder Creek	
Filtration System/Type	***Primary Disinfectant***	***Comments***
Package WTP (3M bag filter)	Chlorine	Protected streams and spring
Forest Springs Mutual Water Company(1)		
Number of Connections:	126	
Watershed Location:	North of Boulder Creek	
Filtration System/Type	***Primary Disinfectant***	***Comments***
Sedimentation only	Chlorine	Spring source
Bonnymede Mutual Water Company(1)		
Number of Connections:	10	
Watershed Location:	On Reggiardo Creek	
Filtration System/Type	***Primary Disinfectant***	***Comments***
--	Ozone	--
Quaker Center		
Number of Connections:	8	
Watershed Location:	Near Ben Lomond	
Filtration System/Type	***Primary Disinfectant***	***Comments***
Package WTP (3M bag filter)	Chlorine	--
River Grove Water System(1)		
Number of Connections:	25	
Watershed Location:	Near Felton	
Filtration System/Type	***Primary Disinfectant***	***Comments***
Slow sand filtration	Chlorine	--

Notes:

Data from the 1996 Watershed Sanitary Survey and waterboards.ca.gov

(1) Small water companies represented by Santa Cruz County

2.4.2 Santa Cruz Water Department

As described in greater detail in Section 2.6, generally, the private water companies that preceded the City of Santa Cruz began establishing pre-1914 water rights to area streams and underflow in the late 1800s. The riparian rights to the North Coast sources were purchased from landowners downstream of the City's diversions. The City has appropriative rights to San Lorenzo River and Newell Creek water via licenses and permits. These rights allow the withdrawal of water at the San Lorenzo River Intake at Tait Street (also known as the Tait Street Diversion) in Santa Cruz for delivery to the GHWTP and the Felton Diversion for storage at Loch Lomond Reservoir. In 1960, Newell Creek Dam was constructed to create Loch Lomond Reservoir, with a then-reported capacity of 8,500 of acre-feet.[4] Jointly, these surface water sources are the primary supply for the City.

Source water development and the supply history of the Santa Cruz Water Department through 1986 were described in detail in the 1996 Watershed Sanitary Survey. In 1986, the City upgraded the GHWTP to improve treatment performance. Improvements consisted of replacing the filter media; modifying the chemical feed systems, flocculators, monitoring and control system, and sludge collectors; and installing tube settlers in the sedimentation basins. In the 1990s the City began advanced filtration of its North Coast sources, which previously were simply chlorinated. An Additional changes in the City water supply and treatment system that have occurred since the 2018 Watershed Sanitary Survey update include replacement and rehabilitation of wells at the Tait wellfield and rehabilitation and upgrades at the Graham Hill WTP, which are discussed in Section 2.8.

2.4.3 San Lorenzo Valley Water District

The SLVWD, originally the San Lorenzo Valley County Water District, was formed by a special election of the residents of Santa Cruz County on April 3, 1941. At that time, the boundaries were established to include 58 square miles of the San Lorenzo Valley in the Santa Cruz Mountains. During the late 1940s, the SLVWD purchased large areas of land with an initial intent of potential reservoir development; as philosophies changed these lands were later preserved for watershed protection in the early 1980s. In 1958, the SLVWD sold 2,500 acres of land to the City of Santa Cruz for the placement of Loch Lomond Reservoir.

Major events in the development of the current SLVWD water supply system are described in detail in the 1996 sanitary survey. The District has not used springs as water sources since 1993 when the Lyons surface water treatment plant was constructed. More recent developments include the annexation of the Mañana Woods Mutual Water Company and the acquisition of protected lands in the Malosky Creek watershed both of which occurred in 2006 and are described in the 2006 Watershed Sanitary Survey.

In 2008, SLVWD acquired the Felton Water System from California-American Water Company. Felton is supplied water from two (2) spring sources and one (1) surface water diversion. The spring sources are Bennett Spring and Bull Spring. The surface water source is Fall Creek.

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[4] Re-surveys indicate a current capacity of about 8,600 acre-feet above the spillway elevation (McPherson, 2011)

Supply water from the combined springs is routed through a raw water transmission line to the Kirby Street Water Treatment Plant. Supply water from Fall Creek is also routed through separate raw water transmission line to the Kirby Water Treatment Plant (Kirby WTP). The Kirby Street Water Treatment Plant was brought online in January 1997 to meet the requirements of the SWTR. The nominal capacity of the Kirby Street Water Treatment Plan is 1.0 mgd using two (2) 350 gpm rated, two stage filtration constant adsorption clarification/tri-media filtration units (CPC Microfloc-Trimite TM-350). Disinfection is provided at the Kirby Street Water Treatment Plant by contact mixing with sodium hypochlorite prior to introduction into the treated water distribution system.

The area formerly served by LCWD is now a part of the SLVWD North system and has approximately 500 service connections (which has not changed as of 1996), which generally surrounds the Lompico area. Lompico is shown just east of the Loch Lomond Reservoir in Figure 1-1.

As part of the LCWD/SLVWD merger process, ownership, and management of the 425-acre Lompico headwaters property that previously supplied water to the community of Lompico transitioned to the Sempervirens Fund.

2.5 Water Sources

2.5.1 Santa Cruz Water Department

The existing City water supply system is described in detail in the 2020 Urban Water Management Plan. The City supply system is comprised of four main production elements: (1) the North Coast streams and Liddell Spring; (2) the San Lorenzo River (San Lorenzo River Intake, Tait Wells and Felton Diversion); (3) Loch Lomond Reservoir on Newell Creek; and (4) the Live Oak wells. The following sections describe in greater detail City's surface water sources (sources 1 through 3). The Live Oak wells system is entirely a groundwater supply source and is not described further.

The main water supply facilities are shown on Figure 1-1.

2.5.2 North Coast

The North Coast sources consist of surface diversions from three coastal streams (Laguna Creek, Reggiardo Creek, and Majors Creek) and one natural spring (Liddell Spring) located approximately six to eight miles northwest of downtown Santa Cruz. City has used these sources since 1890. Reggiardo Creek has not been active in recent years.

A few changes to the facilities described in the 1996 Watershed Sanitary Survey have been made including repairs at the Majors Dam following a failure and sediment transport improvements including new drain valves and operational improvements required by CDFW at Laguna and Majors Creeks. A brief summary follows, for reference. More detailed descriptions are found in the 1996 Watershed Sanitary Survey.

Liddell Spring — Liddell Spring is a natural spring used for water supply. The spring box/diversion is located at elevation 584 feet. Water from the spring is directed through a 10-inch steel pipeline into the Coast Pipeline for transmission to the City service area.

Laguna Creek and a tributary, Reggiardo Creek — Flows from Reggiardo Creek, which are quite limited, were historically captured at a diversion dam located at elevation 630 feet. The diversion is currently out of service due to much needed repairs. When used, diversions are routed through about 850 feet of pipeline to Laguna Creek just upstream of the Laguna diversion and are not monitored separately from Laguna Creek. Diverted Laguna Creek flows, combined with any diverted Reggiardo Creek flows when in operation are captured at a concrete and limestone dam located at elevation 623 feet on Laguna Creek. The original dam constructed in 1890 is still in use today, though the intake structure was upgraded with a Coanda screen in 2021. These diversions are sent through 12,400 linear feet of 14-inch steel pipeline to the junction with the transmission pipeline from Liddell Spring. The junction is known as the Laguna-Liddell "Y". Diversions from Laguna Creek have been reduced to meet fish flows in recent years on accordance agreements proposed in the Santa Cruz Water Rights project, the Operations and Maintenance HCP, and the Anadromous Salmonid HCP, increasing reliance on Loch Lomond and other supplies.

Majors Creek — Flow from Majors Creek is diverted from a concrete dam located at elevation 352 feet. As noted earlier, a dam failure in the winter of 2011, was repaired to restore the original diversion in the summer of 2011. Diversions from Majors Creek are conveyed through 11,300 linear feet of pipeline varying between 10 and 16 inches in diameter before joining the main Coast Pipeline along Highway 1. Because the Majors Creek diversion is located at a much lower elevation than the other North Coast sources, use of the Majors Creek Diversion has historically been limited by the available supply from the other North Coast sources (i.e., the Majors Creek flows can enter the Coast Pipeline only when the head from the other sources is low). Reduced production at Laguna due to the need to provide improved flows for fish in Laguna Creek, allows more of Majors Creek flows to enter the Coast Pipeline but also increases reliance on Loch Lomond and other water sources.

Water from the North Coast diversions flows by gravity to the City system via the Coast Pipeline, which varies from 16 inches in diameter between the Laguna-Liddell "Y" and Majors Creek up to 24 inches in diameter near Bay Street Reservoir. Projects have been underway over the last 10 years to replace badly deteriorated sections of the Coast Pipeline with projects ongoing.

Water from the Coast Pipeline is boosted at the Coast Pump Station to the Graham Hill WTP for treatment.

2.5.3 San Lorenzo River – Intake in Santa Cruz and Tait Wells

San Lorenzo River flows are diverted at the Intake in Santa Cruz just north of Highway 1. Water is diverted at a concrete check dam into a screened intake sump where three vertical turbine pumps are used to pump the water to the Graham Hill WTP. Two of the pumps are converted to a variable frequency drive (VFD) to better match pump output to demand and available flow while one pump is set at a constant speed. These pumps are located in the same building as the pumps for the North Coast diversions. High flows during winter of 2017 have scoured the river bottom in the vicinity of the intake allowing for inspection which indicated that some damage has occurred. This downcutting may have had some water quality benefit as the river flow now has greater velocity in the vicinity of diversion. In addition, the lagoon at the mouth of the San Lorenzo River at the Pacific Ocean has backed up almost to the diversion, which could potentially bring more saline water at the diversion as sea levels rise.

The San Lorenzo River Intake in Santa Cruz also includes three production wells, located on the east side of the river. Two replacement wells, Tait Well No. 1B and Tait Well No. 3B were drilled in 2016 and are about 89 feet deep. One well, Tait Well No. 4, was rehabilitated in 2016, and is 71 feet deep. These wells are tied to the City's appropriative rights for San Lorenzo River flows as there is evidence that the Tait wells are hydraulically connected to the river. The DDW classifies water from the Tait wells as GWUDI (Groundwater Under Direct Influence of Surface Water).

Water produced by the Tait wells is also delivered to the San Lorenzo River intake sump at the Coast Pump Station. The groundwater is then pumped into a common transmission pipeline used to convey water from both the North Coast and San Lorenzo River sources to the Graham Hill WTP for treatment.

2.5.4 San Lorenzo River - Felton Diversion

There have been no major changes or modifications to this system since 2018 when the diversion dam was replaced. The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence, which is approximately five river miles north of the Coast Pump Station and San Lorenzo River Intake. The diversion structure consists of an inflatable rubber dam to divert flows into a screened intake sump. Flows are then pumped through the Felton Booster Station into Loch Lomond for storage via the Newell Creek Pipeline. The desired diversion rate is regulated by using different combinations of the three pumps at the Felton Diversion and the five pumps at the Felton Booster Station.

2.5.5 Loch Lomond Reservoir on Newell Creek

The Loch Lomond Reservoir was created by the construction of Newell Creek Dam, located about ten miles north of Santa Cruz and northeast of the town of Ben Lomond. The reservoir was constructed in 1960, and currently has a maximum storage capacity of about 8,600 acre-feet.[5] Loch Lomond is the only major reservoir in the San Lorenzo River watershed. There have been no major changes in this system in the last five years.

Newell Creek Dam is an earthfill dam, 190 feet high and 750 feet long at the crest. The spillway crest is at elevation 577 feet. Releases from the reservoir are made through outlet works on the upstream face of the dam. Water released from Loch Lomond for use by City is conveyed to the Graham Hill WTP through the Newell Creek Pipeline. The water flows by gravity from the reservoir to the Felton Booster Station, approximately 4.3 miles downstream of the dam. The water is then pumped at Felton Booster Station to clear a ridge in Henry Cowell State Park at an elevation of about 580 feet. To meet fluctuating head and flow conditions, five pumps and alternative valving configurations that allow various pump combinations are available at the Felton Booster Station.

[5] Per a 2009 survey discussed in Section 2.2.7

2.5.6 SLVWD

Clear Creek, Foreman Creek, Peavine Creek, Silver Creek, and Sweetwater Creek are the primary surface water sources for the Lyons WTP which serves the northern portion of SLVWD's service area. The current average stream diversion yearly total is about 900 acre-feet from these sources. SLVWD has pre-1914 appropriative rights to these creeks. These sources are perennial creeks and are located west of Highway 9 along the Ben Lomond Mountain. The watersheds of the creeks are contiguous and rugged with extremely steep slopes. The watersheds above the creek intakes are largely uninhabited. In addition, the SLVWD's Felton system is served by Fall Creek and Bennett and Bull Springs. The approximate location of each creek intake and watershed area is illustrated in Figure 1-1.

The original surface water source for the Lompico portion of the SLVWD north system was Lompico Creek, downstream of the Mill Creek confluence which has a watershed area of about 1,470 acres. SLVWD now has the appropriative water rights for Lompico Creek, which dates to the mid-1940s. A 1707 petition was submitted in 2020 in order to dedicate the water for instream flows.

2.6 Water Rights

2.6.1 SCWD

Table 2-4 lists the City water rights, as listed in the 2020 Urban Water Management Plan. There have been no changes in the City water rights since the preparation of the 1996 Watershed Sanitary Survey although City is developing and submitting filings for a change to the water rights that would allow direct diversion at Felton for delivery to the Graham Hill WTP. The City's 2013 Anadromous Salmonid HCP, which identifies the bypass flows negotiated for the protection of anadromous salmonids as discussed earlier in combination with the Santa Cruz Water Rights Project (SCWRP), are to allow flexibility for diversions.

The SCWRP includes proposed modifications to the City's existing water rights as listed in Table 2-4 and includes associated infrastructure improvements to take advantage of the modifications. The City has petitioned the SWRCB to revise its decades-old permitted and licensed water rights in the San Lorenzo River watershed to allow more options for where and how those water rights can be used. In addition, minimum instream bypass flows (also called Conservation Flows or Agreed Flows) were included in the water rights petitions.

To provide for the needed flexibility in the operation of the City's water system, the SCWRP would add points of diversion and rediversion. Specifically, the SCWRP would add the City's existing Beltz system as points of rediversion into and out of groundwater storage to the City's Tait Licenses, Felton Permits and pre-1914 appropriative rights. These rediversion points would provide flexibility for utilizing the City's San Lorenzo River surface water supplies for the Beltz Aquifer Storage and Recovery subcomponent of the SCWRP. The SCWRP would also add the Tait Street Diversion as a new point of diversion on the Felton Permits, which would give the City the option of diverting water under the existing Felton Diversion water rights at either the Felton Diversion or downstream at the Tait Street Diversion. This change would provide the ability to divert water under the Felton Permits with or without activation of the Felton Diversion inflatable dam and improve operational flexibility. Additionally, when water under the Felton Permits would be diverted at the Tait Street Diversion, water would remain in the San Lorenzo

River longer, bypassing the Felton diversion before being diverted at the Tait Street Diversion, thus providing fisheries benefits. Some other changes from the SCWRP include diversion of water during the winter as well as source changes to accommodate fish flows both of which could result in source water quality impacts.

Table 2-4: Summary of City Water Rights

Source	Period	Maximum Diversion (cfs)	Fish Flow Requirement (cfs)	Annual Diversion Limit (MG/year)
Liddell Spring	Year-round	No Limit	None	None
Laguna Creek	Year-round	No Limit	None	None
Reggiardo Creek	Year-round	No Limit	None	None
Majors Creek	Year-round	No Limit	None	None
San Lorenzo River Tait Diversion	Year-round	12.2	None	Non
Felton Diversion to Loch Lomond Reservoir				
	September	7.8	10	977
	October	20	25	
	November-May	20	20	
	June-August	0	---	
Loch Lomond Reservoir on Newell Creek				
	September-June	No limit	1 (released from Newell Creek Dam)[1]	Max collection: 1,825 Max withdrawal: 1,042

Notes:

Water rights for the North Coast Sources are pre-1914 rights containing all downstream rights. Therefore, the City may divert up to the full natural flow of each stream. City owns all downstream riparian water rights on the North Coast sources.

[1]This requirement has been reduced further as a result of a Temporary Urgency Change Petition during droughts.

It should be noted that the drought emergency starting in 2014 and again in 2020—present, required City file for a Temporary Urgency Change Petition (TUCP) with the SWRCB, Division of Water Rights for relief from the bypass and release requirement at Loch Lomond Reservoir in order to maintain water in storage to meet the community's needs for water for essential health and safety needs. In addition, City is wrapping up the SCWRP to conform water rights that will change the place of use of the San Lorenzo River water and allow flexibility in the use of the various surface waters available to Santa Cruz. The diversion flexibility of the SCWRP also includes more winter diversions, when available, with associated potential water quality impacts that will need infrastructure improvements at GHWTP to provide an adequate level of treatment.

2.6.2 SLVWD

Table 2-5 summarizes the water rights for SLVWD. This table also lists the limiting flow rates or diverted flow rates from the different surface waters, if applicable.

Table 2-5: Summary of Surface Water Rights for San Lorenzo Valley Water District

Source	Right	Limitations
Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek,	Fully appropriated rights	None
Fall Creek, Bennett, and Bull Springs	Fully appropriated rights Not to exceed 1.7 cfs and 345 mg/year	Required minimum bypass flows vary from 0.05 – 1.5 cfs, depending on the cumulative monthly runoff of the San Lorenzo River, as measured at the Big Trees gage; cannot divert once Big Trees drops below 20 cfs per seniority
Lompico Creek	Appropriative Rights	Diversion of up to 24,000 gallons per day of surface water and must have 0.1 cfs bypass

Notes:

Source: DDW Annual Inspection Reports and State Water Resources Control Board Water Rights Database

SLVWD has pre-1914 appropriative water rights to divert from the northern tributaries to the San Lorenzo River and appropriative water rights transferred during SLVWD's acquisition of the Felton System for Fall Creek and Bennett and Bull Springs.

The appropriative water right to divert up to 24,000 gallons of surface water at the Lompico Creek intake structure was originally owned by LCWD but has now been transferred to SLVWD since the 2016 merger.

2.6.3 Water Quantity

Table 2-6 summarizes the water sources and the quantity of water available for each large utility. This table lists the surface water sources for each utility, the approximate average surface water supply capacity for the source, the total supply capacity (including ground water), and the total average day use. Each of the large utilities has a limited supply of water for drinking water purposes. For example, City has about 7.5 mgd of combined ground and surface water available for drinking water purposes, of which about 77 percent comes from flowing surface diversions, about 6 percent from groundwater and the remaining 17 percent from water stored in Loch Lomond at the present time. However, the combination of sources used from day to day can vary with some days reliant on the San Lorenzo River and Liddell Springs sources with other days with much higher Loch Lomond usage than San Lorenzo River. The average day use from 2020 was about 7.1 mgd, with a potential average demand in 2045 of up to 7.59 mgd (2020 City UWMP). Although average water demand appears to be met with the available supply, during periods of drought, flows in the San Lorenzo River and coast sources run low and cannot support average dry-season demands. This situation can stress the system, especially given the unpredictable nature of climate conditions and due to system demand and the need to provide instream flows for fisheries.

Although efforts are made to maximize the volume of water available from surface water sources, especially the San Lorenzo River, after a storm event, the City operates under a maximum turbidity level for withdrawal from the San Lorenzo River sump of 10 NTU at the Coast Pump Station; the sump is a blend of San Lorenzo River and Tait well water. During first flush storm events in the early season, turn outs are bypassed as soon as it starts raining. The City is considering a winter diversion program that could be used for in-lieu conjunctive use of groundwater to improve seawater intrusion conditions which may result in adjustments to the turbidity criteria. City is addressing the challenges to consistently provide and achieve the desired supply capacity, especially during extended drought periods, under the minimum instream flow targets for the HCP, and in the future with the current supply sources with continued water conservation, addition of recycled water, and study of groundwater replenishment with excess surface water and advanced purified water.

Table 2-6: Summary of Water Sources Available to City and SLVWD

Source	Average Surface Water Supply	Average Groundwater Supply	Average Supply Available	Average Demand
San Lorenzo River	4.2 MGD	N/A	2,561 MGY	7.1 MGD
Loch Lomond Reservoir	1.3 MGD	N/A		
Coast Sources including Liddell Spring, Laguna/Reggiardo Creeks, and Majors Creek	1.5 MGD			
Beltz Wells[2] (Active wells only)	N/A	0.14 MGD		
Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek	1.2 MGD	N/A	5.1 MGD	1.91 MGD
Quail Hollow, Olympia, and Pasatiempo Wells	N/A	3.3 MGD		
Fall Creek, Bennett, and Bull Springs	0.5 MGD	N/A		
Lompico Creek[3]	0.06 MGD	N/A		
Former LCWD Wells[3]	N/A	0.06 MGD		

Notes:

Total supply available depends on annual rainfall
Most of the demand is in surface water service area (approximately 70 percent)
Sources from former Lompico County Water District, which merged with SLVWD in 2016.

2.6.4 Source Management

Each of the utilities in the area manages their sources in an attempt to satisfy the water demands for their specific systems. All utilities are dependent upon the surface flows from the various creeks, streams, and springs that make up their drinking water source. Factors such as highly turbid water caused by stormwater runoff make the water more difficult to treat, requiring diversion of the source to be discontinued until the water quality returns to acceptable levels. For example, City does not use water from the San Lorenzo River Diversion during storm events when the sump turbidity which is blend of San Lorenzo River and Tait Wells exceeds about 10 NTU. When flows are diminishing towards the end of a storm and/or on the receding limb of the hydrograph, turbidity of about 25 NTU is diverted. Also, SLVWD does not use highly turbid water at their Lyon and Kirby WTPs during high-turbidity periods.

One of the major challenges for City is managing operations to accommodate the minimum flows in the Operations and Maintenance Habitat Conservation Plan, the conservation flows from the SCWRP petitions, and the proposed instream flow requirements for Endangered Species Act (ESA) requirements under the Anadromous Salmonid HCP on some of the North Coast streams, potentially reducing the volume of flow available from these sources. As discussed in Section 2.3.5, the consequence of reduced North Coast flows would be higher reliance on water from Loch Lomond Reservoir and winter flows from the San Lorenzo River both of which have a higher TOC concentration, and hence a higher potential for formation of disinfection byproducts (DBP). DBP formation can be managed/inhibited/ from both the treatment perspective by carefully selecting source water for lower TOC as well as in the distribution system where regular water sampling occurs for DBP compliance.

City staff has continued to discuss and manage the implications of the SCWRP and ESA instream flow requirements as well as potential future winter water production for regional water supply reliability, which include modifying the treatment process currently underway as part of the Facility Improvement Project and/or constructing horizontal wells at the San Lorenzo River diversion – both of which are activities that will require many years to plan and implement. In addition, Graham Hill WTP improvements to meet LT2 and Stage 2 rule requirements were evaluated in 2010. These improvements include alternatives that could be implemented to meet more stringent D/DBPR requirements and reduce the higher levels of DBP that are associated with elevated TOC concentrations.

Water utilities must therefore balance the need to satisfy their customer demand with the requirement to comply with drinking water regulations. Most utilities, large and small, experience difficulty in treating highly-turbid water, and therefore prepare and adjust for such operations before, during, and after storms events as does SLVWD.

2.7 Facilities

2.7.1 Raw Water Reservoirs

With the exception of small diversions in creeks and streams, the only large raw water reservoir in this study area is Loch Lomond, which is managed by City. This roughly 8,600 acre-foot capacity reservoir, located on Newell Creek northeast of Felton and east of Ben Lomond, also stores San Lorenzo River water diverted at the Felton Diversion structure. SLVWD holds entitlement to a portion of surface water storage in Loch Lomond Reservoir or an equivalent water transfer from the City Santa Cruz Water. SLVWD has not recently exercised its entitlement due mostly to the costly upgrade that would be needed to its Kirby water treatment plant to address the high concentrations of total organic carbon in Loch Lomond raw water.

City commenced construction in 2020 of a project to replace the inlet/outlet pipeline that serves the Loch Lomond Reservoir. A valve on this pipeline was inspected in 2012 and was found to be stuck partially open and no longer operable. An interim plan was agreed to with Division of Safety of Dams in 2015 and the project is expected to complete construction in 2023.

2.7.2 Intakes/Conveyance Systems

The locations of major water intakes are shown in Figure 1-1. Table 2-7 describes the intake and conveyance systems for the large utilities. Note that the San Lorenzo Valley and North Coast watersheds have extensive intake and conveyance systems needed to efficiently use the readily available supply of water in this area. Many of the intake structures have been constructed to prevent contamination from outside sources. Some of the key intake and conveyance systems are discussed below.

Table 2-7: Summary of Conveyance/Intake Facilities for Utilities with More Than 200 Service Connections

Utility	Source	Intake Details	Pipeline Dimensions	Pump Station Capacity	Other
City of Santa Cruz Water Department	San Lorenzo River Intake	Combination concrete check dam and screened intake sump with vertical turbine pumps on wells	Varies	7.8 mgd	
	San Lorenzo River - Felton Diversion	Inflatable rubber dam, screened intake pump	N/A	Felton Diversion P.S. at 2,850 gpm	Diverts water to Loch Lomond
	Loch Lomond Reservoir	Large earthen dam with multi-stage outlet tower	44,000 lf pipeline; 18 to 27 inches diameter	Gravity flow to Felton with Felton Pump Station at 13.5 MGD	Used in specific months to augment supply or when other sources have high turbidity that is difficult to treat
	Coast sources	These sources have small diversion structures or a protected spring box	Diameter varies - total pipelines	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Majors	Concrete full-span dam with wire screened intake	10”	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Laguna	Concrete/stone full span dam with Coanda screen intake	14”	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Reggiardo	Concrete/stone full span dam with wire screened intake	8”	Gravity flow	Gravity fed to Laguna impoundment
	Liddell	Concrete/Corrugated Aluminum spring box with wire screened intake	16”	Gravity Flow	Gravity flow to the Coast pump station then; pumped to GHWTP
San Lorenzo Valley Water District	Clear Creek	Protected spring box at elev 1250 ft,	8-inch pipe to Foreman Creek	N/A	Gravity flow to Lyon WTP
	Sweetwater Creek	Protected spring box at elev. 1230 ft.		N/A	Gravity flow to Lyon WTP
	Peavine Creek	Small diversion structure at elev 1264 ft.	8 in. pipeline to Foreman Creek	Gravity	Gravity flow to Lyon WTP, Christmas tree farm in watershed

Utility	Source	Intake Details	Pipeline Dimensions	Pump Station Capacity	Other
	Foreman Creek	Small diversion structure at elev 927 ft.	8 in. pipeline to WTP	Gravity	Gravity flow to Lyon WTP, small subdivision in headwaters
	Fall Creek	Small wire screen structures	8-inch	500 gpm	Gravity flow to Kirby WTP, Fall Creek St Park
	Bennett Spring	Protected spring box	4-inch	N/A	Gravity flow to Kirby WTP
	Bull Spring	Protected spring box for #1 and #2	4-inch	N/A	Gravity flow to Kirby WTP,
Lompico County Water District (merged with SLVWD in 2016)	Lompico Creek	Secured, screened structure adjacent to creek impoundment dam with concrete deep well and 1 HP pump	2" PVC Raw water line to holding tank 260-ft away	30 gpm Pump	N/A

N/A Not applicable or available.
Note to Reviewers: Info for Big Basin MWC is not included in this table but were included in 1996.

2.7.2.1 City

Figure 1-1 shows approximate intake locations for the City system. These include pipelines from the North Coast watershed and the San Lorenzo Valley. The details of these intakes and conveyance systems are described in Section 2.5 and in the 1996 Watershed Sanitary Survey.

2.7.2.2 SLVWD

Figure 1-1 shows the locations of the surface water sources used by the SLVWD. 4 of the 9 points of diversion are currently inactive due to damage sustained in the CZU Lightning Complex wildfire damage in the summer of 2020. It is anticipated that these will be repaired or replaced in 2023/2024.

SLVWD has an intake, currently unused, on Lompico Creek below the Mill Creek confluence. About 15-20 houses are located upstream of the intake structure. Originally, the LCWD obtained about 25 percent of its water from the Lompico Creek surface intake and the other approximately 75 percent is obtained from groundwater wells.

2.7.3 Treatment Plants/Processes

The water treatment plant facilities for the large utilities in the watershed study areas are summarized in Table 2-8 and are described in more detail below.

Table 2-8: Summary of Surface Water Treatment Facilities for Utilities with More Than 200 Service Connections

Utility/Treatment Plant (Capacity)	Subject Watershed Source(s)	Pretreatment Process	Coagulant/ Flocculation Process	Sedimentation	Filtration (Rate)	Disinfection
Santa Cruz Water Dept. Graham Hill WTP [(1)] (24 mgd)	San Lorenzo River, Loch Lomond, and North Coast sources	Potassium permanganate or chlorine for oxidation, powdered activated carbon and potassium permanganate for taste and odor removal	Alum and cationic polymer Horizontal paddle mixers	Conventional - enhanced using tube settlers	Dual media (6gpm/ft2)	liquid chlorine
San Lorenzo Valley Water District - Lyon WTP (1.0 mgd)	Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek	Sodium Hypochlorite	Adsorption clarification/ filtration (Neptune Trident Microfloc)	Adsorption onto floating media which is equivalent to sedimentation	3 multi-media filters at 350 gpm rating each (6gpm/ft2)	Sodium Hypochlorite
San Lorenzo Valley Water District - Kirby WTP (0.5 mgd)	Fall Creek, Bennett, and Bull Springs	Sodium Hypochlorite	Adsorption clarification/ filtration (Neptune Trident Microfloc)	Adsorption onto floating media which is equivalent to sedimentation	2 – filters at 350 gpm rating	Sodium Hypochlorite
San Lorenzo Valley Water District – Mill Creek WTP (on standby)	Lompico Creeks	None	None	None	Microfiltration membrane 0.5 gpm/m2 of membrane area	Chlorine Post-treatment

Source: DDW Annual Inspection Reports

N/A = Not applicable, *Note to Reviewers*: Info for Big Basin MWC is not included in this table but was included in 1996.

[(1)] Beltz WTP is not included because it is a groundwater source and Loch Lomond Recreation Area WTP is not included because it is a transient non-community water system.
[(2)] Orthophosphate is added for corrosion control in the water distribution system to prevent leaching of lead and copper

2.7.3.1 SCWD

Figure 2-6 represents the approximate layout of the facilities at the GHWTP site. The GHWTP is a conventional treatment plant with key processes such as preoxidation, coagulation, carbon/potassium permanganate contactors (for taste and odor control), flocculation, sedimentation, filtration, and disinfection. These processes are fully described in the 2019 Inspection Report by DDW. In addition to upgrades at the Graham Hill WTP to the filters and replacement of tube settlers described in the 2018 Watershed Sanitary Survey update, other upgrades to allow treatment of higher turbidity source water are under design. City is in process of Facilities Improvements Program at GHWTP including to the flocculation, sedimentation and filtration basins, and replacement of three of the four concrete tanks at GHWTP. Following that, an upgrade of the overall GHWTP will commence, moving to the use of plate settlers, ozone, granular activated carbon filters for a more robust treatment process will help adapt to climate change and decreasing water quality. The updated GHWTP will better address total organic carbon and associated disinfection by products as well as Contaminants of Emergency Concern. The improvements allow use of high flows such as during and after storm events projects that otherwise would need to be bypassed. These investments are designed to address aging infrastructure and prevent noncompliance with drinking water standards under anticipated future conditions.

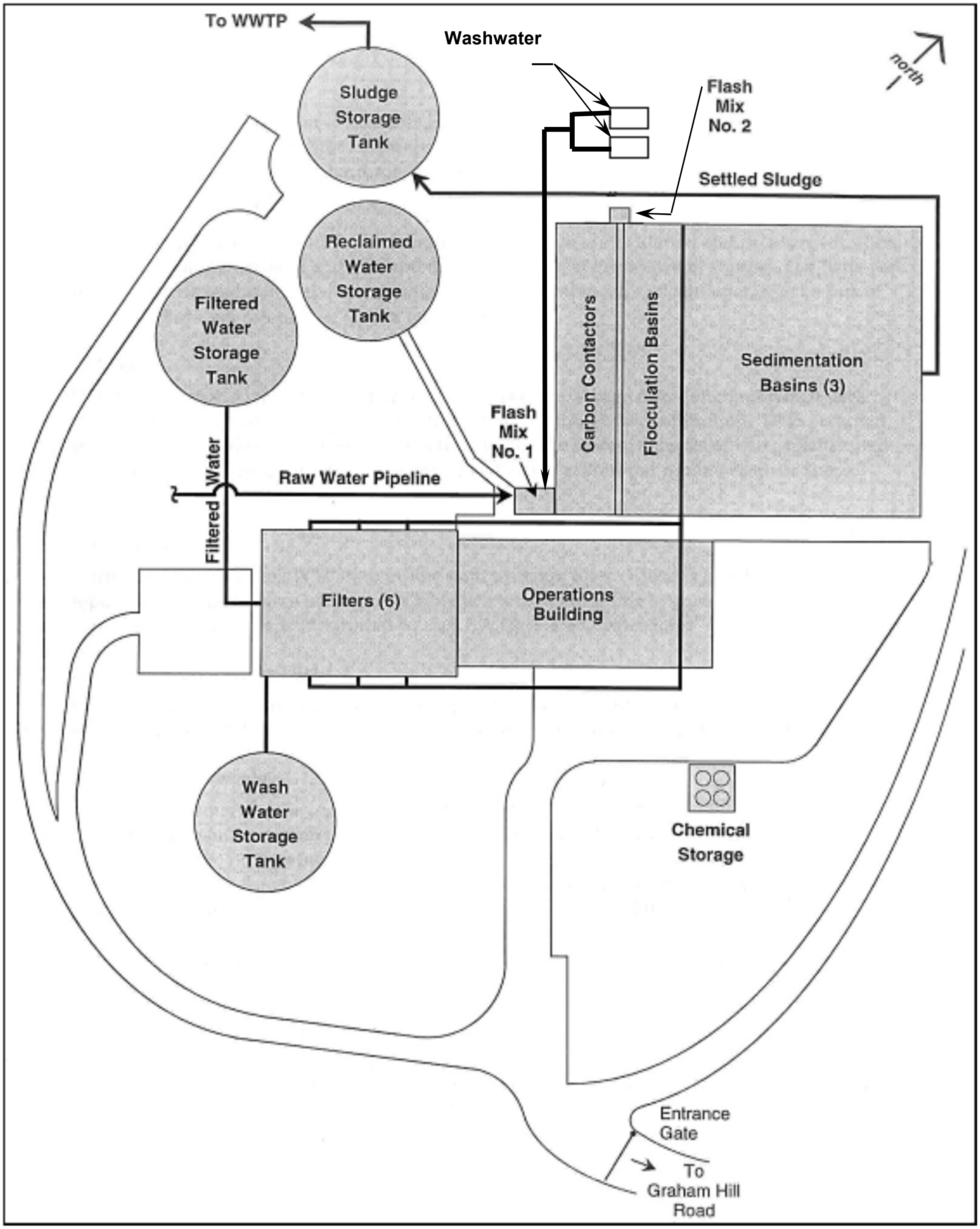
The Loch Lomond Reservoir Recreational Area (LLRRA) water system previously used a microfiltration system to provide water for park users and the caretakers of the reservoir watershed. The system is no longer used, and water is instead purchased from SLVWD.

City also operates two treatment facilities that serve the Live Oak (previously Beltz) Wells. These facilities are only used to treat groundwater and are not fully described in this update. Details on the Live Oak Wells Filtration Plant are provided in previous surveys.

2.7.3.2 SLVWD

SLVWD constructed the Lyon WTP in 1994, a two-stage package filtration plant which uses floating media to remove floc particles followed by a granular media filtration. DDW accepted this process as equivalent to conventional treatment. The system consists of three prefabricated adsorption, clarification, and filtration units each rated at 350 gpm. Due to piping system constraints, however, the maximum treated water production rate is 1,150 gpm.

In addition, SLVWD operates the Kirby WTP in Felton which is described in Section 2.4.3



Source: CDM - Camp Dresser & McKee Inc., 1996

Figure 2-6 Process Layout of the Graham Hill Water Treatment Plant, Santa Cruz Water Department.

2.7.4 Pipeline Data, Capacity

Table 2-9 summarizes the pipeline data for each of the large utilities. Table 2-10 lists the distribution system reservoirs for each of the large utilities. The distribution system storage capacity for these utilities appears sufficient to account for short-duration periods when the lower quality water is diverted, and water treatment facilities are not used. The maximum storage capacity for these utilities is about two to ten times more than the average daily use, with City typically at the lower end of that range. Therefore, each utility has enough storage to allow a short-term period when water treatment facilities are not operational.

Table 2-9: Summary of Distribution Systems for Utilities with More Than 200 Service Connections

Utility	*Number of Service Connections*	*Total Pipeline Length*	*Notes*
City of Santa Cruz Water Department	24,653 in 11 pressure zones	263 miles	Satellite disinfection available at 4 locations
		(1in. to 36 in.)	
San Lorenzo Valley Water District	6,000 in 23 pressure zones 1,300 in 6 pressure zones for Felton System 484 in 3 pressure zones in Lompico System	155 miles (SLVWD 125 miles, Felton 30 miles, Lompico System 32 miles) (2 in. to 16 in.)	Satellite disinfection available at 2 locations

Note to Reviewers: Info for Big Basin MWC is not included in this table but was included in 1996.

Table 2-10: Summary of Distribution System Storage Reservoirs for Utilities with more than 200 Service Connections

Utility	Reservoir Name	Capacity (Gallons)
City of Santa Cruz Water Department (14 reservoirs total)	Carbonera	1,000,000
	University #5	2,000,000
	University #4	400,000
	University #2	1,000,000
	Bay St. (2 tanks)	12,000,000
	DeLaveaga 1	1,000,000
	DeLaveaga 2	1,000,000
	S.C Gardens 1	250,000
	S.C Gardens 2	250,000
	Rollingwoods	270,000
	Pasatiempo 1	750,000
	Pasatiempo 2	300,000
	Finished Water Tank @ GHWTP	1,000,000
San Lorenzo Valley Water District (46 reservoirs total)	Echo	75,000
	Reader	150,000
	Brookdale	721,000
	Big Steel	1,400,000
	Lyon	3,000,000
	Little Lyon	250,000
	Blue Ridge	40,000
	Huckleberry	125,000
	Bear Creek Estates	75,000
	Ralston	10,000
	Eckley	5,000
	Blackstone 1	12,000
	Blackstone 2	12,000
	Highland	60,000
	Nina 1	53,700
	Nina 2	53,700
	South 1	9,000
	South 2	9,000
	South 3	9,000
	South 4	9,000
	Spring	65,000
	Swim 1	10,000
	Swim 2	10,000
	Quail 1	211,000
	Quail 2	240,000
	University	51,000
	Ralston	20,000
	Reagon	500
	Riverside Grove	380,000
	Probation	100,000
	Lower Pasatiempo	100,000
	Upper Pasatiempo	100,000
	Blue Tank	65,000
	Charlie Tank	45,000
	Felton – Kirby	250,000
	Felton - Blair	255,000
	Felton - El Solyo	20,000
	Felton – McCloud	284,000
	Felton- Pine Tanks	20,000
	Felton Acres	100,000
Lompico County Water District (merged with SLVWD in 2016)	Kaski 1	42,400
	Kaski 2	42,400
	Lewis 1	114,400
	Lewis 2	114,400
	Madrone 1	75,500
	Madrone 2	75,500

2.7.5 Satellite treatment facilities

Besides small chlorination systems for numerous wells used throughout the area, the main satellite treatment facilities are chlorination facilities used by City at the University Reservoir. Satellite chlorination equipment is housed in a separate room from the source. SCADA systems are used to control and monitor these facilities. The targeted chlorine residual leaving these facilities to the appropriate pressure zones is about 0.5 mg/l of free chlorine. SLVWD has a similar facility at one of its reservoirs.

2.8 Emergency Plans

Most utilities experience periodic emergencies that disrupt water treatment or water supply. The SWTR requires utilities to develop standard and emergency response plans for specific types of emergency episodes. These include chemical spills, fires, equipment failure, serious power failure, and deliberate water fouling. Some emergency plans may include responses to seismic episodes, floods, and droughts. In addition, the Bioterrorism Act of 2002 requires that drinking water systems serving a population greater than 3,300 (or 1,000 service connections) complete a vulnerability assessment in regard to terrorist activity and modify their emergency plans to reduce the risk posed by terrorist attacks. More recently USEPA mandated water system risk and resiliency assessments and emergency response plans were required.

Most of the utilities in the study area have developed emergency response plans as part of the Operations Plans for each WTP. These emergency response plans were also updated to address vulnerabilities identified by the risk and resiliency assessments. Also, the County uses the emergency response dispatch, NETCOMM, to notify drinking water utilities of chemical spills, fires, and other emergencies in the watershed. The Emergency Plan includes a response when episodes are notified via the 911 emergency telephone number. However, City staff has indicated that notifications are not always made; therefore, a recommendation to have an annual discussion with emergency response dispatchers has been made. Specific emergency plans for each utility are discussed below.

2.8.1 SCWD

The City issued a revised *Emergency Operations Plan* in 2013, which addresses natural and man-made disasters such as earthquakes, tidal waves, flood, fire, vandal-caused disasters, and chemical spills. This *Emergency Operations Plan* would be used in the event of contamination of the water supply by acts of terrorism or vandalism. The response to equipment failures and serious power failures at the WTP is included in the September 2016 GHWTP Operations Manual.

City has conducted a seismic risk evaluation called the Earthquake Response Procedures for the Newell Creek Dam and Other Critical Structures. This information is available in the 2005 *General Emergency Plan* City also has a Water Shortage Contingency Plan which was adopted by resolution of the Santa Cruz City Council in 2021 and an Ordinance (Santa Cruz Municipal Code Chapter 16.01) that implements water shortage regulations and restrictions. Both of these documents are a part of the 2020 *Urban Water Management Plan* and call for an aggressive conservation effort and public relations program to reduce the drinking water demand of the customers during emergencies.

In addition, City conducted a comprehensive assessment of the Newell Creek Dam and spill way concurrent with an update to the dam Emergency Action Plan. During the winter of 2017, City increased dam inspections from monthly to daily during the heaviest rains. The dam was also inspected at a reconnaissance level by the Division of Safety of Dams in Spring 2017 as a precaution; the state inspection identified potential geologic, structural or performance issues that could pose a risk during a flood event. It is anticipated that these risks will be further studied, and remedies proposed during the comprehensive dam assessment currently underway.

The broader 2015 *Santa Cruz County Operational Area*[6] *Emergency Management Plan* addresses the consequences of any emergency or disaster which may occur within the County. The plan also provides a means by which State and Federal assistance is requested if necessary. Depending on the size and complexity of the incident, an emergency operations center (EOC) may be activated under the direction of the Santa Cruz County Office of Emergency Services. The Santa Cruz Operational Area transitioned to a Standardized Emergency Management System (SEMS) in 2007 that is compliant with the National Incident Management System (NIMS). NIMS was developed by the Department of Homeland Security to improve national readiness to respond to not only terrorist events but all types of disasters (Santa Cruz County Office of Emergency Services, 2005). The City has a water system risk and resilience plan and emergency response plans for the City prepared in 2021, as well as an emergency response plan specific to Loch Lomond and one for the City as a whole.

2.8.2 SLVWD

SLVWD recently updated their emergency response plans in 2021 which are contained in the *Lyon WTP Operations Plan*. This plan includes a response to most natural disasters and chemical spills in the watershed. For other emergencies, SLVWD can rely on the County EOC infrastructure. In addition, SLVWD is planning to complete an agency specific Local Hazard Mitigation Plan.

[6] The Santa Cruz Operational Area consists of the County and all political subdivisions within the County.

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Section 3 Potential Contaminant Sources in the Watersheds

3.1 Survey Methods

The survey consisted of a combination of discussions and meetings with several County staff and Water Department staff, update calls to selected agencies, and a review of several agency websites and files. Contacts are listed in Table 3.1. The survey work was also supplemented with additional data and report review and discussions with various agency staff. This section discusses the specific potential contaminant sources.

Table 3-1: Santa Cruz Watershed Sanitary Survey Contacts

Name	Agency/Title	Sections Contributed To	Contact
Chris Berry	City of Santa Cruz Watershed Compliance Manager	Overall Report	cberry@cityofsantacruz.com (831) 420-5483
Zeke Bean	City of Santa Cruz	Overall Report	ebean@cityofSantacruz.com
Carly Blanchard	SLVWD Environmental Programs Manager	• Recreation • Unauthorized Activity • Geologic Hazards • Wildfires	cblanchard@slvwd.com (831) 430-4639
Sierra Ryan	County of Santa Cruz Environmental Health/Health Services Agency Water Resources Manager	• Wastewater • Agricultural Land Use • Quarries and Mine Runoff	Sierra.Ryan@santacruzcounty.us (831) 345-5202
Gar Eidam	City of Santa Cruz	• Recreation	geidam@cityofsantacruz.com
Matt Johnston	County of Santa Cruz Environmental Coordinator/Principal Planner for Environmental Planning	• Wastewater • Quarries and Mine Runoff • Solid and Hazardous Waste Disposal Facilities	Matt.Johnston@santacruzcounty.us (831) 454-5357
Sam LoForti	County of Santa Cruz Cannabis Licensing Manager	• Agricultural Land Use • Unauthorized Activity • Wildfires	Sam.Loforti@santacruzcounty.us (831) 454-3426
Lisa Lurie	Resource Conservation District of Santa Cruz County Executive Director	▪ Grazing Livestock • Concentrated Animal Facilities	llurie@rcdsantacruz.org (831) 205-3397

Name	Agency/Title	Sections Contributed To	Contact
Erin McCarthy	County of Santa Cruz Environmental Health/Health Services Agency Water Resources Planner	• Grazing Livestock • Concentrated Animal Facilities	Erin.McCarthy@santacruzcounty.us (831) 454-2810
Heather Reynolds	County of Santa Cruz Environmental Health/Health Services Agency Land Use Program Manager	• Wastewater	Heather.Reynolds@santacruzcounty.us (831) 454-2022
Audrey Levine	County of Santa Cruz Environmental Health/Health Services Agency Water Quality Program Manager and Water Quality Laboratory Director	▪ Wastewater	Audrey.Levine@santacruzcounty.us (831) 454-2736
Lindsay Neun	City of Santa Cruz Water Quality Manager	▪ Pesticide and Herbicide Use	lneun@cityofsantacruz.com (831) 420-5486
David Carlson	County of Santa Cruz, Community Development, and Infrastructure Resource Planner	▪ Quarries and Mines Runoff	David.Carlson@santacruzcounty.us (831) 454-3173

3.2 Wastewater

Onsite Wastewater Treatment Systems (OWTS), commonly known as septic systems, are a common method of treating and disposing sewage in rural areas where sewer systems are not available. OWTS are designed to treat wastewater using a combination of physical processes for solid-liquid separation coupled with biological processes for inactivating pathogens and stabilizing organic matter and nutrients. Conventional OWTS includes a septic tank to retain solids a grease and provide primary treatment of the wastewater, and a leaching trench disposal system such as a leach field that allows the wastewater to percolate into soil for further treatment.

A number of communities and organizations are served by package wastewater treatment systems that discharge to common leach fields as shown on Figure 3-1. These entities include: County Service Area No. 7 in the vicinity of the Boulder Creek Golf and Country Club, Bear Creek Estates, the Mt. Hermon Association, the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell and several other camps and conference centers. County

Service Area No. 10 - Rollingwood Estates connects to the City of Santa Cruz wastewater treatment plant which discharges the wastewater through the City of Santa Cruz ocean outfall. Both Henry Cowell State Park and Castle Rock State Park have restrooms. The septic system for Henry Cowell State Park, located near the Felton Diversion, is being reconstructed.

However, the great majority of the residences and businesses in the San Lorenzo River watershed are on individual or community (e.g., trailer parks) septic systems. The dispersed rural population in the North Coast watersheds is served by individual septic tank and leach field systems that are regulated by the County; inspection of septic systems has declined in recent years. There are no direct discharges of municipal wastewater to surface waters regulated by National Pollutant Discharge Elimination System (NPDES) permits in the San Lorenzo Valley or North Coast watersheds.[7]

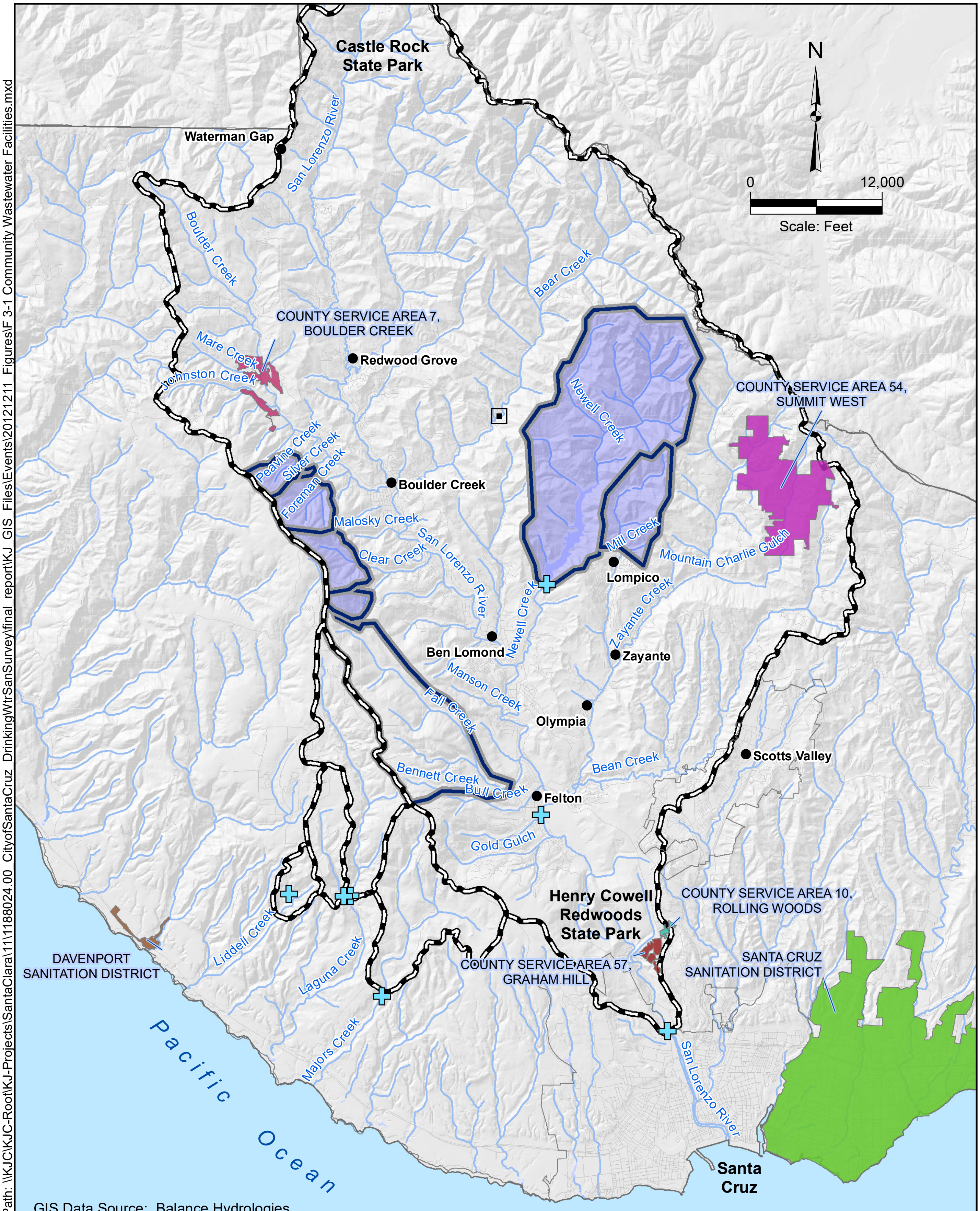
The types and number of OWTS in Santa Cruz County are shown in Table 3-2.

Table 3-2: Types of OWTS in Santa Cruz County

Type of System	Number
Conventional, meets standards	6,175
Conventional, does not meet all standards	209
Pressure Distribution	24
Mounded Bed	52
Sand Filter	22
At-Grade	5
Enhanced Treatment System (proprietary)	686
Haul away	21
Large Systems (>2,500 GPD)	12
Older system, performing satisfactorily	1,558
Older system, no information available (pre-1995)	18,983
Total	27,747

As shown on Figure 2-1, the majority of the land in the watershed areas is designated either as existing parks and recreation, resource conservation, or mountain residential by the Santa Cruz County General Plan. The state parks have hiking trails and limited wastewater facilities; Henry Cowell State Park facilities are undergoing upgrades. Only a small portion of the SLVWD watershed lands are designated rural residential with associated septic systems; these lands are near the upper watershed, quite a distance from the diversion locations.

[7] The Watkins Johnson site in Scotts Valley, has had declining levels of TCE and PCE that have been treated and released. The site owners are currently negotiating with the USEPA to formally close the site.



Area Locations
Streets
Stream
Lakes
SLVWD Bear Creek WWTP
Santa Cruz Water Department Diversions
Santa Cruz City Water Supply Watersheds
Sub-Watershed

Santa Cruz Water Department
WSS Update

Figure 3-1: Community Wastewater Facilities

As reported in the Santa Cruz County LAMP for OWTS, a properly functioning OWTS returns a significant amount of water back to the groundwater basin. During the dry season, about 15 percent of the baseflow in the San Lorenzo River is estimated to be discharged from OWTS and has percolated through the soil to reach the San Lorenzo River as clean groundwater. If septic systems are improperly designed or installed in highly-permeable soils, such as sandy soils noted earlier, wastewater constituents can leach into groundwater and from there seep into nearby surface waters. Surface water contamination from septic systems can also occur by system 'failure,' or insufficient percolation rates leading to ponding and surfacing of effluent. A 'failing' septic system can allow large amounts of nutrients, viruses, and bacteria to contaminate nearby surface waters. The portions of the San Lorenzo Valley that overlie high permeability soils has a higher probability of nitrates entering groundwater from the individual septic systems through excessively rapid percolation to groundwater rather than by system failures as a result of the sandy soils discussed in Section 2.3.1. According to the LAMP, 0.1 percent of installed or proposed OWTS in Santa Cruz County are/will be fast permeability sandy soils (percolation rate faster than 5 minutes per inch (MPI), and 12.9 percent are/will be in moderate permeability loams (percolation rate between 5 and 30 MPI).

Surface water contamination by nutrients and coliform bacteria from septic systems in the San Lorenzo Valley has been extensively studied previously. The 1979 Watershed Management Plan identified improperly functioning septic systems as one of the major pollutants sources to the San Lorenzo River. In 1995, the County Board of Supervisors and the Regional Board adopted the Wastewater Management Plan for the San Lorenzo River watershed which has been considered a model for the onsite septic wastewater management standards in the State under AB 885 as discussed in Section 4.9. Septic system repairs and upgrades have occurred regularly since the 1995 adoption of the San Lorenzo River Watershed Management Plan.

The Wastewater Management Plan contains management practices to prevent further degradation of water quality from septic systems and corrective measures to improve existing systems and reduce the loading of pollutants to the San Lorenzo River. The County implements a series of activities including septic tank pumping reporting to manage onsite wastewater systems as discussed in Section 5. Many of these measures were emplaced after extended field trials at sites throughout the valley under a range of soil and slope conditions. Since 2018, the County has approved approximately 150 minor repairs, 22 re-pipes, 57 enhanced treatment repairs, 2 enhanced treatment repairs (tanks only), 189 upgrades to conventional systems, 50 new conventional systems, 48 new enhanced treatment systems, and 38 upgrades to enhanced treatment systems, for a total of about 550 septic repairs and modifications in the watershed (Heather Reynolds, personal communication 2022). Of these 550 repairs and modifications, approximately 206 were considered major repairs.

As of September 2022, about 24 complaints regarding septic systems have been recorded in the San Lorenzo River watershed. This is similar to the number of annual complaints reported in 2018, and significantly less than the 130-160 failures per year recorded in the 1990s. Most complaints are resolved fairly quickly (within a couple of weeks). A small number require longer enforcement times due to cost of repairs, complexity of repairs, and responsiveness of the property owner (Heather Reynolds, personal communication 2022).

In 2022, 27 applications for new development were received. Santa Cruz County can provide septic evaluation services to potential home buyers for a fee, including review of septic records and parcel research. Santa Cruz County is also in the process of developing a Point of Sale program, which is planned for implementation in 2023 (Heather Reynolds, personal communications 2022). Additionally, if a new ADU is added, review of the existing septic system is triggered to confirm compliance with current sewage disposal code. If existing code standards are not met, the septic system must be upgraded. It is rare that existing septic systems can meet current standards for an ADU addition (Heather Reynolds, personal communications 2022).

3.2.1 Contaminants of Concern

Contaminants in wastewater can be divided into those that present an acute health risk and those that may pose a chronic, or long-term health risk. An acute health risk is posed by the presence of pathogenic microorganisms. A chronic health risk is posed by excessive concentrations of compounds present in the source water or formed in the water treatment process.

Wastewater contains a number of pathogenic microorganisms responsible for causing diseases, such as hepatitis, typhoid, cholera, dysentery, salmonella, giardiasis, and cryptosporidiosis. In a properly functioning septic system, the effluent is treated by the soil and the microorganisms are removed. If the system is not functioning properly, incompletely treated effluent may enter streams, or reach ground water.

Wastewater also contains high concentrations of nutrients and organic carbon. Most nitrogen in wastewater is converted to the nitrate form, which is highly soluble and readily transmitted through the soil to ground or surface waters. Nutrients can stimulate biological productivity in surface waters leading to high concentrations of organic carbon at downstream water intakes. Organic carbon combined with disinfectants used at water treatment plants produces trihalomethanes (THMs), five haloacetic acids (HAA5) and other disinfection byproducts (DBPs) which can have long-term health implications. Excessive algal growth, promoted by introducing additional nitrate into a natural system in which phosphorus is widely available, also causes taste and odor problems in drinking water systems.

Blooms of blue-green algae (cyanobacteria), which form in nutrient-rich, non-turbulent waters, could cause more serious problems as some of these organisms produce harmful toxins. In September 2009, the EPA finalized its Drinking Water Contaminant Candidate List to include cyanobacteria, which prioritizes this issue for further investigation. Usually, management practices to control taste and odor help to reduce the likelihood of toxic blue-green algal blooms also known as HAB; however, prevention is the preferred method because some types of treatment can rupture the cells and release the toxins.

County policy requires permitting of greywater sumps and includes connection of all greywater to an adequately sized septic system for the winter time when irrigation demands are low. SB 1258 passed in 2008 directs the California Department of Housing and Community Development to develop a more wide-ranging set of greywater standards for both indoor and outdoor uses than current law allows. These standards are expected to be incorporated in California Plumbing Code updates. Proposed standards include consideration of source water protection through containment on the site where generated and disposed of, prohibition on ponding and runoff, and prohibition of the use of greywater containing infectious (e.g. diapers) or hazardous contaminants. Both the County and the City provide guidance for use of greywater systems.

A greywater system collects and disposes of wastewater from systems such as the washing machine, shower, and bathroom sink. Greywater sumps are used by some homeowners to reduce loadings on a septic system with inadequate leaching capacity and to be able to reuse greywater for landscape irrigation. Although greywater contains fewer pathogens, solids, and nutrients than toilet wastes, it can still present a significant health hazard.

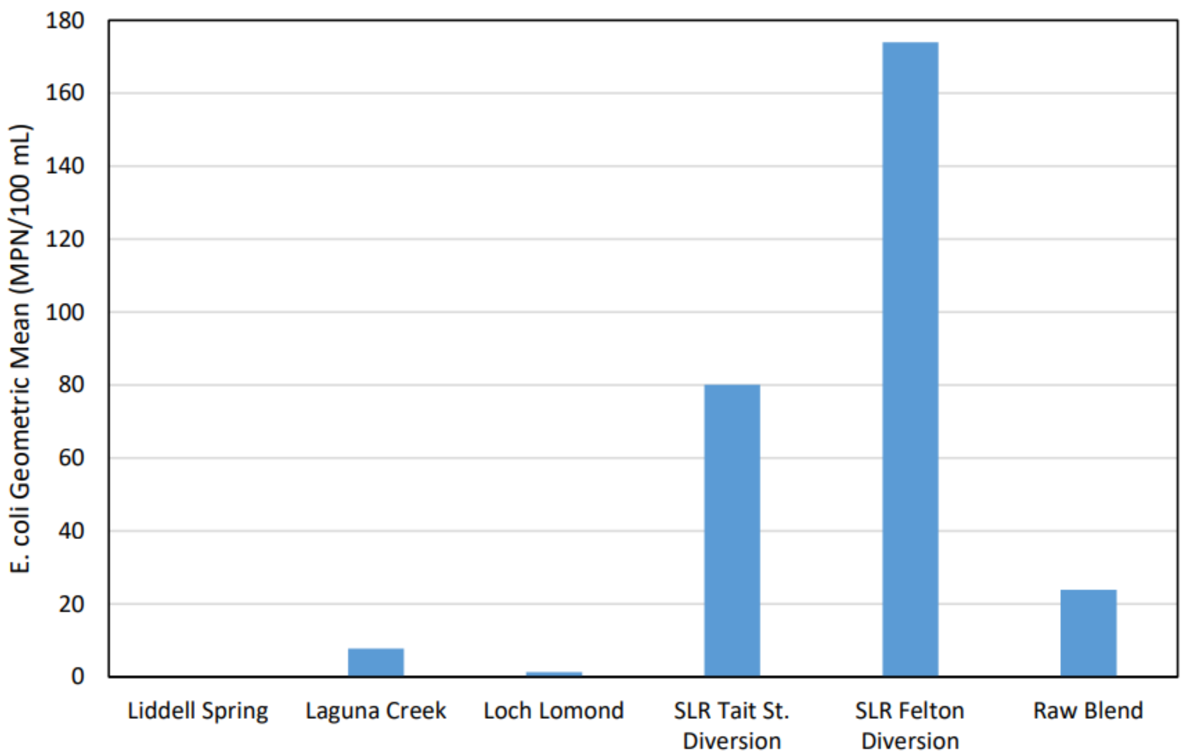
As noted earlier, the County requires building permits for installation of a greywater system. Very few greywater sump permits, and no greywater repair permits have been issued since 2018 (Heather Reynolds, personal communication 2022). The County Environmental Health Department only issues greywater sump permits for subsurface disposal only (not for greywater irrigation).

3.2.1.1 Bacteria

A number of studies have been conducted to evaluate the proportion of the bacterial contributions resulting from wastewater discharge versus the proportion resulting from other sources, including waterfowl, livestock, pet waste, failing septic systems, sewer system leaks, encampments, and urban runoff. Groundwater monitoring conducted in Boulder Creek in the early 1980s and as part of the County's historic monitoring program has shown that fecal coliform levels decrease to background levels more than 25 feet from septic systems. Beginning in 1981 the County has assessed fecal coliform concentration in shallow groundwater underlying developed areas. The absence of fecal coliforms indicates that incidents of bacterial contamination of surface waters do not result from cumulative contamination of groundwater but result from failures and discharges to the ground surface from individual systems.

More recently the City 2021 Source Water Monitoring Study Report reported that the San Lorenzo River watershed is densely populated with septic systems, and failing systems are considered a threat to water quality. Bacteria concentrations (specifically *E. coli* and Entercocci) are highly variable by water source and increase during the wet season due to storm events. The Felton Diversion and Tait Street Diversion are the most variable and susceptible to increases in microbial load, however, these sources are blended with Liddell Spring and Loch Lomond, which provide a buffer against the water quality fluctuations of the San Lorenzo River.

Figure 3-2: Summary of *E. coli* geometric mean of source waters from October 2020 through September 2021 (2021 Source Water Monitoring Report)



Per discussions in the 2021 Source Water Quality Monitoring Report, results of recent microbiological source tracking indicate human waste is the largest contributor to microbial load during the wet season. Animals such as birds and cattle contribute more to the overall microbial load during the dry season, when flows are low and animal activity is increased.

Blue-green algae (cyanobacteria) are closer to bacteria than algae and can release harmful toxins, resulting in HAB. HAB have been reported in Loch Lomond Reservoir several times during warm summer conditions in the last five years.

3.2.1.2 Nitrate

Although nitrate concentrations in the San Lorenzo River had increased five to seven times over background levels (Ricker, 1995), as discussed in Section 5, it was estimated that 50 to 80 percent of this increase is attributable to nitrate from wastewater (Ricker, 1989). This increase in nitrate is consistent with the high growth in Santa Cruz County with the population increasing 3.5 times from 66,534 in 1950 to 229, 734 in 1990. Approximately two thirds of the nitrate load in the river comes from the area of the watershed underlain by the highly permeable Santa Margarita sandstone. Unlike bacteria, there has been a significant cumulative release of nitrate from septic systems in the watershed, particularly in areas underlain by sandy soils.

A Nitrate Management Plan was first implemented in 1995 and was subsequently formalized as a TMDL for nitrate in 2000 as a result of the rising nitrate levels and is discussed in Section

4.9.1. The extensive effort in improving wastewater management since 1995 has likely moderated nitrate levels. As shown on Figure 5-10a-d, nitrate levels in the San Lorenzo River over the last forty years appear to show a gradual increasing trend; however, further reductions to nitrate concentrations will be challenging. Since San Lorenzo River water is pumped to Loch Lomond Reservoir, the linkage between nitrate, algae production, and the resulting odors and disinfection-by-product precursors will continue to be a challenge for City and SLVWD.

3.2.2 San Lorenzo River Watershed

The Regional Water Quality Control Board is responsible for permitting and management of wastewater systems that discharge greater than 20,000 gallons per day (gpd). As part of County Service Area No. 7, the County-operated Boulder Creek Wastewater Treatment Plant serves the neighboring country club, 18-hole golf course, tennis facilities, restaurant, and pro shop, as well as about 200 townhouses and residences built along the fairways. The collection system includes 24 miles of 6- and 8-inch gravity mains, a 4-inch PVC force main, and five lift stations. The plant was upgraded to tertiary treatment in 1996 and has a capacity of 104,000 gpd. The treated effluent is pumped to a leach field, where it is disposed of by subsurface discharge. In the past, tertiary treated water has also been delivered to the Boulder Creek Golf and Country Club, blended with raw water, and used for irrigation. Since 2010, process improvements to reduce the nitrate concentration, improved distribution of effluent to the leach field, as well as force main upgrades to reduce spills between the treatment plant and leach field have been implemented. (J. Ricker, Personal Communication, 2012). The force main and other improvements have particularly reduced spills to Boulder Creek. In addition, improvements to the wastewater treatment plant including upgrades to the blower line for aeration, replacement equalization tank, and sewer line improvements are planned and awaiting federal funding as of 2022.

The Bear Creek Estates Wastewater Treatment Plant, which is owned and operated by the SLVWD, serves approximately 56 homes. SLVWD has a waste discharge permit to treat up to 12,000 gallons per day of wastewater, then discharge it to a community leach field. In 2005, SLVWD installed improvements for nitrogen removal pursuant to the Regional Water Quality Control Board's minimum discharge requirement of 50 percent nitrogen removal, prior to subsurface disposal. Heavy winter rains in 2016-2017 resulted in groundwater infiltration resulting in overflows which have been reported to the RWQCB and County. SLVWD is considering a replacement of the WWTP to provide more reliable treatment. In addition, there are about 150 septic systems within 3 of the SLVWD source watersheds (SLVWD Watershed Management Plan, 2010).

The Mt. Hermon Association is another significant community wastewater disposal system in the watershed. The Mt. Hermon Association is served by a sequential batch reactor package plant that treats wastewater from a hotel, cabins, and homes. The plant has a permitted capacity of 63,000 gpd but operates at about 45,000 gpd. Treated effluent is pumped uphill and discharged to a community leach field above the plant. More recently, the Rollingwood subdivision of about 30 homes, near Scotts Valley has been connected to the City of Santa Cruz Wastewater Treatment Plant.

Significant institutional wastewater disposal systems in the San Lorenzo Valley include those serving Camp Harmon, Camp Campbell, and other organized camps, as well as the San

Lorenzo Valley Unified School District (high school, junior high school, elementary school) facility in Felton. The latter system is unique in that treated effluent is further polished in a constructed wetland prior to being discharged to a leach field. The Santa Cruz County 2021 LAMP estimates that there are over 27,700 OWTS in the County of which 18,983 were constructed before 1995 with limited available information. As of 2017, the County estimated that there are approximately 13,292 individual septic systems in the San Lorenzo watershed alone Including Carbonera and Branciforte Creeks (J. Ricker, 2017). The density of systems is higher than that of any other comparable area in California watershed. Overall, the density of development in the creek bottoms, both along the river itself and on the river's tributaries, is quite high. Many residences were originally used as summer homes and are now occupied year-round. Some homes were built with part of the building supported by stilts, over the floodplain. In many areas the density is akin to urban areas in California which are served by municipal sewer systems. Some of these homes may have been destroyed in the CZU fire and if rebuilt, will need to meet current standards.

During a more extensive previous study described in the 1995 *Wastewater Management Plan,* there are a number of limitations to onsite disposal systems in the San Lorenzo Valley watershed, such as*:*

- Approximately 55 percent of the developed parcels are less than 15,000 square feet and 11 percent are less than 6,000 square feet. This significantly limits the size of leach fields and the opportunity to install back-up/replacement leach fields.
- Two-thirds of the systems are substandard in size and did not meet the repair standards of 1995. Significant improvements have been made to at least 3,000 systems since 1986.
- About 40 percent of the systems were constructed before 1975 and have not experienced significant additions (i.e. remodels/expansions/subdivisions) or do not have second leach fields.
- About 14 percent of the systems are located less than 100 feet from a stream.
- Winter groundwater levels are less than 10 feet from the surface in 30 to 50 percent of the systems and less than 3 feet from the surface in 3 to 6 percent of the systems.

The County has conducted numerous surveys and evaluations of the septic systems in the watershed since 1986. The County has continued to have a low frequency of septic-system surveys since the late 1990s, as relatively few changes were reported and the value of continuing the surveys does not compete effectively with enforcement or other County Environmental Health Service priorities (John Ricker, personal communication, 2017). Implementation of the LAMP will require some point of sale inspections of septic-systems prior to property purchase. Because there is real value to neighborhood- or community-scale discussion, the community-scale results from the 1996 Watershed Sanitary Survey are included and updated as appropriate[8]:

Kings Creek - The greater Kings Creek area includes 800 developed parcels in the neighborhoods of Wildwood, Redwood Grove, River Rights, Lower Kings Creek, Sunbeam Woods, Blue Ridge, Madrona and Sequoia Drives, Lower Two Bar Creek, and Juanita Woods. This area has soils with significant clay content, high winter groundwater levels, small lots, and steep slopes. Despite potential significant constraints to septic systems, over 80 percent of the systems were found to be performing without any signs of failure during the wet winter of 1986. Most of the failing systems could be adequately upgraded using conventional systems. The *Wastewater Management Plan* concludes that a community system is not feasible because it lacks a disposal site.

Boulder Creek - The Boulder Creek area includes the developed areas centered around downtown Boulder Creek and extending a short distance up the valleys along Bear Creek, Boulder Creek, and the San Lorenzo River. This area has relatively permeable alluvial soils with some localized areas of clay soils. Winter groundwater levels are less than 10 feet below the surface in most of the area. Groundwater underlying Boulder Creek probably contributes nitrate to the San Lorenzo River. There have been repeated instances of septic system failure, with discharge of untreated effluent to roadside areas and eventually to the San Lorenzo River. During the early period of the County's wastewater management program, the river downstream from Boulder Creek had the highest incidence of contamination by sewage of any area in the watershed. Conditions have improved significantly during recent years. During the winters of 1987 and 1988, 85 percent of the parcels surveyed were performing adequately and 4 percent were found to have surfacing sewage. In 1991, re-inspection of systems repaired as a result of the survey found that 90 percent were performing satisfactorily, and 95percent of the systems were performing adequately in 1999 and 2001 (John Ricker, personnel communication, 2007). A feasibility study conducted for a community sewage disposal system for the downtown area found it to be too costly at the time. This option is currently being reevaluated. A community service district provides a regular pumpout service for the downtown area, with disposal outside of the watersheds.

Ben Lomond - The Ben Lomond area includes 780 developed parcels. There are no constraints to septic system performance in most of the Ben Lomond area. Historically the water quality in Ben Lomond has been the best of any developed area in the watershed. The survey conducted from 1989 through 1991 showed a 1 percent failure rate. In 1993, the failure rate was down to 0.5 percent. A community sewage disposal system is not warranted because of the cost and the low incidence of problems in this area.

Glen Arbor - The Glen Arbor area includes 500 parcels south of Ben Lomond. The area consists of three distinct zones; an upland area underlain by the Santa Margarita sandstone, an area of relatively steep slopes, and a lower area on well drained soils of the river terrace. Although the upland systems perform well, the effluent discharged to the highly permeable sandy soils contributes to elevated nitrate levels in the river. The lower portions of Glen Arbor have contributed to bacterial contamination of the river caused by high groundwater and some

[8] Balance Hydrologics staff also reviewed the long-term data provided by the County and City for indications that the 1989 Loma Prieta earthquake or the storms of 1995 and 1998 may have damaged sufficient systems to make a difference in bacterial or nitrate loadings. Neither constituent appears to have been affected by the three events queried

pockets of clay soil. In recent years, a number of systems have been repaired. During the 1990 through 1993 surveys, a failure rate of 2 percent was found. A community disposal system was judged to be infeasible because of high cost and potential impacts on the Quail Hollow groundwater basin. Most homes in the Glen Arbor area were constructed during the late 1960s through late 1980s. Relatively few changes in the number of homes or of waste disposal systems since the early 1990s (White and Hecht, 1993) suggests that little if any change in effects on downstream community water supplies would be expected.

Felton - The Felton area includes 820 developed parcels. This area was surveyed in 1989 and 1991. Much of the Felton area is on a broad alluvial flat, with high groundwater and small lot sizes being the main constraints to proper septic system functioning. Failure rates in 1993 were 0.6 percent. El Solyo Heights is a separate neighborhood of 80 developed parcels at the north end of Felton. Failure rates in this area were 13 percent in 1989. Constraints to proper septic tank functioning include high ground water, clay soils, shallow depth to bedrock, moderate slopes, and presence of cuts and fills. Alternative systems are being required on a case-by-case basis. A community disposal system feasibility study concluded that there was not an adequate disposal site and that the project would be too costly to justify.

Brook Lomond - The Brook Lomond area consists of 120 developed parcels between Ben Lomond and Brookdale. This area has permeable alluvial soils with high groundwater and some areas of clay soil. In the 1987 survey, 6 percent of the parcels were found to have failing septic systems. The County recommends improved onsite disposal rather than a community disposal system.

Forest Lakes - The Forest Lakes area includes 970 developed parcels immediately south of Felton. This area has small lots, and localized pockets of high groundwater and dense clay soils. The 1990 and 1991 survey found a failure rate of 2 percent. There has been no indication of wastewater contamination in Gold Gulch, the stream that drains most of the area. Because of the scattered occurrence of problem parcels, community collection and disposal is not a feasible alternative to onsite treatment.

The two most significant potential impacts of wastewater disposal on the drinking water supplies in the San Lorenzo watershed are the release of pathogenic organisms and excessive nutrients. However, focus to wastewater management by the County in the late 1990s as well as connection of some onsite systems to community wastewater treatment with off-site disposal has reduced the risk of contamination by wastewater. Concerns remain though that some of the existing onsite systems, especially those near riparian areas, may not be functioning optimally after heavy rains. Other water quality concerns related to wastewater are recreation and homeless encampments that may not have proper sanitary facilities and could contribute contaminants of emergency concern like artificial sweeteners and pharmaceuticals in addition to pathogens and nutrients. Specific sources may be difficult to discern without additional sampling and monitoring.

Wastewater facilities in the SVLWD, are limited to residential septic systems, none of which are located near the diversion locations.

3.2.3 Loch Lomond Reservoir Subwatershed

About half of the watershed tributary to Loch Lomond Reservoir is owned by the City of Santa Cruz and the structures under the City's jurisdiction are park visitor facilities and the ranger's residence. Septic systems serve a handful of homes on parcels not held by the City and two wineries and several medical marijuana grow facilities that drain to Loch Lomond Reservoir. County staff has noted road development to these developed parcels in these headwater areas (see Section 3.15.3). Loch Lomond stores wastewater from its recreational areas in vaults, which are pumped periodically and transported to the City Wastewater Treatment Plant.

3.2.4 North Coast Watersheds

Most septic systems in the North Coast watersheds are not anticipated to be a significant source of contamination because of: (a) very low residential densities, (b) a highly-dispersed pattern of residential settlement, and (c) soils and underlying geologic units which are generally loamy or crystalline and favorable for the use of conventional onsite systems. Scattered areas in these watersheds have substrates with limited percolation rates, principally in some of the older soils along Empire Grade (including the Pineridge subdivision), some shallow soils along Ice Cream Grade, and small areas underlain by shales in the upper Majors watershed. Karst, which is associated with subsurface connectivity through the limestone, can occur in portions of the watersheds including the upper portions of the Liddell Spring and Laguna Creek drainages as shown on Figure 2-4. These areas are sparsely populated, and it is not known if wastewater sources directly overlie karst areas. The County is updating the septic ordinance to identify setbacks for systems in karst areas. The largest community in the area, Bonny Doon, does not drain to the watersheds of Laguna or Majors creeks.

The water quality data presented in Figure 5-2 in Section 5 indicate that the annual geometric mean of the total coliform bacteria concentrations in the Laguna and Majors Creek watersheds have varied from 146 MPN/100 mL up to 2261 MPN/100 mL over the past 5 years. Liddell Spring's total coliform data are consistently lower with a geometric mean of less than 5 MPN/100mL. The County's 2006 microbiological source tracking effort (Ricker and Peters, 2006) did not collect data for North Coast streams but instead focused on the San Lorenzo River watershed, where development is concentrated and is the subject of a pathogen TMDL. The County has also focused bacteriological testing on County beaches at the river mouth and to the south, which receive the greatest number of visitors. Failing septic systems are a potential source of increased coliforms in these streams, as are wildlife, waterfowl, and livestock.

A review of nitrate data from 2012 and 2018 compared to the data presented in Section 5 shows a decreasing trend in annual median nitrate concentrations in Laguna Creek and Majors Creek over the past 30 years, with no long-term trend distinguishable in Liddell Springs.

The previous hydrogeologic report on the Bonny Doon quarry (Watkins-Johnson, 1992) indicated that nitrate concentrations were high (over 6 mg/l as nitrogen) in monitoring wells upgradient of the quarry. Because very little development exists upstream of this facility, the report suggested without elaboration that septic systems or a former poultry operation along

Smith Grade as the sources of this nitrate.[9] Among other potential sources are explosives formerly in use at the quarry. While active quarrying has discontinued, the site is currently used for an aerospace research and development facility with employees that is regulated by the County. The likely sources of nitrate in the Laguna Creek and Majors Creek watersheds are the same as for microbial contamination.

3.2.5 Significance

After many years of study, the County and the Regional Board have concluded that the large majority of existing septic systems do not consistently contribute significantly to dry-season microbial concentrations measured in surface waters. Occasionally, failing septic systems are responsible for significant localized degradation of bacterial quality in surface waters during summer months. However, bacterial contributions from septic systems are probably greater during or following wet periods when runoff can convey surfacing sewage from failing systems to the San Lorenzo River. Efforts made since 1995 to improve septic system performance have reduced the septic failure rate and therefore the water quality degradation related to septic systems.

The San Lorenzo Nitrate Management Plan (Ricker, 1995) concluded that an estimated 84 percent of the nitrate load in the River resulted from human activities in the watershed. Two-thirds of the nitrate was attributed to wastewater discharges, particularly from septic systems in the highly-permeable Santa Margarita sandstone. An update to the nitrate load estimate maybe prudent to consider as almost forty years have passed since the 1995 study and changes in OWTS management and stormwater management have occurred in the intervening years.

3.3 Urban Runoff

Urban runoff is that portion of stream flow originating from urban or densely-suburbanized areas. Most urban runoff occurs during storms; however, inter-storm period nuisance flows from urbanized areas can account for significant components to flow during those times. Urban runoff flows and contaminant concentrations are highly variable. Some factors affecting this variability include duration and intensity of rain events, specific urban land use (residential, commercial, industrial), and the length of the preceding dry period during which pollutants build up on the land surface. In addition to specific land uses, the atmosphere and automobiles are significant contributors to the contaminant load in urban runoff.

In October 1990, the EPA issued final regulations requiring NPDES Municipal Stormwater permits for urban runoff from cities with a population of 100,000 or greater, from certain types of industries, and from construction sites which involve a land disturbance of greater than 5 acres (Phase I). Although there are no cities this large in Santa Cruz County, the Central Coast office of the Regional Board, which administers the NPDES stormwater permit program, worked with County and municipal staff in anticipation of future regulations. In 1999, EPA expanded the NPDES Municipal Stormwater permit program to require permits for urban runoff discharges from cities with a population of less than 100,000 and from industries or construction sites which

[9] The former poultry farm, in a highly karstic area locally known as the 'sinkhole plain', was discontinued at least 30 years ago, and should no longer seriously be considered as a discernible source of nitrogen in this sanitary survey.

result in a land disturbance of from 1 to 5 acres (Phase II). The City and County subsequently developed comprehensive Storm Water Management Plans (SWMPs) describing compliance with the new regulations. The plans were submitted and approved by the Regional Board with applications for coverage under the Phase II permit. The County of Santa Cruz also joined the Central Coast Regional effort to develop hydromodification criteria by October 2012. Additional details about urban runoff regulations are included in Section 5 of this sanitary survey.

Watersheds in the study area are relatively unindustrialized, so there are few facilities which must comply with the state's NPDES General Industrial Stormwater permit program. The state permit requires industrial facilities to implement pollution prevention measures and to collect monitoring data during rainfall events. Each industrial facility files a Notice of Intent (NOI) which certifies that it will comply with these permit requirements. There is currently little oversight and enforcement of the industrial stormwater permit program because most of the state's effort has been channeled into simply identifying facilities which should be under permit. Types of industrial facilities which must file a NOI to comply with the state permit include: manufacturers (food, textiles, lumber, paper, chemicals, petroleum, rubber, plastic, metals, stone, clay, glass, machinery, electric, electronic, equipment, instruments, cement, phosphate, asphalt, fertilizer); confined animal facilities with over 700 animals; printing operations; recyclers; landfills; mining operations; transportation businesses (such as bus and trucking companies and airports); petroleum bulk plants; all NPDES wastewater dischargers with a design flow greater than 1.0 million gallons per day; Superfund sites; and steam electric power generator facilities.

A list of active industrial stormwater permittees in Santa Cruz County was downloaded from the SWRCB database in September 2022. Of the 273 permittees listed in the SWRCB database, only 117 are active. Most are located in Watsonville (62) and the City of Santa Cruz (19), which are located outside of the sanitary survey area. The active industrial permittees within the study area are listed in Table 3-3.

Table 3-3: Active Stormwater Permittees in Study Area

Location	Permitee
Ben Lomond	San Lorenzo Valley School District
Ben Lomond	Santa Cruz County Department of Public Works
Bonny Doon	Beauregard Vineyards
Boulder Creek	Big Basin Vineyards
Felton	Granite Construction (Felton Quarry)
Felton	Granite Rock Company (Quail Hollow Quarry)
Felton	CEMEX Construction (Olympia Quarry)
Scotts Valley	Granite Creek LLC
Scotts Valley	Bay Photo LLC
Scotts Valley	Expertech
Scotts Valley	Fox Factory
Scotts Valley	Armitage Wines
Scotts Valley	IMG Larkin LLC
Scotts Valley	Thermo Fisher Scientific
Scotts Valley	Tony's Machine Shop

Since 2009, any construction activities greater than 1 acre requires permitting under the revised statewide Construction General Permit (CA 2009-0009-DWQ.) The local jurisdictions (City and County) have construction best management practices that are required for smaller projects to control erosion and sediments that could negatively impact water quality.

3.3.1 Contaminants of Concern

The urban runoff contaminants of most concern to drinking water are microbial organisms and suspended sediments. Sources of microbes in urban runoff include: animal wastes from pets, birds, and rodents; human waste from sewer system leaks and encampments; diffuse (nonpoint source) runoff, and decaying organic material in storm drains. Suspended sediment levels are often high in urban runoff because of the ease of mobilization and transport of small particles on impervious surfaces. In addition, suspended sediments are higher in runoff from erosion from newly-developed areas prior to establishment of vegetation. Suspended sediments in urban runoff contribute to high turbidities in the stream system during wet weather and also are significant because contaminants may be adsorbed to the sediment particles and transported into the streams. Note that construction of new impervious surfaces in urban areas can result in higher peak flows which, without mitigation, can lead to increased instream erosion and turbidity.

Other common contaminants of concern in urban runoff include: metals (notably copper, lead, and zinc), hydrocarbons, and pesticides. These contaminants can be significant to aquatic life in the receiving stream but at the levels found in the Santa Lorenzo River, have not been shown to be of exceptional significance to the drinking water quality.

3.3.2 San Lorenzo River Watershed

The urbanized population in the San Lorenzo River watershed centers on the communities of Boulder Creek, Ben Lomond, Brookdale, and Felton. There are also pockets of development in the Boulder Creek Golf and Country Club area, along Newell Creek (Rancho Rio), lower Bear Creek, Zayante Creek, Lompico Creek, and Paradise Park, and in numerous small valleys confluent with the San Lorenzo River. Rural residential areas along Bean Creek Road at the fringes of Scotts Valley are also experiencing growth. The rest of the watershed, as noted above, is sparsely populated.

Many houses and residential areas were built during several speculative vacation housing booms in the 1890s, 1900s and from 1920 to 1940. A large percentage of existing homes were built before 1960. More recent housing has been primarily for year-round residences. Many of the older vacation homes were built very close to the creeks. Further development within the riparian corridors is currently limited, requiring County exemptions. Riparian corridors now extend out to the edge of the riparian woodland if the woodland is extensive enough to have been mapped on County vegetation maps. Otherwise, they are defined to be 50 feet from the high water mark for a perennial stream, less for an intermittent stream, and more in the coastal zone area. As discussed in Section 3.13.2, violations of the County Riparian Corridor and Wetlands Protection ordinances occurs but limited enforcement resources are available to limit potential damage. Most new housing has been infill in more urbanized areas or on rural acreage, with few if any major subdivisions within County jurisdiction. Future residential growth is expected to be mostly accommodated with minor land divisions. Future residential development will be permitted under current County regulation and is not expected to have major impacts to source water quality.

The San Lorenzo River watershed is in Zone 8 of the Santa Cruz Flood Control District. Drainage in the towns along Highway 9 consists of a combination of sheet flow, roadside swales and ditches, and some inlets and piping in low spots. In smaller population centers, the engineered drainage system consists mostly of cross culverts to move stormwater across roads. There is an urban runoff control structural feature, a detention basin, and several check dams downstream of the Rancho Rio subdivision. These facilities were installed by the County Planning Department after construction of the subdivision to minimize the considerable erosion resulting from disturbance of this sandy area. Maintenance of the facilities is unconfirmed.

The County's Water Resources Program has been sampling the San Lorenzo River since 1968 for chemical and microbial constituents. The program is being revisited to reflect changing priorities and requirements in the recently adopted Local Agency Management Program, and improved technology. The program currently samples up to 45 sites along beaches, creeks, and freshwater lakes.

Heavy metals (e.g., zinc, copper, cadmium, and lead) and toxic organic compounds, such as pesticides and PCBs, have often been detected at low levels in ambient receiving waters of the San Lorenzo River watershed and occasionally at higher levels in storm drain discharges. This was corroborated by the City 2021 Source Water Monitoring Study, which observed elevated color, turbidity, dissolved organic carbon, total organic carbon, total coliform, and metals in City's source water and upper watershed after storm events. Elevated constituents returned to normal baseline levels once precipitation and streamflow decreased a few days following a storm event.

Because these constituents can bioconcentrate in tissues, the County conducted a study focused on sampling sites in the lower River, including analysis of tissues from freshwater clams (Ricker and others, 2001). The results were generally consistent with previous monitoring studies in the watershed, the region, and the State (c.f. EPA Nationwide Urban Runoff Program): low levels of pesticides and PCBs (at 2 to 7 percent of hazardous thresholds), elevated concentrations of cadmium and zinc (both of geologic origin); and elevated levels of lead (potentially from prior use in gasoline or from the prior use of lead shot at a gun range near Castle Rock State Park). In all cases, concentrations were below levels of biotic or regulatory concern.

Bacteria levels in the San Lorenzo River have often exceeded County water quality objectives and on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region. The Pathogen TMDL was approved by the SWRCB, Office of Administrative Law, and USEPA in 2011. However, bacteria levels in the upper watershed are typically much lower than those at the mouth of the river, and recent monitoring data show considerable improvement in dry-season bacteria levels. The County focuses bacterial monitoring in locations with highest public uses like the beaches and has less monitoring in the watershed. Bacteria levels in the San Lorenzo River watershed are discussed in greater detail in Section 3.2.

As part of the 2021 Source Water Monitoring Study, City conducted Microbial Source Tracking (MST) to identify the particular sources of fecal contamination in water (i.e. human, cattle, and bird). City monitored Universal Bacteroids, Human Bacteroids, MS2 Coliphage, and Somatic Colifage. Universal Bacteroids test for fecal contamination from all sources (animal and human), while Human Bacteroids, MS2 Coliphage, and Somatic Colifage are fecal indicators of human influence from wastewater. Human Bacteroids, MS2 Coliphage, and Somatic Coliphage concentrations are generally higher during winter storms (likely from septic systems in the San Lorenzo Valley), and Universal Bacteroids were high during the dry season where flow rates are low, animal activity is increased, and recreational usage is increased.

Work in coastal San Mateo County (Ivanetich and others, 2006) was also able to distinguish fecal bacteria originating from dog, deer, horse, seagull, and human sources. It is notable that the Santa Cruz County microbial source assessment study found that dogs alone accounted for about 7 percent of the dry-season bacteria in the upper watershed, and about 12 percent of wet-weather bacteria at Felton (Ricker and Peters, 2006). Waste from domestic animals such as cats, dogs, and chickens as well as from homeless encampments probably contribute greatly to the high fecal coliform counts in the first flush of stormwater through urbanized areas. The County has not conducted further ribotyping work since the 2006 Watershed Sanitary Survey. Further inquiries into sources and travel pathways of pathogens in the San Lorenzo Valley watershed, in particular, would be worthwhile, with special attention to streams reaches downstream of densely-urban communities and in areas receiving summer baseflow from sandy aquifers.

3.3.3 Loch Lomond Reservoir and the Upper Newell Creek Watershed

Urban runoff into Loch Lomond is effectively limited to contributions from Bear Creek Road, which are minor in magnitude. However, urban runoff constituents from the water pumped from the San Lorenzo River to Loch Lomond may be present in Loch Lomond.

3.3.4 North Coast Watersheds

There are no major towns in the North Coast watersheds. The Bonny Doon Airport is a small landing strip for private planes.

3.3.5 SLVWD

Based on conversations with staff from the SLVWD, there is no urban runoff that influences surface water in their watersheds. Most of the roads within the watershed of the SLVWD are district owned and maintained or are private access roads. Only the staff of the SLVWD has access to District roads.

3.3.6 Significance

Overall, urban runoff directly contributes a significant part of the total microbial load in the river system during summer and winter, it enriches summer baseflows with added nutrients, and it contributes some part of the sediment load entering the River during rain events.

Most development in the San Lorenzo Valley is residential. Many of the residents seek a rural lifestyle, and the contributed contaminants (microbes from both domestic and wild animals, nutrients, sediment) may best be seen in that light. There are homes in the four main communities that are very close to and positioned well above the stream system, such that contaminants can move rapidly from neighborhood areas in the main communities into the channels. In these areas, source control to reduce runoff as well as redirecting runoff to areas for infiltration has particular value as a way of reducing contaminants. In particular, the results of the microbial source tracking study show that efforts to minimize or prevent dry-season runoff from landscape irrigation and other human activities would reduce transport of bacteria and other contaminants to storm drains and the River during the summer months when dilution is minimal and recreational use is at its peak.

Development overlying sandy soils contribute a disproportionate volume of nutrients which enter the streams through the sandy aquifers. As discussed further in Sections 5 and 6 later, nutrient concentrations are elevated during summer months in the streams with appreciable sandy soil areas in their watersheds, offering different source-control opportunities in the sandy areas away from the streams. Because sandy soil areas occur in both the North Coast and San Lorenzo watersheds, efforts to address the particular issues of sandy soils can be especially effective over a period of decades. There are few industrial facilities or large expanses of paved areas.

3.4 Agricultural Land Use

Santa Cruz is a strongly agricultural county. However, the majority of the existing row-crop acreage is located along the coast, in the Pajaro Valley in South County and on the marine terraces of the North Coast, neither of which extend into the watersheds of this survey. Commercial cropping with the study area watersheds is presently limited to small areas of vineyards and Christmas tree farms. Both watershed areas once supported widespread cultivation of apples and other orchard fruits wherever suitable sites with deep soils and southern exposures were found, but most such areas had already gone out of commercial production before the onset of extensive pesticide use in orchards began during the early 1960s. In scattered locations throughout the study area, some row crops are grown on a commercial or horticultural basis but these operations are on limited acreage and typically use organic practices. As discussed in Section 2.3, regulation of cannabis cultivation is currently underway as cultivation potentially poses significant water quality, and other threats if not appropriately managed.

3.4.1 Contaminants of Concern

The primary contaminant of concern from these types of agricultural uses is sediment from erosion of fallow or improperly tilled land and from eroding drainages downstream from cultivated areas. Other potential contaminants include nutrients, pesticides, herbicides, and organic matter in stormwater runoff.

3.4.2 San Lorenzo River Watershed

In the San Lorenzo Valley, vineyards and Christmas tree farms occupy the largest agricultural acreage. Several established vineyards exist in the area; in Felton (Hallcrest Vineyard), next to

Bear Creek Road on the ridge above Loch Lomond (Byington and David Bruce Vineyards), and inside valleys near Boulder Creek (P & M Staiger), and along the top of the watershed divide at Skyline Boulevard (Zayante Vineyard). Some vineyards that historically had been in the area appear to have closed since 2018. Small personal vineyards are commonly seen on larger residential parcels with adequate sunlight. Land clearing for vineyards has the potential to be problematic, if not done correctly, e.g., poor drainage design, improper grading, and inadequate erosion control. Santa Cruz County regulates agricultural grading in an effort to protect water quality but has limited enforcement resources to monitor grading in general.

Unlike vineyards, Christmas tree farms are operated with little cultivation or disturbance to the soil surface. Field visits to several of these operations throughout the watershed showed that annual grasses, forbs, and bracken serve as a cover crop between rows of spruce and fir. The roads in the tree farms are intermittently used, with the greatest use generally during the two months prior to Christmas.

To a lesser extent, apples and other tree fruits are still grown in the old and declining orchards in the sunnier aspects of the Santa Cruz Mountains. According to County Agricultural Commission staff, little to no new commercial acreage has been developed during the last two decades. The existing orchards tend to be managed organically or with few applications of chemical pesticides or fertilizers, and minimal tillage.

Small commercial greenhouse operations and flower farms exist along Bean Creek and in the San Lorenzo Valley. Rhododendrons are no longer grown in the Bean Creek subwatershed, nor elsewhere in the San Lorenzo Valley (Roberta Haver, former owner, personal communication, 2006). Pesticide use is minor. University of California Agricultural Extension staff indicated that the primary potential contaminant in these container greenhouses is nitrogen, which is flushed through the containers , and which exceeds crop needs typically by 20 percent during each watering. These operations are located on the extremely permeable Santa Margarita sandstones, which provides the excellent drainage needed for these uses, but which may permit the greenhouses to become a source of nitrogen to both Bean Creek and the Santa Margarita aquifer.

Legal cannabis cultivation is highly regulated with a robust licensing program and ongoing check-ins with operators. There is currently one licensed cannabis cultivation site in the San Lorenzo River watershed. In addition, the County conducts fly-overs of the study area that search for illegal cannabis grows that exceed 500 square feet. Illegal grows are shut down upon discovery.

Cannabis cultivation is highly regulated by several agencies, including the California Department of Fish and Wildlife (which limits the impact to riparian bodies and surface water sources), California RWQCB (sedimentation and runoff regulations), and Santa Cruz County (limits usage and prohibits hydroponic cultivation). As a result of strict regulation, legal cannabis cultivation has a very light footprint compared to other agriculture in the watershed (Sam LoForti, Santa Cruz County, personal communications, 2022). Santa Cruz County plans to continue strict enforcement of cannabis regulations moving forward.

3.4.3 Loch Lomond Reservoir Subwatershed

In addition to the vineyards described above, there are also small medical cannabis operations in the Loch Lomond subwatershed. In the past, small-scale diversions associated with covert cannabis cultivation have been reported on tributaries that drain into Bear Creek and Loch Lomond.

3.4.4 North Coast Watersheds

The coastal terraces of northern Santa Cruz County are one of the classic agricultural areas of California, supporting far more cultivated acreage than the San Lorenzo Valley. The crops are grown mainly on the lowest two terraces along Hwy 1, *below the diversion points* on the North Coast streams. These areas are farmed primarily for brussels sprouts and (less frequently) artichokes. Both crops require the unique climate dominated by marine fog found on these lower terraces. Other crops include lettuce, strawberries, broccoli, and flowers.

Four vineyards operate in the North Coast, the Bonny Doon and McHenry Vineyards, and recently the Rancho Madera Roja[10] in the upper Liddell Creek watershed and Redwood Meadows Ranch Winery and Beauregard Vineyards in the upper Majors Creek watershed. Cattle are occasionally grazed on the mosaic of grasslands, oak/madrone woodland, and mixed evergreen forests which separate the belt of row crops along the coast from the residential areas and orchards of the Empire Grade portion of the Bonny Doon area. A small portion of this area drains to Majors Creek upstream of the intake. Some Christmas tree farms are also located in Bonny Doon, near the northern end of Empire Grade.

3.4.5 SLVWD

The only known commercial agriculture known to be present is a Christmas Tree farm along Upper Empire Grade Road within the Foreman Creek watershed. There has been no contamination observed due to this farm’s operations. The 2020 CZU fire drastically impacted this operation.

There are no known commercial agricultural land uses within the Lompico Creek and Felton sub-watersheds.

3.4.6 Significance

As a minor land use in the water supply watersheds, agricultural production does not appear to be a major source of concern at present and in the foreseeable future. The two most visible crops in the watersheds, Christmas trees and grapes, tend to be grown at higher elevations, along ridges and in areas above the fog line, away from the major streams. Past observations at Christmas tree farms in the survey area suggest that these are unlikely to be major sources of contamination, or erosion. Vineyards, on the other hand, are typically located on slopes with loose, sandy soils, and controlling weeds by harrowing between rows leaves soils exposed to rainfall and rill erosion. Marginal to poor drainage design and inadequate erosion control can

10

result in vineyards being a source of sediment and persistent turbidity. Some vineyards use organic practices; others employ pesticides to a light or a moderate degree.

Cultivation of other crops is less likely to affect the quality of water supplies, because of the minimal acreage of land under cultivation and the generally low-level use of pesticides. Pesticide and herbicide use is discussed in Section 3.7.

3.5 Grazing Livestock

Watersheds in the study area are primarily forested or vegetated brushlands of various types, so the extent of grazed areas is also limited, particularly in the San Lorenzo watershed. The North Coast watersheds are better suited for livestock and have had several cattle and dairy operations working in the subject water supply drainages. Throughout the watersheds, impacts from grazing cattle are less than those of confined horses, except in areas where cattle are watered from streams. This section includes discussion of cattle and individual or small horse groupings; the main discussion of horses as they affect water quality is within Section 3.6.

3.5.1 Contaminants of Concern

Erosion and waste products are of primary concern. Where unfenced, destruction of streambanks and wetland vegetation by grazing animals causes an increase in erosion, indirect loss of channel stability (eventually generating pulses of sediment entering directly into the creeks), and persistent turbidity. Manure, urine, and pathogens such as cryptosporidium from young calves, may be introduced directly into streamflow year round, with elevated rates of transport into waterways during wet periods.

3.5.2 San Lorenzo Valley

Residential development of the valley bottoms, stream terraces, and sunny ridgelines in the survey area puts a premium on "buildable" land. This trend, combined with the gradual succession from grassland to chaparral, in the absence of wildfire, has gradually reduced cattle and sheep operations in the San Lorenzo Valley.

No active commercial cattle operations are known in the San Lorenzo Valley, other than occasional use of small acreages in the Bean Creek subwatershed. Equestrian use is widespread in the watershed and horses are kept on residential parcels and at commercial or boarding stables. The latter facilities typically have more horses but also have larger pastures for grazing (and dispersal of animal wastes). As a result of the low numbers, grazing animals pose a minor threat to the water quality of the San Lorenzo watershed. Concentrated animals such as horse stables upstream of water intakes pose a greater threat and are discussed in Section 3.6.2.

3.5.3 Loch Lomond Reservoir and upper Newell Creek watershed

No grazing animals were encountered in the Loch Lomond area during prior visits to the lake and upper watershed. The City does not allow riding animals in the watershed area.

3.5.4 North Coast Watersheds

As discussed above, a limited amount of rangeland drains to Majors Creek upstream of the City's diversion structure, including the northern parts of Grey Whale Ranch. These areas seem to be grazed intermittently, principally by individual horses or small groups of horses, with occasional cattle grazing (apparently) under lease arrangements. Most of these grasslands are located along ridgelines or on slopes distant from the streams, reducing but not eliminating the potential for contributing nutrients, pathogens, and sediment to the streams. Further downstream on Liddell Creek, beyond the boundaries of the survey area, issues of livestock management are being addressed by the County. Trails, and roads used as trails, do come close to the main stem and east fork of Majors Creek; these could prove to be a small, but perhaps growing, source of sediment and pathogens.

3.5.5 SLVWD

There is no commercial grazing livestock present within the SLVWD. Based on conversations with staff from the district, indicated that there may be a limited number of residences that may have goats and chickens, but these would be unlikely to impact the watershed.

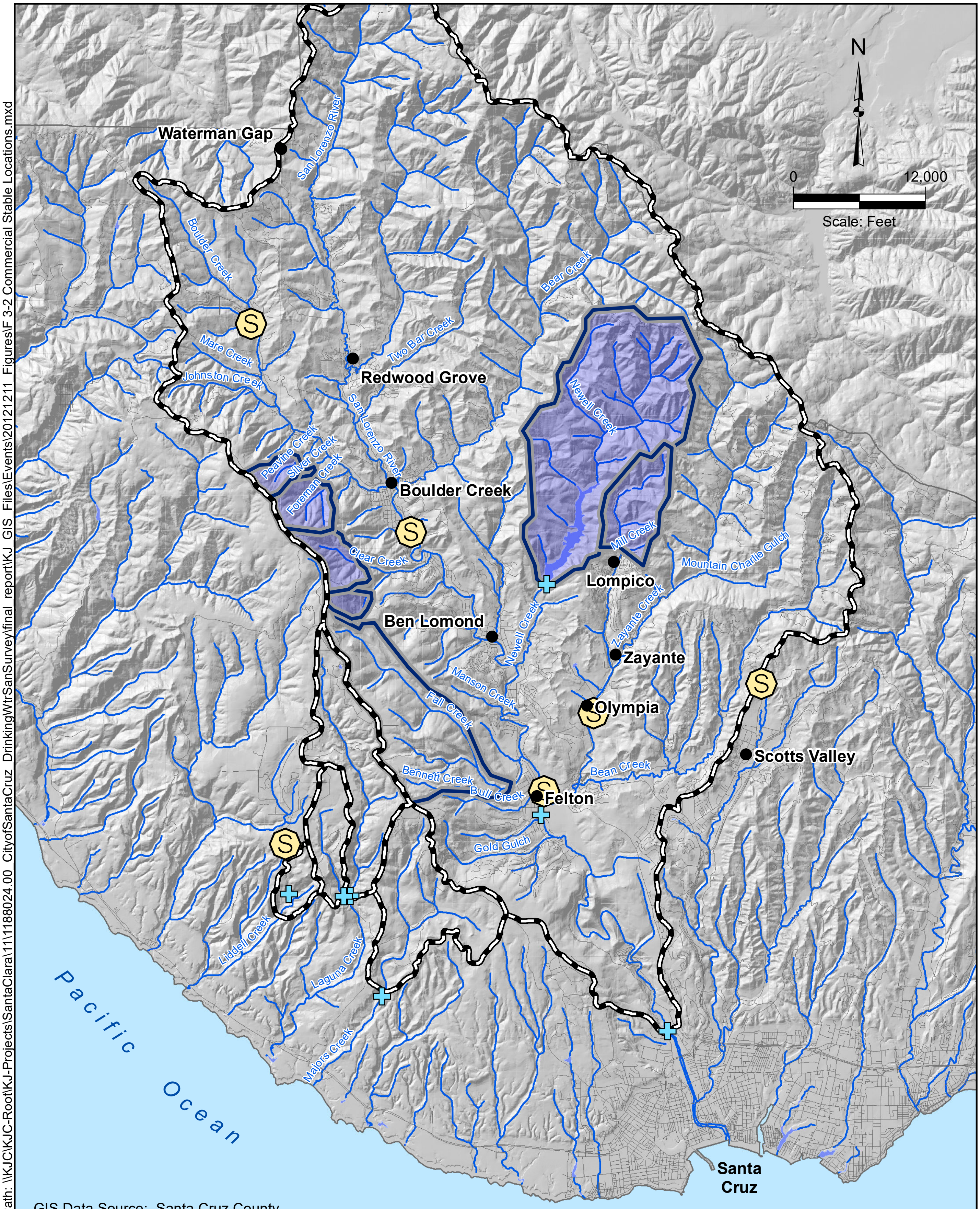
As in the SLVWD, there is no known commercial grazing livestock present within the Lompico Creek watershed although horses are known to be present at one residence within the watershed and there are some chickens and goats at other homes. It is believed that runoff from these residences would be highly unlikely to reach Lompico Creek.

3.5.6 Significance

The San Lorenzo River Pathogen and Nitrate TMDL list livestock as sources of the respective constituents. Pathogenic microorganisms are the major source of concern when contact between grazing animals and water supplies occurs. Hecht and others (1991) identified horses as a significant contributor to the San Lorenzo Valley nitrate budget and the County has taken measures to assess and control equine nitrate contributions to both surface and ground waters (c.f., the 1995 Wastewater Management Plan, and the 2001 Watershed Management Plan Update) to reduce costs of treatment for taste and odor problems. Where access to water is limited only to streams, degradation of habitat and bank stability is evident (see also Section 3.6). Development of improved water sources for grazing animals has played a significant part in limiting erosion impacts on water quality. Fencing, which is associated with water source improvements also reduce the impacts of manure and urine by creating buffer zones between grazing animals and waterways. That said, percolation of urine, especially in areas overlying sandy soils may be a source of nutrients from grazing livestock. Since 2005, the Santa Cruz County Resource Conservation District has partnered with a local NGO to provide resources in a Livestock and Land program, described in greater detail in Section 3.6.1 to assist homeowners in proper management measures to reduce water quality impacts of livestock and small agricultural activities.

3.6 Concentrated Animal Facilities

While traveling through the watershed it is apparent that although there are a number of commercial stables which house larger numbers of horses as found on Figure 3-2, there are also many residences that support one or two horses, despite small lot sizes and/or limited acreage suitable for pasturing horses or applying manure. While many of these small residential facilities are well-managed, it is also common to observe corral areas that are bare or partially denuded of vegetation from overgrazing, and manure management is often limited to stockpiling on site. Conditions contrast with the commercial facilities, which tend to have greater capacity to manage drainage and manure accumulations responsibly, in part because of their greater visibility and liability.



Path: \\KJC\KJC-Root\KJ-Projects\SantaClara\11\1188024.00_CityofSantaCruz_DrinkingWtrSanSurvey\final_report\KJ_GIS_Files\Events\20121211_Figures\F 3-2 Commercial Stable Locations.mxd

- Area Locations
- Santa Cruz Water Department Diversions
- Santa Cruz City Water Supply Watersheds
- Stables
- Sub-Watershed

Santa Cruz Water Department
WSS Update

Figure 3-3: Commercial Stable Locations

3.6.1 Contaminants of Concern

Horses are considered a major source of pathogens and nitrogen and can also contribute to persistent turbidity in the water supply watersheds. While horses were a relatively newly-recognized concern during the 1996 Sanitary Survey, some important actions were taken to protect water quality and improve care of the animals.

One key step was publication of *Horsekeeping: A Guide to Land Management for Clean Water,* in 2001 (CBARCD, 2001). This manual for horse owners, developed by the Council of Bay Area Resource Conservation Districts and the USDA NRCS, explains water quality concerns, provides technical assistance with design and implementation of structural control measures, and includes a directory of conservation-related resources for further exploration. Based on use of this manual, and with funding from the SWRCB through Propositions 13 and 50 (Manure and Erosion Prevention), the Santa Cruz County RCD and Ecology Action developed a Livestock and Land Program to educate owners about best management practices for manure and drainage management, as a way to effect positive changes to mitigate water quality concerns from livestock facilities. As a part of this program, the RCD has previously worked with both commercial and residential facilities, and coordinated with the Santa Cruz County Horsemen's Association to provide technical assistance and cost-sharing to install filter strips, erosion control grids, and other practices at a number of demonstration sites. The program is not currently funded but RCD continues to take requests for assistance. Additional services provided through partnership with the Natural Resource Conservation Service (NRCS), include free onsite consultations and technical assistance.

Manure management plans are required in case of valid manure-related complaints. In addition, the County also requires best management practices (BMPs) to be implemented to address potential water quality impacts of manure. The County is currently working to update their process to require manure management plans for any new development that includes large animals. This update includes requirement of manure management plans as an addendum to erosion control plans for those new developments. The RCD continues to support manure management through its Livestock and Land Program.

It is estimated that the equine population in the survey area has not changed over the last five years based on permitting of facilities and review of commercial stable listings. While many more horses are now boarded in private paddocks or boarding facilities with control measures in place than was the case at the time of the 1996 Sanitary Survey, City and County staff still report problems, particularly with new and unpermitted facilities (Chris Berry, personal communication, 2022). Throughout the subject watersheds, stables or paddocks are sometimes located on the edges of properties, often in swales and along waterways. This bare ground can be a source of sediment and offers minimal breakdown of manure and nitrogen uptake by plants. The net result is often a rapid transport of these pollutants into surface and shallow ground waters during periods of rain.

3.6.2 San Lorenzo Watershed

The County is working to improve their inventory of stables but in prior WSS Updates staff estimate that there may be more than 300 horses in large stables within the San Lorenzo River watershed, and an equal number in smaller residential stables. While numbers of animals at commercial stables vary from year to year, some of the largest stables are Covered Bridge, formerly Chaparral Stables (70 to 100 horses) in Felton, Eddy Ranch (40 to 50 horses) on Bear Creek, Zayante Equestrian Center, formerly Horse Haven (20 to 40 horses) on Zayante Creek, Glenwood Equestrian Center (20 to 25 horses) on Bean Creek, and Lichen Oaks (15 horses) in Quail Hollow. A search of commercial stables indicates that there do not appear to have been changes since 2012; however, a new operation Deerhorn Ranch in Felton appears to have recently been established. Additionally, the Santa Cruz County Horsemen's Association has resumed a regular calendar of events at the Graham Hill Showgrounds after shutting down in 2020 and 2021, including short-term stays for multiple animals.

Livestock in riparian areas also occurs. It has also been noted there is a flock of sheep grazing the riparian areas on private lands adjacent to the San Lorenzo River upstream of the City's Tait intake.

3.6.3 Loch Lomond Reservoir Subwatershed

No confined animal facilities are reported or were noted in this watershed.

3.6.4 North Coast Watersheds

The numbers of animals kept in the North Coast watersheds are not available. Some homes are on one-to-five-acre parcels, often with one or two horses, several chickens, and other domestic animals. Areas of bare soil are sometimes seen in the paddocks and associated areas. The Vigne Farms is a commercial stable located in Bonny Doon, which is temporarily closed, which is not in the surface drainage to Liddell Spring. However, the underlying karst in the area may provide a subsurface conduit to Liddell Spring. The County regulates the facility which has covered, concrete floored manure storage and surface water monitoring as a condition of approval. There is another large animal facility close to the Wilder Ranch State Park, but the livestock count is unavailable. Continued attention by regulatory and NGOs to manure management at confined animal facilities, especially those near surface waters upstream of diversions is an important element of pathogen and nitrate control.

3.6.5 SLVWD

There are no known concentrated animal facilities within the SLVWD.

3.6.6 Significance

The San Lorenzo River Pathogen and Nitrate TMDLs list domestic animals/stables as sources of the respective constituents. Wastes from horses have been estimated to contribute significantly to the pathogen and nitrogen load in the region's upper watersheds. One systematic study (Hecht and others, 1991) estimated that horses in the San Lorenzo Valley contributed nitrogen equal to one fifth or more of the amount released from septic systems. The San Lorenzo Nitrate Management Plan estimated that livestock and stables contributed about 6 percent of the nitrate load in the River (Ricker, 1995). The microbial source assessment found that horses were responsible for 10 percent of the wet weather *E. coli* samples at the Felton station but less than 2 percent of the wet weather *E. coli* load downstream (Ricker and Peters, 2006). No bacteria contributions from horses were noted in dry season samples. Most other types of confined animal facilities do not appear to be a major concern in the subject area except those located close to riparian areas such as the sheep upstream of the Tait diversion.

Both commercial stables and backyard paddocks can be found in almost all sub-watersheds of the San Lorenzo and North Coast water supply drainages, and animal wastes receive less treatment than human wastes and are more easily mobilized into streams. These facts suggest that effective manure management at all times of the year, but especially during winter and spring months, is critically important in reducing nitrogen and pathogen transport to ground and surface waters. Nitrate data, described in Section 5, indicate that nitrate concentrations have declined and stabilized in recent years suggesting that livestock management, as well as other management measures, has been successful in improving water quality.

3.7 Pesticide and Herbicide Use

Pesticides and herbicides are chemical compounds specifically formulated for their lethal effects on animal and plant life. Pesticides and herbicides are used in: (1) agriculture, (2) rights-of-way along roadsides, (3) landscaped areas such as parks and golf courses, (4) for structural pest control, and (5) by individuals. Volumes of specific chemicals used annually for the first four uses are represented in the reported use information collected by the County Agricultural Commissioner and reported to the State Department of Pesticide Regulation (DPR). The fifth use, by individuals in the home and garden, is unreported. Thus, a complete accounting of the chemicals used or the amounts applied is unavailable. The toxicity of compounds available to individuals – and generally to licensed professional applicators as well – has decreased markedly since the late 1980s.

All pesticides and herbicides used by licensed applicators (such as crop dusters, landscape maintenance professionals, and structural control businesses) are reported and sales of “restricted” chemicals are also reported by distributors. The Department of Pesticide Registration determines whether a pesticide/herbicide is classed as restricted based on its potential hazard to humans, animals, crops, or the environment in general. The County Agricultural Commissioner enforces related laws and regulations within the county, issues Restricted Materials Permits, and collects the use data which is then reported to the DPR. In addition, both City and SLVWD’s Integrated Pest Management (IPM) policies guide pesticide and herbicide use on their lands. Using a limited data set, the RWQCB has listed the San Lorenzo River under CWA Section 303d for a suite of pesticides and prepared a TMDL in 2014 for chlorpyrifos on Zayante Creek and the San Lorenzo River below Felton which attributed allocations of chlorpyrifos to urban stormwater and irrigated agriculture. However, given the banning of chlropyrifos and low concentrations in sampling results, it appears that use of chlropyrifos has diminished significantly and the TMDL is being met.

Comprehensive information on the specific types and locations of pesticide and herbicide use throughout the North Coast and San Lorenzo River watersheds was not developed for the original 1996 Sanitary Survey or any subsequent updates. Logically, such use will be a tiny fraction of the applications throughout Santa Cruz County. Most pesticides for which regional records are kept are used for agricultural activities in the Watsonville area and in the marine terrace agriculture downstream of the North Coast watersheds, rather than within the North Coast and San Lorenzo watersheds. Similarly, most of the reported structural pest control use will be from the urban and industrial areas which are mostly outside the survey watersheds; i.e. the Cities of Santa Cruz, Watsonville, and Scotts Valley. However, per the latest list of impaired waters which was updated by the SWRCB in 2022, the San Lorenzo River continues to be 303d listed for chlordane and chlorpyrifos pesticides (source unknown), indicating that residues from commercial and/or residential applications are regularly reaching the river.

In 2012, the USDA conducted a water quality study in the San Lorenzo River for a range of insecticide, herbicide, fungicide, and metabolite compounds at the low parts per trillion detection levels. Out of over 4,000 treated water samples analyzed weekly over nine months, only two detectable results were found and at levels 1,000 times lower than the public health goal set for the compound. The diligence paid to pesticide/herbicide use in the watersheds indicate that the raw water remains at a low risk for contamination from these compounds.

3.7.1 Contaminants of Concern

While all pesticides and herbicides can be considered undesirable in a drinking water source, the legacy pesticide, chlordane, and the organophosphate pesticide, chlorpyrifos, are of greatest concern as shown by the 303d listing, and the TMDL prepared in 2014 is for these constituents recently established by the RWQCB. Other specific chemicals of concern are the synthetic organic chemicals (SOC) regulated under the Phase II/V Rules (see Section 5.4.5.1). The Phase II/V pesticides and herbicides are those which EPA has established requirements for drinking water (see Section 5.4.5.1).

3.7.2 San Lorenzo River Watershed

The most sensitive right-of-way in the watersheds, because of its proximity to the San Lorenzo River, is State Highway 9 maintained by the California Department of Transportation (Caltrans). Caltrans staff report that herbicide use along Highway 9 has been reduced 50 percent or more since the early 1990s under the agency's NPDES permit for roadside vegetation maintenance (Kris Griffin, personal communication, 2012). A revised NPDES permit adopted in 2022 for stormwater management requires Caltrans to prepare a vegetation control plan that minimizes use of herbicides. Previously, targeted applications of less-toxic materials occur at low rates immediately adjacent to fixed safety hardware (e.g., signposts, guardrails, reflectors), maintaining a minimum 20-foot buffer between the spray zone and the edge of live streams or the River. Caltrans staff previously applied two herbicides annually, both in late fall/early winter: a systemic pre-emergent, Goaltender 2 (oxyfluorfen), and a more typical pre-emergent, Oust (sulfometuron methyl), that also has some post-emergent properties. Oxyfluorfen disperses readily in water, is slightly mobile and is acutely toxic to aquatic organisms but practically non-toxic to terrestrial biota and birds. Sulfometuron methyl is also readily dispersible in water and moderately mobile, but practically non-toxic to both aquatic and terrestrial biota. Both materials are moderately persistent.

Caltrans has used spot treatments as needed with the broad spectrum (non-selective) systemic herbicide Roundup (glyphosate), and the selective (broadleaf) systemic herbicide Garlon 4 (triclopyr) for brush control in the highway right-of-way, to remove woody vegetation such as blackberries, poison oak and tree seedlings before they interfere with visibility or impinge on the roadway. Roundup has been considered to be one of the more benign herbicides from a drinking water point-of-view, because the active ingredient, glyphosate, is practically non-toxic to aquatic and terrestrial biota and effectively immobile, being strongly adsorbed to soil. However, recent research suggests that at least one of the inert ingredients in Roundup has higher toxicity. Triclopyr is slightly soluble in water, moderately persistent, potentially mobile, and slightly toxic to mammals but highly toxic to aquatic biota.

Vegetation maintenance along County roads in the San Lorenzo River watershed has relied on targeted mowing since the Board of Supervisors passed a three-year moratorium on roadside herbicide spraying in May 2005. A 2015—2016 report identified the use of County Integrated Vegetation Management Program to minimize herbicide use, but herbicides are used along roads as needed. Similarly, Pacific Gas and Electric (PG&E) also implements an Integrated Vegetation Management approach to managing vegetation in their right of way.

Because mowing is far more labor intensive than spraying, mowing efforts concentrate on maintaining safe sight distance at critical intersections, road curves and other areas. While roadside maintenance in riparian areas involves herbicides to clear brush for flood control purposes, the County is exploring alternatives, such as organic substances, to reduce the environmental impact of conventional spraying. When used, herbicides are typically applied using a brush on the cut branch to minimize overuse.

The four State parks in this watershed are: Big Basin Redwoods State Park, Castle Rock State Park, Fall Creek State Park[11] and the Henry Cowell State Park. These parks use very little pesticides and herbicides as they are mostly preserved natural environments with very little landscaped area.

The four County parks in this watershed are: Felton Covered Bridge, Highlands Park, Ben Lomond Mill Street Park, and Quail Hollow Ranch. The County has limited use of pesticides and herbicides – a previous WSS update reported one application of Roundup along fence lines and on baseball fields at Pinto Lake and Polo Grounds Parks which are outside of the survey area.

The golf course at the Boulder Creek Golf and Country Club is managed based on IPM principles and use of least toxic materials at the lowest rates feasible. The course had previously employed two licensed pesticide applicators and primarily uses broadleaf weed control herbicides and fungicides.

In 2021, SLVWD prepared an Integrated Pest Management Policy, which aims to eliminate use of all pesticides on the District's properties, and to minimize the quantity and risk of pesticide use where complete elimination is not possible. City has a similar Integrated Pest Management program as discussed in Section 4.8

3.7.3 Loch Lomond Reservoir and upper Newell Creek watershed

The Loch Lomond Recreation Area is mostly non-landscaped and uses mechanical weed control for road right-of-way and other park maintenance. Although no pesticides, herbicides, or fertilizers are applied in these areas, consistent with the City of Santa Cruz policy, glyphosate is occasionally applied on the firebreaks/ridgetops as part of a multi-faceted strategy for fuel load

[11] More correctly, the Fall Creek unit of Henry Cowell State Park. Popular nomenclature use

reduction, access maintenance and invasive species management.; The need to reduce ladder fuels in an effort to reduce potential for crown fire and related impacts on the water resources at Loch Lomond is balanced with the potential water quality impacts of glyphosate use. Monitoring of Loch Lomond has shown that glyphosate has not impacted Loch Lomond. Other fuel management efforts include manual and mechanical French broom eradication efforts.

The City has attempted several methods to control algae (primarily blue-green algae or cyanobacteria) in the reservoir. Historically, pesticides containing copper as the active ingredient were successfully used. Since the 2018 WSS update, the City has moved away from PAK27 (a sodium bicarbonate and hydrogen peroxide mixture) and instead uses liquid GreenClean to control algae growth in the Loch Lomond Reservoir. GreenClean Safety Data Sheet identifies key ingredients as sodium carbonate peroxyhydrate and sodium carbonate (soda ash). The City has continued to also use copper-based algaecides under the terms of a permit with the State Water Resources Control Board on an as-needed basis. Algae growth is monitored year-round, and Loch Lomond Reservoir is aerated regularly to help limit growth. (Lindsay Neun, personal communications 2022).

3.7.4 North Coast Watersheds

Use of pesticides and herbicides in these watersheds is likely to be very small as landscaped areas are a very minor land use, and there are no large urban areas or major thoroughfares. There is limited agriculture, including some small vineyards that are potential source of pesticides and herbicides. Pesticides are not being used within the City managed watershed lands on the North Coast currently. However, they may be used as part of the City's multi-faceted IPM program if warranted.

3.7.5 SLVWD

SLVWD's watershed management plan, restricts, and where feasible, excludes the use of pesticide or herbicide within SLVWD lands. SLVWD also supports the minimal and restricted use of herbicides and pesticides in the District's service area as well as contributing to the control of herbicide and pesticide use in the greater San Lorenzo River watershed. The District has also imposed a complete ban on all glyphosate use on District properties.

3.7.6 Significance

The RWQCB's decision to place the San Lorenzo River on the 303d list for chlordane and the 2014 TMDL for chlorpyrifos suggest pesticides and herbicides as well as chemicals are a potential contaminant source of concern. However, City has provided written input to the RWQCB that these listings may be inappropriate in that the pesticides are no longer commercially available, the sources are unknown and the data that supports the listings is fairly limited. Additionally, these compounds have never shown up in the City's source monitoring. In the TMDL report, RWQCB acknowledged City's comment and noted that for chlorpyrifos, the detections are located downstream of the City intakes.

3.8 Wildlife

3.8.1 Contaminants of Concern

Wildlife may pose a threat of contamination to public water supplies under certain conditions. The likeliest condition is the contact between water supply sources and animal or waterfowl waste. The potential for transmission of waterborne pathogens such as Giardia cysts and Cryptosporidium oocysts varies with fluctuations in wildlife populations. While considered a potential problem, the relative importance is lessened when compared with the impacts of domestic and confined animals.

3.8.2 San Lorenzo Valley, North Coast Watersheds, and SLVWD

The wild animals that have the greatest potential impact in the San Lorenzo Valley and the North Coast watersheds are wild pig, black tailed deer, California ground squirrel, and the other local terrestrial mammals. Canada geese populations at Loch Lomond have been observed and maybe a contributor to HAB events during the summer. Terrestrial mammal populations fluctuate with changes in residential development, droughts, and other factors. Wild pigs specifically have historically been linked to erosion problems due to their foraging and wallowing habits – however, sightings of pigs by City staff have decreased over time, possibly due to changes in weather patterns associated with climate change or changes in residential development. Recent genetic studies of dogs may help to differentiate the presence of wild animals versus domesticated animals in the watershed.

California ground squirrels are a minor potential source of sediment and fecal coliform bacteria. Ground squirrels are a source of bank instability in grassland areas and along levees and earthen dam structures. This instability often necessitates eradication efforts that when done by rodenticides may be a source of chemical contamination to adjacent water sources. In small spring systems, it was noted that occasionally other rodents, like the dusky footed woodrat and deer mice, as well as a variety of lizards may foul water supplies when they die and decompose in water sources. This issue illustrates the need for vigilance on the part of the small-scale water suppliers and spring owners.

3.8.3 Significance

Pigs, Canada geese and other wild animal populations appear to have a moderate potential for contamination of surface waters at this time.

3.9 Quarries/Mine Runoff

There are currently four active quarries in the study area – Wilder, Quail Hollow, Felton, and Olive Springs, as described in Section 2.3.5.

The quarries are regulated under California's Surface Mining and Reclamation Act (SMARA) and by the County's Mining Ordinance. The County Mining Ordinance requires that the application package be submitted to the water purveyor in the drainage area of the quarry. The County inspects the quarries four times each year and the state inspects them annually. The

County conducts an extensive review each five years. At that time, the County Planning Commission can impose conditions on the quarry as part of the Certificate of Compliance. The Regional Board issues NPDES permits that set limits on contaminants that can be discharged to surface waters from quarries.

3.9.1 Contaminants of Concern

Sediment, nitrate, dissolved metals, and minerals are all contaminants of concern related to quarry operations. The Felton Quarry has historically been a source of dissolved minerals, sulfate, iron, and manganese in moderately elevated concentrations while the Bonny Doon Quarry for limestone, which recently closed, was associated with high sulfate, turbidity, sediment, and nitrate. The other quarries in the watersheds are closed but may be a source of sediment if not properly maintained. Each active quarry is discussed further in the following sections.

3.9.2 San Lorenzo River Watershed and SLVWD

This section presents existing conditions of the four active quarries in the San Lorenzo River watershed.

Felton Quarry - Felton Quarry, mined by Granite Construction Company, is a 262-acre granite quarry rising in elevation from 550 feet at the eastern edge to 1,550 feet at the northwest corner. The Felton Quarry mineral deposit, a spatially-limited unit of fractured and stained granitic rock (mapped as adamellite, also known as alaskite), is located on the southeastern side of Ben Lomond Mountain. The quarry consists of an active open pit, an asphalt plant, a washwater recirculation system, a polymer clarifier system, and settling ponds. It produces both decomposed granite used in construction and a stained aggregate marketed as a high-value landscaping rock under the 'California Gold' trademark.[12]

Mining occurs on approximately 85 acres of the site (Carlson, 2005). The quarry has been active since the early 1970s, and has been operated under the present permit for 31 years with an additional 19 years of feasible mining projected. Limestone Brook drains through the center of the site in a southerly direction forming the headwaters of Gold Gulch, which flows east to the San Lorenzo River. Washwater is recirculated and stored in three detention ponds. It is not discharged except during major storm events. Stormwater runoff from the site is also stored in the three onsite detention ponds. Prior to major storm events, water is pumped from the ponds and discharged to Gold Gulch to increase pond capacity for stormwater runoff. The ponds are designed to handle a 2-hour, 100-year storm, providing a median detention time of at least 20 to 40 minutes. During extreme storm events the capacity of the detention ponds is exceeded and stormwater flows out of the ponds to downstream receiving waters. Discharges to surface waters are regulated under an NPDES permit issued by the Regional Board. The quarry submits quarterly discharge reports to the Regional Board.

Granite monitors groundwater and surface-water quality twice each year at a number of monitoring locations. Groundwater levels are measured in nine wells and samples are collected

[12] See Hecht, 1978 for a discussion of the hydrogeologic and weathering conditions which have led to deep weathering and the lightly-stained rock mined at the site.

for pH and conductivity. Surface water samples are collected at 16 locations including the settling ponds, springs, Gold Gulch, and Limestone Brook. All samples are analyzed for pH and specific conductance. Selected samples are analyzed for general water quality parameters such as total dissolved solids, calcium, and sulfate. In April 1995, a sample was collected from the effluent of the clarifier and analyzed for the 13 priority pollutant metals. Most of the metals were not detected. Lead and nickel were detected at concentrations well below drinking water standards. High concentrations of sulfate, calcium, iron, and manganese have been detected in the groundwater basins of Limestone Brook and Gold Gulch. County requirements call for developing a set of protective measures should water quality change by more than 20 percent. The Felton Quarry has controlled erosion at the site by revegetation with native plants.

Historically there was concern that the quarry's operations might affect the water supply of the Forest Lakes Mutual Water Company, as the quarry's product of partly-weathered rock is part of the source aquifer for the Company's wells. A hydrogeologic assessment study (Hecht, 1978) showed that there was no impact on groundwater levels; however, the operator drilled a new well for Forest Lakes MWC that provides 18 acre-feet of water to the water district each year. Conditions of approval for the quarry require that if the water supply were to diminish, Granite would be required to provide a new water supply to this purveyor.

Quail Hollow - The Quail Hollow Quarry encompasses 240 acres and is located on Quail Hollow Road near the community of Ben Lomond (Carlson, 2005). Mining is estimated to continue for decades from the present and is permitted for a maximum production rate of 250,000 tons per year. The Santa Margarita Sandstone is mined for sand which is used in the construction industry; however, the Quail Hollow quarry is locally unique in that it also contains fine, industrial grade sand used by the glass industry (Carlson, 2005). The quarry consists of an open pit, a washwater recirculation system, and detention ponds. In 1998, the Planning Commission certified an EIR for the project and approved the Mining Approval and Certificate of Compliance.[13] In 2007, the first permit review since the 1998 approval was conducted and staff concluded that the quarry was in substantial compliance with the Conditions of Approval (Carlson, 2007). Additional best management practices were installed to better manage stormwater runoff. The capacity of the site to retain stormwater runoff has been exceeded under extreme conditions, such as occurred during the 2016—2017 wet season, and further improvements to the storm water pond system have been implemented and additional improvements are planned to better manage and treat stormwater runoff before it leaves the site (Carlson, 2018).

In 2008, Graniterock finalized the Long Term Management and Maintenance Plans (LTMMP), which was a stipulation of their 1998 Mining Approval and Certificate of Compliance. The purpose of the Plan is to implement the conservation goals of the Habitat Conservation Plan by describing the management and maintenance actions that will be undertaken to preserve conservation and reclaimed areas of the mine in perpetuity (Carlson, 2008). The LTMMP calls for a more comprehensive monitoring program to include, invasive species mapping, vegetation community mapping and plan plant species mapping, as well as an adaptive and research-

[13] There are actually two Approvals for the Quail Hollow Quarry and two corresponding sets of conditions of approval. The approval for the "Current Mining Area" was in 1994, and that for the "Future Mining Area" was in 1998.

oriented approach that will allow management to be refined and improved as new information is obtained.

3.9.3 Loch Lomond Reservoir and the upper Newell Creek watershed

There are no active quarries in this watershed.

3.9.4 North Coast Watersheds

There are no active quarries in this watershed.

3.9.5 Significance

Within the four quarries in the San Lorenzo River watershed, occasional heavy sedimentation can occur because of exceedance of settling pond capacities during major storms. This condition is not likely to change in the foreseeable future. The potential water quality impact is more significant with the operational quarries at Felton and Quail Hollow. Bonny Doon Quarry (in the North Coast watersheds) is no longer active, and thus Liddell Spring water quality will no longer be negatively impacted by blasting events. However, potential industrial land uses at the site by an aviation firm producing drones may pose some risks which should be monitored for regulatory oversight such as use permits by the County and evaluated in a future WSS update. The Peninsula Open Space Trust and Sempervirens Fund with other organizations acquired the San Vicente Redwoods from CEMEX in the winter of 2011. In 2014, these organizations joined with others to collaborate on the Living Landscape Initiative design for a plan that protects wildlife habitat, recreation, and sustainable timber harvesting for the 8,500-acre property. As noted earlier, allowing public access to these lands increases risk of wildfire with associated water quality risks

3.10 Solid and Hazardous Waste Disposal Facilities

In California, there are three main categories of waste disposal facilities: (1) solid waste disposal facilities, (2) hazardous waste treatment, storage, and disposal (TSD) facilities, and (3) illegal dump sites. Solid waste facilities are regulated by the California Department of Resources, Recycling and Recovery (CDRRR, formerly the State Integrated Waste Management Board), although pollution problems are handled by the Regional Boards. Hazardous waste facilities are overseen by the State Department of Toxic Substances Control (DTSC). The County removes trash and abandoned articles from illegal dump sites.

There is one closed solid waste facility in the San Lorenzo River watershed, discussed below. A review of Geotracker, the database of TSD facilities showed there are no new active TSD facilities in any of the watersheds and that the former Santa Cruz Lumber Company and Valeteria Dry Cleaners sites in Felton remain under state oversight.

3.10.1 Contaminants of Concern

Leachate from waste disposal facilities is a liquid formed as infiltrating rainwater seeps through the landfilled material mobilizing a variety of contaminants. Leachate is typically a highly mineralized liquid containing heavy metals, dissolved solids, nutrients, and organic chemicals. The composition of leachate from any particular landfill will depend on the nature of the decomposing landfilled materials. Although regulations aim to minimize or eliminate leachate from contaminating the underlying groundwater and nearby surface waters, complete leachate control is difficult to achieve.

3.10.2 San Lorenzo River Watershed

There are no active solid waste disposal facilities in the watershed. The County provides trash pick-up service in all the watersheds and transports the material to one of the two operating landfills, both of which are outside the watershed areas for this study.

There is one closed County landfill, the former Ben Lomond Landfill. This facility was in operation since the early 1950s and was classified first as a Class II Landfill, then later as a Class III Landfill. The landfill ceased acceptance of waste in July 1991 and it is now used as a transfer station and recycling center and is known as the Ben Lomond Transfer Station. It is located on the north side of Newell Creek, downstream of Loch Lomond, in the highly permeable Santa Margarita sandstone which is underlain in this area by the south-southeast dipping Monterey shale.

Requirements for management of active landfills, closure of landfills, and air and water quality testing are described under Subchapter 15 of the California Code of Regulations. The CDRRR implements source reduction and recycling requirements, waste handling and landfill design, and waste disposal standards. Landfills are to be designed and closed to permit no off-site movement of leachate. Both active and inactive solid waste disposal sites are required to conduct monitoring specifically to identify the content of any leachate leaving the site and whether there are water quality problems posed by the site. The monitoring results are reported to the Regional Board in Solid Waste Assessment Test (SWAT) reports.

The entire Ben Lomond Landfill is now under a clay cover. Regional Board staff report this cover has been effective in reducing the cadmium levels. Closure measures include gas extraction, installation of a sedimentation basin, and installation of a drainage system. The County submitted a closure plan to the Regional Board in 1996.

There is a groundwater plume beneath the Ben Lomond Landfill but concentrations of most monitored constituents are at low levels. A few VOCs are detected above MCLs in three of the wells close to the landfill perimeter. Downgradient groundwater monitoring wells, however, show no evidence of VOC contamination. Monitoring of Newell Creek shows some increases in mean constituent concentrations from upstream to downstream of the landfill, including an apparent increase in turbidity. Leachate inflow into Newell Creek would be unlikely to cause the turbidity increase; this apparent increase may have some other source, possibly erosion within the Rancho Rio subdivision on the opposite creek bank.

3.10.3 North Coast Watersheds and the Loch Lomond Reservoir

There are no identified and no permitted waste disposal facilities in any of the other watershed areas.

3.10.4 Significance

Waste disposal facilities most likely are not a significant threat to the water quality of the San Lorenzo River or the creeks in the North Coast watershed. There are no hazardous waste disposal facilities in any of the watersheds. The closed Ben Lomond Landfill in the Newell Creek watershed appears to have created a low-concentration groundwater plume with a few elevated VOCs but the plume does not appear to be migrating into the creek. There is an apparent turbidity increase in the creek from upstream to downstream of the landfill. The landfill leachate, however, is unlikely to be the source of this turbidity increase.

3.11 Timber Harvesting

Logging is part of the land-use mosaic and tradition in Santa Cruz Mountains. Most old-growth redwood had been cut by 1915. Douglas fir and hardwoods have also been extensively logged. Timber harvests were historically an integral part of the local economy. However, in recent decades, timber harvesting has been used primarily as a tool for forest management and fire resiliency as evidenced by limited timber harvest plan submittals to the RWQCB since 2004. Neither the City of Santa Cruz nor the San Lorenzo Valley Water District plan to continue timber harvesting outside of the context of forest management for fire resiliency and restoration purposes. Section 3.16 discusses wildfire forest management in more detail. If timber harvest activities occur after fire, they pose a risk to mobilize sediments and other pollutants which should be scrutinized. Other timber harvest objectives including forest management and land restoration.

3.12 Recreation

Principal recreational activities in the watersheds include swimming, fishing, hiking, and horseback riding. There has been a continued interest in mountain biking occurring on trails in the watersheds including development of illicit trails upstream of the City's water intakes on the North Coast. Water contact recreation (swimming) occurs primarily during fair weather and relatively warm temperature conditions, conditions typical of May through October on both the San Lorenzo River and some of the tributaries. The peak water-contact recreation season is traditionally from the Memorial Day through the Labor Day weekend and is limited to natural swimming holes as temporary dams are limited by CDFW; however, informal summer dams have been observed such as the one on Zayante Creek at Mount Hermon just upstream of the Bean Creek confluence. In addition, weekend use is generally more intensive than weekday use. Swimming and wading has been listed as the most popular recreational activity in the watersheds. Recent water quality sampling has found the insect repellent DEET in the San Lorenzo River at Felton in November and December 2020 as well as January, February and March 2021 which could potentially be associated with recreational and other human activity. Hiking, mountain biking, and horseback riding are more year-round activities (County General Plan).

Future trails are currently being developed by the Santa Cruz Mountains Trail Stewardship and Sempervirens Fund, as described In Section 2.3.6. Increased usage of the watershed for recreational purposes may result as more areas of the watershed open up for public access. Typical usage of the watershed for recreation is for walking and hiking, which has a fairly limited impact on source water quality. If mountain biking and motorized vehicles like electric bikes become more frequently used, the impact on watershed erosion may be greater.

On March 19, 2020, a shelter-in-place order was issued by the California Department of Public Health to limit the spread of COVID-19. Since this order allowed for outdoor recreational activities, the San Lorenzo River watershed saw an increase in visitation throughout the COVID-19 lockdown order. Recreational activities included increased hiking, mountain biking, and recreational fishing encouraged by stocking of fish at Loch Lomond. Increased recreational activity of this kind could potentially contribute to increased erosion in the watershed.

3.12.1 Contaminants of Concern

Water-contact recreation is a potential source of viruses, pathogens, and bacteria, principally from the introduction of human fecal matter (most likely from infants and children) directly into the stream. Hiking, mountain biking, and particularly horseback riding, can contribute to erosion and increased turbidity, especially when conducted off established trails and at stream crossings. Human access to watersheds also exacerbates fire hazard. Fishing activity is limited to catch-and-release steelhead, except at Loch Lomond where CDFW stocks fish, and is a potential source of contaminants including nutrients that could result in HAB, especially with the increased fishing activity during the COVID-19 pandemic. In addition, live bait at Loch Lomond is limited to night crawlers to prevent invasive species introduction.

3.12.2 San Lorenzo River Watershed

There are three state parks, four county parks, one City recreation area, one private country club, and several public and private swimming holes within the watersheds. Water contact recreation is prohibited in the City recreation area but is widespread elsewhere in the creek system. The state parks include Castle Rock State Park, the Henry Cowell State Park, and a small portion of the Big Basin Redwoods State Park. The state parks are essentially open spaces. Prior to the CZU fire in 2020, which burned 97 percent of Big Basin Redwoods (Big Basin) State Park’s 18,000 acres, there were many miles of trails for hiking, biking, and horseback riding, 147 developed campsites, 6 trail camps, and 36 tent cabins. As of 2022, Big Basin is open for limited day use with about 20 miles of trails reopened. Castle Rock State Park has more than 5,000 acres and 34 miles of trails for hikers and equestrians. Camping is for backpackers only at two primitive sites with pit toilets. Henry Cowell State Park consists of two units; a main park area of about 1,800 acres and the Fall Creek Unit which has about 2,500 acres and has about 20 miles of trails. Some trail sections are designated for horses, leashed dogs, or bicycles, but most trails are for hiking. There is also a 112-unit campground. Illicit recreational uses in Henry Cowell State Park and adjacent lands have recently increased, particularly mountain biking off the designated trails. Passage of Proposition 68 in 2018 has made more state funding available for parks and it is hoped that enforcement of park regulations will return. There is continued concern that additional demands for access for recreation including mountain biking will exacerbate erosion and other water quality concerns.

The County parks include the Felton Covered Bridge County Park (playground, covered bridge, horse trail access, volleyball); Highlands County Park (senior center, swimming pool, picnicking, playing fields, nature trail); Ben Lomond Mill Street Park (picnicking, small playing field); and Quail Hollow Ranch County Park (equestrian facility).

The Boulder Creek Golf and Country Club is a private facility which provides an 18-hole golf course as well as other recreational facilities, such as tennis courts and a swimming pool.

Historically, there were several small dams constructed across creeks to afford summer swimming holes at locations that included, San Lorenzo Woods, Bear Creek Scout Camp, Gold Gulch in Forest Lakes, and Zayante Creek in Mt. Hermon. Swimming holes are now limited to natural swimming holes which are located in less accessible portions of the watershed although illegal dams constructed of cobbles and plastic are frequently constructed. The County Health Services Agency continues to monitor coliform bacteria at two locations on the San Lorenzo River. The coliform data can indicate sewage contamination from failing septic systems, urban runoff, domestic animal wastes, wildlife, birds, and/or water contact recreation itself. In addition, the County monitors for mycrocystin which is the toxin associated with cyanobacteria at two locations on the San Lorenzo River downstream of City diversions.

3.12.3 Loch Lomond Reservoir and the upper Newell Creek watershed

Loch Lomond Recreation Area occupies the east side of the reservoir and is owned and operated by the City. Recreational use averages around 55,000 visitors per year. There is day use only, with hiking, dog walking, picnicking, fishing, and boating as the primary activities. Only electric powered boats and manually paddled boats such as rowboats are allowed. There is no water-contact recreation allowed. Recreational fishing is augmented with CDFW stocking of fish at Loch Lomond; there is a concern that wastes associated with an increased fish population, as well as increased geese population may be linked to the increased HAB events.

Wastewater is trucked out of the recreation area and virtually no pesticides or herbicides are currently used in the area. The park is open from March 1 to September 15 and on weekends after Sept 15 until the second weekend in October from 6 AM roughly to sunset (varying times). On private lands of the upper Newell Creek watershed, there are a few septic systems to serve homes and wineries.

3.12.4 North Coast Watersheds

There are several recreation areas or regional parks in the North Coast watersheds such as the recently formed San Vicente Redwoods, some of which drains into the Laguna and Liddell watersheds, CDFW's Bonny Doon Ecological Reserve which drains into the Reggiardo Laguna, and Liddell Creeks; the Wilder Ranch State Park, some of which drains Majors Creek and the Coast Dairies State Park which is located on the lower portions of Laguna Creek. In addition. there are informally established horse and mountain bike trails in these watersheds.

3.12.5 SLVWD

The Fall Creek State Park is available for day use, and is located just upstream of the Fall Creek intake. Since this area is only available for day use, there is a limited chance of contamination occurring. Recreation activities consist mainly of family picnics and hiking. The road along fall creek is gated just past the campground, so vehicles other than SLVWD vehicles, do not have access beyond Fall Creek State Park.

The Olympia Wellfield is open to hiking and equestrian use. There are no surface water diversions on site.

Recreational use is restricted within other areas of the SLVWD lands but are occasionally subject to illicit use by hikers and mountain biking to which the District responds by deterring trespass through various methods.

Lompico Creek has limited recreation activities within its watershed. There is a small pool below the former Lompico Creek intake which is used for recreation and swimming. Other activities that may exist in the watershed are limited to hiking and possibly some mountain biking.

3.12.6 Significance

Many recreational activities are relatively benign and non-polluting. Large recreational areas, especially those which are mostly open space like Henry Cowell State Park or are managed specifically for water quality such as the Loch Lomond Recreation Area, appear to enhance water quality. As discussed above, bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).

Recreational activities generally considered of most significance involve water-contact recreation. However, an evaluation of the County fecal coliform bacteria data conducted during prior watershed sanitary surveys, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system. It has been observed, however, that the dammed swimming areas do grow algae later in the summer as water temperatures warm and there is concern that these conditions could contribute to HAB. The first winter rains can carry the algae mats as well as first flush stormwater that should be monitored for and managed as a source water constraint.

An examination of the geographical distribution of the County fecal coliform data from 2012—present continues to show that the urbanized portions of the river system, generally between Boulder Creek and Felton, have fairly similar average and median values. Historically, there has been an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. data indicate that total coliform counts at Loch Lomond are lower than the counts at the Tait Street and Felton Diversions as shown in Section 5. The County's wastewater management program evaluation found no significant increases of fecal coliform bacteria in the swimming areas of the San Lorenzo River system, indicating that water contact recreation at parks and designated recreation areas is not a significant source of the bacterial load in the river (John Ricker, personal communication, 2017).The potential for erosion from hiking, horseback riding, and mountain biking may also be significant and has been observed in locations such as Henry Cowell State Park and upstream of the Tait diversion on the San Lorenzo River. [14] Downhill biking continues to be increasingly popular biking-induced damage (including the building of illegal jumps) has stirred controversy in the San Lorenzo River watershed (Betsy Herbert, personal communication, 2012). There are few signs to alert bikers coming from legal trails on UCSC's upper campus that they are entering closed trails under state park control, and law enforcement has issued tickets to riders exiting Henry Cowell State Park onto Highway 9. Signage has been vandalized and/or removed in Henry Cowell State Park which requires monitoring and replacement.

There are a limited number of formal trails in the county for downhill bikers such as in the Soquel Demonstration Forest and a few other locations which cannot meet demand, Officials and bikers represented by the Mountain Bikers of Santa Cruz have collaborated to start building a park on federal land maintained by the Bureau of Land Management near Davenport at the Cotoni Coast Dairies National Monument. About 3 miles of a planned 19 mile trail system have been completed to date.

3.13 Unauthorized Activity

Unauthorized activities are found at varying levels throughout the San Lorenzo Valley and North Coast watersheds and include unpermitted grading, illegal timber harvests, and unauthorized dumping of solid and liquid wastes, often associated with homeless encampments. Area resource managers find that land clearing, road construction, and maintenance by individual landowners are the primary sources of avoidable erosion. Cannabis cultivation, which has occurred illegally, is now regulated as discussed in Section 2.

Homeless encampments can also be a source of human waste and are the subject of targeted enforcement. The City of Santa Cruz passed Ordinance No. 2021-12 (Camping Services and Standards Ordinance), which aims to provide regulation for the time, place, and manner for sleeping outside in the City of Santa Cruz. This ordinance intends to allow the City to better balance health, safety, and environmental concerns through a combination of prohibitions on camping, increased outreach and education, and connections to available services and safe sleeping sights. The camping ordinance is still pending implementation, as it requires that adequate shelter space be developed before prohibitions on camping in the watershed can be enforced. Additionally, staff bandwidth to implement the ordinance will be an ongoing challenge regardless of shelter space conditions.

3.13.1 Contaminants of Concern

Generally, sediment caused by eroding land is a primary contaminant of concern. In addition to the erosion risk, chemical spills including pesticides, herbicides, and fuels, and accumulation of debris pose additional water quality threats. There is also concern regarding increases to coliform and bacteria levels in source water due to increased homeless encampments in the

[14] SLVWD does not actively manage much of its land for recreational purposes; however, in 2011, SLVWD approved limited recreational use (equestrian, walking, and dog walking) on the Olympia watershed property.

watershed – many of which are located immediately adjacent to the water in local riparian areas.

3.13.2 San Lorenzo River Watershed

Numerous violations of the Santa Cruz County Erosion Control Ordinance can be seen throughout the subject watersheds, primarily in connection with roads. County staff estimate that in the project area, there are scores of "active" violations of the County Grading and Erosion Control, the Riparian Habitat Protection, and the Sensitive Habitats Protection Ordinances. In addition, several large illegal roads in the Bear Creek and King Creek watersheds remain open and are a significant source of sediment and persistent turbidity. County enforcement staff do their best to obtain compliance for these situations, however with limited resources, violations are prioritized based upon severity and overall threat to life and safety. For larger land clearing or grading violations, it may take years to ultimately resolve the violation due to many factors including the magnitude of the violation as well as the property owner's willingness and financial ability to comply.

Besides grading and brush clearing by individual landowners, unpermitted timber harvests for firewood occasionally occur in the watersheds. Illegal timber harvests are seen by resource managers as causing more aesthetic damage than water supply damage.

Other unauthorized activities that may have an adverse impact on water quality are associated with homeless encampments in and around the San Lorenzo River from the Highway 1 bridge to Paradise Park as well as other bridges on the San Lorenzo River. Reports on homelessness in Santa Cruz County indicate that the homeless population has likely increased by about 6 percent since 2019 to an estimated homeless population of 2,299 in 2022 (Santa Cruz County Housing for Health Partnership, 2022). It should be noted that this is a reduction since 2011 when the homeless population was estimated to be 2,771 (Applied Survey, 2017).

The upper portion of this corridor is upstream of the Tait Street Diversion, the downstream limit of the survey area. The wooded riparian area just upstream of the Tait Street Diversion has historically been used as an informal settlement with efforts made by the City to resolve homeless issues with multiple approaches including providing social services. Because there is a lack of sanitary facilities in the vicinity of the encampments, these sites may be a source of human waste. The City has increased patrols in the area, and has continued to negotiate with riparian landowners upstream of the Tait Street Diversion for the right to conduct maintenance and restoration along the river (Chris Berry, personal communication, 2022). Homelessness is a complex issue, and while cleaning up one site does not solve the underlying problem, it is significant that the City has been working to keep riparian areas clean. Encampments in the Pogonip remain an issue and have been addressed with increased patrols; they likely have less of an adverse impact on San Lorenzo River water quality than those along the river because of the greater distance. In November 2020, the County established a Housing for Health Division within the County Human Services Department to collaborate with other partners to create a Santa Cruz County Housing for Health Partnership to reduce homeless households by 25 percent by 2024.

3.13.3 Loch Lomond Reservoir Subwatershed

While the upper Newell Creek watershed is sparsely populated, a number of rural residential parcels have been developed. Formerly almost inaccessible, this area was cited by County resource planners as an area to watch. Old roads have been regraded to provide better access for the few households that have developed. Because of this new increased intensity of use, including year-round use, City staff has seen increased damage from vehicles to roadways in the last several years.

3.13.4 North Coast Watersheds

Previously, County enforcement staff indicated that numerous violations of the grading and erosion control ordinances, sensitive habitat protection ordinance, and timber harvest plans have occurred in the North Coast area. More recently, post-CZU fire, timber salvage and tree removal by PG&E have required enforcement action by CDFW. Sedimentation of Majors Creek has been cited as evidence of a general trend towards erosion and illegal grading and a potential TMDL is discussed further in Section 4.9. Although the general consensus was that violations are widespread throughout the subject watersheds and will continue, legacy logging roads are still considered the primary sediment source.

3.13.5 SLVWD

There has been some evidence of unauthorized activity within the SLVWD including use of trails by motorcycles. There are no regular or recurring inspections of the entire SLVWD lands because much of the watersheds are inaccessible to SLVWD staff, however, the staff do make visits to diversions sights and intakes approximately once per week when intakes are in service and prior to placing an out of service intake into service. Signs are posted throughout the watersheds that notify the public that the streams and surrounding areas are used for public water supply. Signs of vandalism have been rare, and most intakes are accessed by roads that are gated to control access by the public. With the exception of the Fall Creek intake and the Bennett Spring intake, intakes are not fenced but are behind gated roads. A few intakes are only accessed by roads that cross private lands, for which the District has easements in order to cross. Per conversations with SLVWD staff, no signs of dumping or illegal activity have been witnessed by the staff or have been reported to the District.

3.13.6 Significance

Unauthorized activities can be significant sources of sediment from eroding property in the watersheds. Small-scale grading for roads frequently use poor practices which lead to barren, unprotected roads, yards, etc. Finally, homeless encampments can increase the concentration of microbial and particulate contaminants in streams, as well as damage to riparian vegetation and are identified as a source contributing to water quality objective violations in the San Lorenzo River Pathogen TMDL.

3.14 Vehicle Upsets and Spills

Vehicle upsets are potential sources of contamination of hazardous materials into surface waters through the spilling or rupturing and subsequent discharge of the materials being transported. In addition to spilling of any cargo being carried, collisions can release petroleum products from the vehicles themselves. Factors that affect the level of risk for vehicle spills include overall traffic volume, amount of hazardous materials being transported, highway characteristics, and road conditions. There are no prohibitions on the transport of hazardous materials within the study area watershed.

There are two major transportation routes suited for heavy vehicles, both in the San Lorenzo River watershed. State Highway 9 is the major traffic route through the San Lorenzo Valley, while State Highway 17 skirts the eastern edge of the San Lorenzo watershed (see Figure 1-1). There are no major transportation routes in the North Coast watersheds. Empire Grade Road skirts the east boundary – and the west boundary of the San Lorenzo River watershed – but is not as heavily traveled as Highways 9 and 17. The risk for spills is generally present, and historically several spills were noted by City staff including an event that resulted in a fish kill in Brookdale, cars that had entered the creek near Lompico, and the application of fire-fighting foam some of which entered the creek during the previous wildfires. Specific spill events were not noted since 2018.

The Santa Cruz County Hazardous Materials Area Plan was updated in January 2017 and summarizes how local agencies have planned, prepared, and will respond to such an event in Santa Cruz County. The document is an annex to the County Operational Area Plan describing how county resources will be utilized to deal with many different kinds of emergencies affecting the county. Any public safety official on scene can declare a hazardous materials incident, and should immediately call 911. The dispatchers at 911/NetCom (Santa Cruz Consolidated Emergency Communications Center) will route the call to the appropriate local agency. Depending on its size and significance, the incident could be handled by local fire departments, by specialized hazmat teams, or coordinated by an operational area Emergency Operations Center. County staff then preliminarily assess the nature of the contamination, how far it has gone, and whether it has entered a waterway. County staff will then request assistance from the CDFW if a waterway is affected and will directly notify the downstream water user if appropriate. City staff routinely coordinate with County staff, NetCom and relevant first responders to ensure adequate communication regarding these incidents.

3.14.1 San Lorenzo River Watershed

Within the town of Felton, there are three known groundwater contamination plumes which are seeping into the San Lorenzo River. These are the only sites known to be impacting stream water quality. They are under the jurisdiction of the Regional Board.

3.14.1.1 Valeteria Dry Cleaners (6539 Highway 9)

This site was identified when perchloroethylene or tetrachloroethylene (PCE) was detected in the San Lorenzo River in 1985 (0.5 µg/l). Further monitoring tracked the PCE, in 1988, to a spring near this dry cleaner shop which continues to show evidence of PCE in the 2017 Annual Report. The source was determined to be contamination of soils in the dry cleaner's septic system and leach field originating during the 1960s. The owner conducted a remediation that included removal of sludge within the onsite waste disposal system, steam-cleaning the redwood septic tank, and backfilling with sand. The remediation proved insufficient, and the site was re-excavated in 2002 (U.S. EPA, 2002). The leach field was then relocated and contaminated soil was exported. Groundwater monitoring results continue to show elevated PCE and TCE concentrations at a location approximately 20 feet upgradient of the San Lorenzo River, and downstream San Lorenzo River monitoring results also show low PCE concentrations. This suggests that the wastes released at the site have migrated, and may continue migrating downgradient. The responsible party is now required to submit a Corrective Action Plan to evaluate and select remedial alternatives for controlling groundwater contamination plume from further migration and impacting the river and for complete cleanup of the groundwater contaminations (Briggs, 2011). The Felton Diversion, which is about 1 mile downstream of the dry cleaner's, has had historical detections of PCE as high as 1.7 µg/L on November 1, 2011 relative to an at-the-tap maximum contaminant level of 5.0 µg/L but no detections were reported in the 2021 Source Water Quality Monitoring Report. According to the State of California Geotracker web site, this site continues to be open as remediation continues and was awarded funding in 2017 to continue investigation and remediation.

3.14.1.2 Chevron Underground Storage Tank Leak (6325 Highway 9)

A groundwater plume beneath this site caused by a leaking underground storage tank is contaminating a nearby seep to the river. Chevron has installed an interception sump which collects the seepage. In the seep, recent levels of total purgeable hydrocarbons have been measured at 67 to 7,400 µg/L and benzene has been measured at 2 to 1,700 µg/L, which were consistent with historical concentrations (Stantec Consulting Corporation, 2011). During dry weather, this system appears to be effective in intercepting much of the gasoline-contaminated ground water. During long wet periods, however, the effectiveness is limited. Monitoring occurs quarterly. Currently, Chevron is doing bi-weekly free product pump outs and high-vacuum groundwater extractions on a regular basis and is in the process of getting a commingled plume agreement with the Cornerstone property at 6320 Hwy 9, Felton. According to the State of California Geotracker web site, cleanup has been completed and the site has been closed as of 27 December 2021.

3.14.1.3 Sturdy Oil (former Exxon Station) Storage Tank Leak(s) (6225 Graham Hill Road)

The former Exxon Station near the Covered Bridge in Felton reported leaking conditions in 2000. A groundwater cleanup program was initiated, and, following a brief uptick in gasoline and MTBE concentrations in early 2005, this site is now deemed currently in compliance, with ongoing quarterly monitoring. The on site concentrations of MTBE has dissipated over time, due to the high solubility of MTBE in water, to non-detect concentrations. According to the State of California Geotracker web site, cleanup has been completed and the site has been closed as of February 5, 2013.

3.14.2 Other Sites with Potential Plumes

3.14.2.1 Watkins-Johnson Superfund Site (440 Kings Village Road)

Watkins-Johnson operates an extraction and remediation program at its manufacturing facility next to Bean Creek in western Scotts Valley. Watkins-Johnson used a variety of chemicals in the manufacture of industrial furnaces and electronic parts. Past operations resulted in contamination of the underlying Santa Margarita sandstone with methylene chloride, chloroform, and TCE. The plume contributed TCE to Bean Creek. The site is overseen by the EPA and has an ongoing remediation system which consists of several pumping wells and treatment by granular activated carbon adsorption. The treated water is considered contaminant-free and is either recharged to the aquifer through a leach field, re-used onsite as non-process cooling water, or discharged to Bean Creek. In addition to monitoring the treated discharge, Bean Creek is monitored at one upstream and two downstream sites. Contaminants are now non-detectable in Bean Creek. According to the State of California Geotracker web site, this site continues to be open with remediation and monitoring continuing.

3.14.3 Significance

The existing County system is used to report and clean-up traffic accident and other surface spills. Notification of the downstream water user is part of the response process although it is inconsistent and City staff made efforts to improve notification. Remediation occurred at all four groundwater contamination sites and resulted in a lessening of the contaminant levels seeped to the river at three sites, and possibly at the fourth.

3.15 Geologic Hazards

The two main geologic hazards affecting the quality of drinking water in the study area are earthquakes and landslides. These, along with other infrequent or less challenging geologic hazards, are discussed in this section.

3.15.1 Seismic Events

Few areas of the state are as familiar with the effects of an earthquake on public water supply systems as Santa Cruz County. Santa Cruz County purveyors had to repair a substantial number of emergency main breaks and re-sanitize their distribution systems in the days immediately following the 1989 Loma Prieta event. Observed or potential effects on water supply sources include:

Significant changes in the flow of springs — While springflows have been stable in recent years, the yield of Liddell Spring reportedly increased to about 8 to 10 mgd for two months following the October 17, 1989 earthquake and returned to normal, less than 2 mgd, in March 1990. The yield of the nearby quarry spring is reported to have doubled. Many other streams and springs in the region reported similar responses.

Source water quality may change — The mineral quality of most of the northern San Lorenzo tributaries changed noticeably following the 1989 event, and seem to be gradually returning to pre-event conditions. The bacterial pathogen levels of any of the surface sources can potentially change as surface soils and debris are dislodged and enter the stream system. This is particularly a risk with the sources emanating from karstic watersheds. Also, soils and surficial debris can be dislodged by seiches (waves in lakes generated by earthquakes or landslides) and enter Loch Lomond.

Constituent release from reservoir-bottom sediments — While not reported after the 1989 earthquake, other earthquakes could potentially cause the release of gases, pathogens, and oily substances, all of which were observed in Searsville Lake near Palo Alto following the 1906 earthquake (Lawson and others, 1908).

3.15.2 Significance

Seismic events are a significant potential source of contamination and structural damage to existing water supply systems throughout the project area. The ability of treatment plants to anticipate and respond to damage to their own facilities, while also responding to fluctuating water quality and quantity, is a critical factor in the overall management of drinking water in the project area.

3.15.3 Landslides and Other Major Slope Instabilities

Landslides are prevalent throughout the Santa Cruz Mountains, and particularly in the San Lorenzo Valley. Nonetheless, the City and other purveyors have been quite successful in maintaining continuity of service and in avoiding the elevated turbidity and other water quality problems associated with landslides upstream of water intakes. This record reflects, in part, an awareness of the chronic landslide hazard which prevails throughout the subject watershed, and the judgment of senior staff of the purveyors in avoiding water sources which are especially prone to landslides. Large slope instabilities, including landslides, do occur periodically within the subject watersheds, and are expected to keep recurring. Landslides constrain local water systems well beyond concerns over turbidity. Sediment entering the channels limits habitat values that can result in regulatory burdens including need for greater in-stream flow, change in release timing, and other water agency action that can limit water availability in the long-term.

For example, the sandy material which has been entering Bean Creek since the 1960s from the Mount Hermon slide does not appear to elevate turbidities either at the Felton Diversion or at San Lorenzo River Intake at low flows, although the sandy sediment does complicate and add to the cost of diversions and causes other critical environmental damage. The Newell Creek Pipeline, which crosses a landslide at Brackney is slated for rehabilitation as loss of the pipeline could limit use of Loch Lomond water which would result in reliance on lower quality water from Tait Street Diversion. Hence, landslides might be seen as constraining water supplies both when (and just after) they occur as well as during the subsequent period when habitat is impaired downstream – generally the following spring and summer, when water may not be divertible because it is needed to sustain sufficient habitat.

During the past several decades, there have been a number of very large landslides along nearby streams in settings similar to those which prevail near certain intakes. In addition to the Mount Hermon slide, and Bean Creek slides in general, two examples are:

Baldwin Creek — A very large rock fall completely dammed and impounded Baldwin Creek. Based on observations made by project staff in 1968, the rockfall may have occurred during the prior 10 or 20 years. The setting in which this rockfall occurred is very similar geologically to those found near the Majors Creek intake and along Laguna Creek downstream of the intake.

Love Creek Landslide — In January 1982, a landslide occurred in moderately dipping fractured Monterey shales, such as occur upstream of a number of other areas west of Highway 9 between San Lorenzo Valley High School and Boulder Creek.

While no major landslides have occurred in the watershed since the 2018 Sanitary Survey, landslides remain a concern after wildfire events like the CZU fire especially if they are followed by significant winter rainfall events.

3.15.4 Weather-related Events

Occasional major windstorms or snow falls can introduce a very large amount of organic debris to the watersheds upstream of the intakes. For example, a snowstorm during the first week of January 1974 broke off an astounding number of branches, mainly of oaks and other hardwoods, many of which fell directly into the stream system and decomposed in place. Access to intakes was greatly inhibited for a period of several days to a week or longer.

A series of small to moderate landslides occurred during the winter storms of 2017, greatly impacting the watershed lands and facilities of City and SLVWD. The combination of several years of drought followed by extremely wet conditions with many severe storms with heavy rainfall seemed to produce optimum conditions for landslides and slope failures that significantly impacted diversions, pipelines, and treatment facilities. With the region experiencing longer and more intense wildfires, potential for debris slides due to the fires is now a bigger concern for the agencies. For example, a debris flow occurred at SLVWD's Foreman Creek diversion that required almost two weeks to clear to return to service.

3.15.5 Significance

Landslide and slope failures are common occurrences in the Santa Cruz Mountains. The greatest potential impact is at points of diversion and immediately upstream. Major landslides may occur as a result of seismic activity and/or rainfall throughout the subject watersheds and it can be difficult to differentiate weather related impacts from landslides as they often occur in similar time periods. Damage to intakes, pipelines and stream channels in their vicinities may render such facilities inoperable from a period of days to several weeks. In the case of several smaller purveyors, such an occurrence could prevent the delivery of treated surface water to their service areas.

3.16 Wildfires

CalFire is responsible for fire suppression and management in State Responsibility Areas (SRAs) and the Santa Cruz County Fire jurisdiction. Outside of SRAs, local governments typically have jurisdiction, e.g., fire districts in Boulder Creek, Felton, Ben Lomond, Zayante, and Scotts Valley. Since the last watershed survey, there has one been major wildfire, the CZU Lightning Complex Fire (86,509 acres). In August 2020, the CZU Fire burned almost 20 percent of the San Lorenzo River watershed including over 75% of the SLVWD owned watersheds. The fire also burned the headwaters and upper reaches of the North Coast watersheds with the majority of impact to the Laguna watershed and recharge area of the Liddell watershed with some fire activity in the Majors Creek headwaters. The fire resulted in damage to vegetation, structures, vehicles, and infrastructure.

As discussed in the 2013 and 2018 surveys, the CalFire San Mateo-Santa Cruz Unit, RCD for San Mateo County, and Santa Cruz County developed the Community Wildfire Protection Plan (CWPP), a strategic plan identifying risks and hazards associated with wildland fires in the wildland urban interface (WUI) based on input from local stakeholders and the general public and adopted by the Board of Supervisors for both counties (CALFIRE and others, 2021). The plan identifies some critical resources such as Lexington Reservoir but omits Loch Lomond, while identifying the firebreak at Loch Lomond, and makes recommendations aimed at preventing and reducing both infrastructure and ecosystem damage associated with wildland fires. It was updated in 2021.

Fuel reduction projects identified in the CWPP receive priority for federal funds. The funding is made available primarily through the California Fire Safe Council's grant clearinghouse. The Fire Safe Council (FSC) provides resources for local communities to form their own FSC. Since 2008, the Soquel, South Skyline, and Bonny Doon FSCs have formed, each of which has submitted roadside and neighborhood shaded fuel breaks project proposals to the CWPP. In addition, a county-wide FSC was formed in 2017 in order to ensure that prevention services can be provided county-wide. Fire management in the region is primarily done on a small-scale, working with FSCs and landowners on projects to reduce fuels and create defensible space. The City is developing a wildfire resiliency plan for the water infrastructure that includes consideration of vegetation management, facility hardening, access and emergency response. In addition, the City is actively creating/maintaining fuel breaks and coordinating with fire agency's regarding City properties as well as with neighboring property owners.

3.16.1 San Lorenzo River Watershed

The San Lorenzo watershed contains substantial areas of fire-adapted vegetation, reported to burn at historical intervals of typically 40 to 80 years (Hecht and Kittleson, 1998). Several fires occurred in the 1930s and 1940s, with a large fire known as the Sawmill Fire in the 1950s. One other fire of note was the Love Creek fire in 1970. Numerous small fires occur every year, including the Bear Fire near Boulder Creek in October 2017 yet in total, they have not had much impact on reducing total fuel load. The approximately 400-acre Bear Fire is suspected to be a consequence of a lack of code enforcement creating an environment where fire could easily spread in a rural area. City fire was part of mutual aid for the Bear Fire and specifically asked for a fire line to be developed to keep it away from Loch Lomond Reservoir. As experienced in 2020 with the CZU fire, the potential for other large-scale fires with multi-year consequences for water supply remains which could be exacerbated by sudden oak death syndrome as well as vegetation stressed by drought and historic forest management that has resulted in overstocked, second-growth forest stands.

Communities in the San Lorenzo River watershed are impacted by wildfires, which results in incinerated cars, homes, and industrial buildings that contain chemicals, computers, electronics, plastics, paint, and other items that leave behind chemicals and heavy metals. Additionally, the

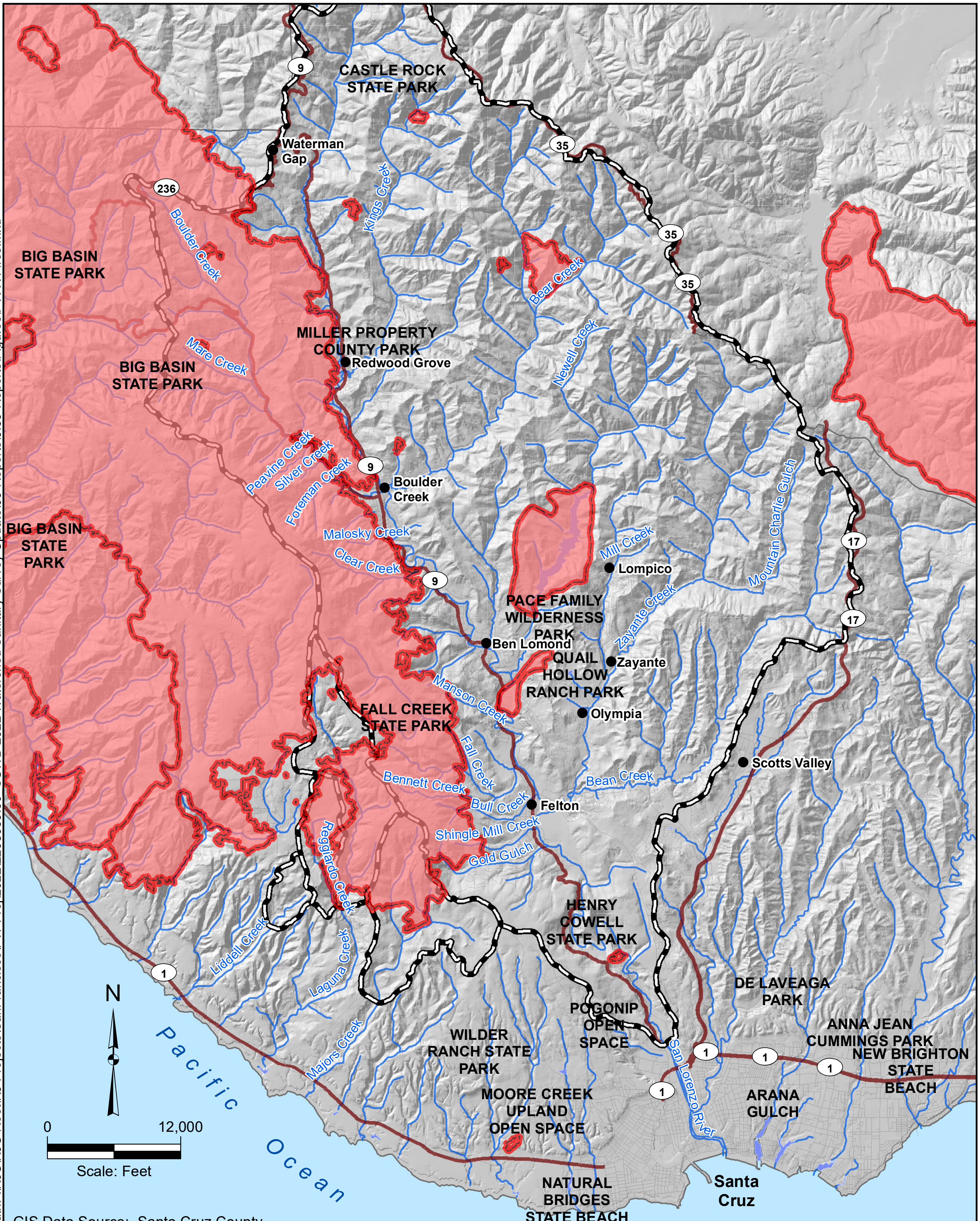
San Lorenzo River watershed has septic systems that, if damaged by fires, may increase the microbial load in the San Lorenzo River. Runoff from burned areas and may contain ash, nitrates, phosphate, chemicals, organic carbon, sediment, metals, and suspended solids that may enter source water during winter storms.

Potential increases in nutrient levels downstream of the City's intake following a fire may also lead to increased algae growth. During the summer, water levels in the San Lorenzo Lagoon have been observed to occasionally back up to the Tait Street Diversion which is currently being evaluated with respect to sea level rise and the need for a lagoon control structure. Thus, algae growth downstream of the Tait Street Diversion should be monitored during the summer and especially following a fire event.

3.16.2 Loch Lomond Reservoir and the Upper Newell Creek watershed

The City has taken several steps to address fire hazards within Loch Lomond and other watersheds that may fill gaps in the CWPP. The City has a draft fire plan for watershed properties and routinely meets with fire chiefs to review maps, keys, gates, and field conditions, ensuring access to City watershed property for fire suppression and minimizing wildfire hazards. Additionally, the Ben Lomond/Lompico fuel break was expanded in 2016 and plans made to improve the Loch Lomond/Love Creek fuel break in 2018. Maintenance of fuel breaks including cutting brush and removing dead trees occurs as needed in the winter; with periodically more intensive fuel management efforts also occurring. (G. Eidam, personal communication, 2022) Most recently, City partnered with local fire agencies to pilot the use of a remote-controlled masticator – which has vastly improved the ability to maintain fuel breaks around Loch Lomond. Additionally, City renewed use of glyphosate on a limited basis to facilitate ladder fuel reduction. Finally, City is currently considering more active forest management relative to fire resiliency and overall restoration goals.

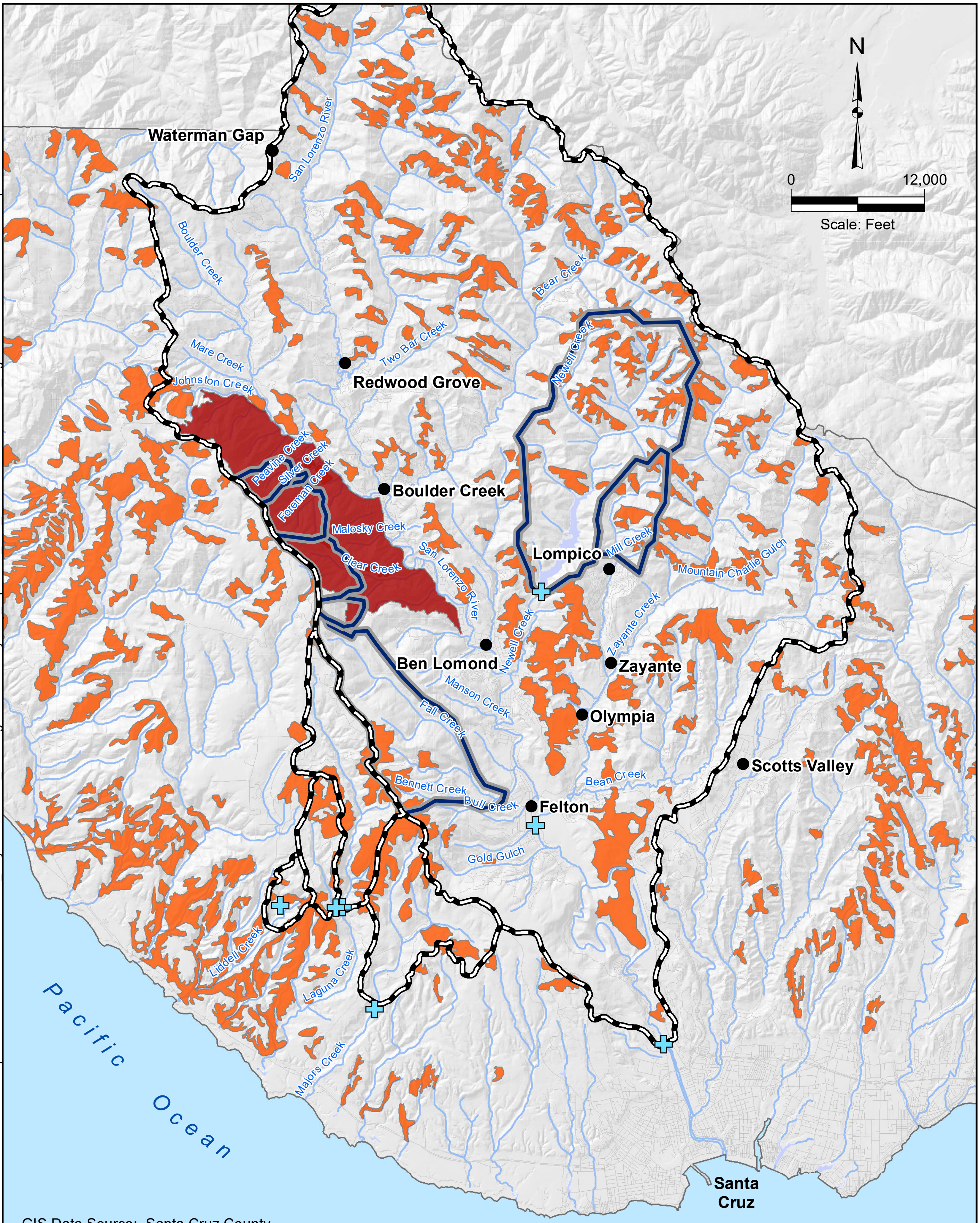
The upper watershed of Newell Creek was not directly impacted by the CZU Lightning Complex fire, however, any large fire event in the vicinity may have significant effects due to ash and smoke particles settling on the reservoir surface and into surrounding soils. These particles may contain nutrients and organic carbon that may contribute to increased algae blooms during the summer months, or flow into Loch Lomond Reservoir during high flow winter storms.



Area Locations
Santa Cruz City Water Supply Watersheds
Lakes
Stream
Streets
Fire Perimeters

Santa Cruz Water Department
WSS Update

Figure 3-4:
Historic Fire Perimeters



Path: \\KJC\KJC-Root\KJ-Projects\SantaClara\11\1188024.00 CityofSantaCruz DrinkingWtrSanSurvey\final report\KJ GIS Files\Events\20121211 Figures\F X-X Fire Haz - 2022 update.mxd

Area Locations
Streets
Stream
Lakes
Sub-Watershed
Santa Cruz Water Department Diversions
Fire Hazard Areas
High Fire Hazard Area
Santa Cruz City Water Supply Watersheds

Santa Cruz Water Department
WSS Update

Figure 3-5: Fire Hazard Areas

3.16.3 North Coast Watersheds

Brushfires in the North Coast watersheds have occurred periodically, both by human sources (i.e., arson, prescribed burns) and lightning fires. The 2008 Martin Fire was predominantly fuel-driven, and March through June rainfall amounts were the lowest ever recorded for the area, about eight percent of normal (Gordon and Ferreira, 2009). Since the fire, the Reggiardo Creek crossing has been completed, a new fuel break in Bonny Doon was completed in cooperation with CalFire in 2016.

The primary potential effects to North Coast watershed sources from the CZU Lightning Complex Fire include runoff from burned areas that contains ash, chemicals, organic carbon, sediment, metals, and suspended solids. These contaminants accumulate on the ground and in soils following fire events, and can get washed into source water during winter storm events. The Majors and Laguna Creek watersheds were particularly vulnerable to runoff from the CZU Lightning Complex Fire, as there were multiple residential structures burned in the Majors Creek watershed, and fire lines were immediately adjacent and upstream of the City's Laguna Creek intake. While there are potential impacts to water quality in Majors and Laguna Creek, given the land use in these areas combined with cleanup efforts by the EPA and land management assistance to private owners by the Santa Cruz County Resource Conservation District, it is not expected that post-fire residential and industrial runoff will be as much a concern as in the Laguna Creek watershed.

3.16.4 SLVWD

The CZU Lightning Complex Fire of 2020 followed major wildfires in 2008, 2009, 2016 and 2017 which resulted in large areas of fire-adapted vegetation that typically would burn every 40-80 years. The CZU Lightning Complex Fire directly impacted over 75% the SLVWD-owned lands including sub-watershed lands of Foreman, Peavine, Sweetwater and Clear Creeks damaging 7.5 miles of raw water supply lines from those creeks as well as other water distribution infrastructure. Private and SCWD-owned watershed lands and residential neighborhoods upstream of SCWD diversions on Majors and Laguna creeks were also impacted. The CZU Lightning Complex Fire resulted in the evacuation of the entire SLVWD service area and resulted in immediate and potential delayed vegetation mortality, hazard trees, and created potential erosion issues upstream of SLVWD and SCWD diversions and infrastructure.

Higher fuel loads along with the impacts of climate change increase the likelihood of catastrophic fire in the future. While the CZU Lightning Complex Fire reduced some of these fuel loads there are still many areas on SLVWD, SCWD, and private watershed lands that are susceptible. The CZU fire also caused canopy loss and decreased competition in the watershed allowing invasive vegetation species to establish in previously undisturbed areas. A lack of native vegetation on hillsides can lead to increased erosion and sediment loads in local waterways. Although water sampling has not found contamination in SLVWD and SCWD water supply, the threat of contamination from burned homes, cars, and other infrastructure exist. The Foreman Creek & Peavine Creek sub-watersheds were particularly vulnerable to runoff after the CZU Lightning Complex Fire, as residential homes lost in the fire were directly upstream of both diversion structures. However, as mentioned in section 3.16.3, cleanup efforts by the EPA and land management assistance to private owners by the Santa Cruz County Resource

Conservation District, in coordination with SLVWD and SCWD, risk of post-fire residential and industrial runoff was significantly decreased.

The SLVWD and SCWD are taking steps to mitigate the impacts of fire on their respective watershed lands, the SCWD district service area, and their source water watersheds as a whole. The District's Watershed Management Plan Part II outlines various objectives aimed at gaining a better understanding of the future threat of wildfire while minimizing impacts from past burns. These objectives include reducing the risk of wildfire, managing fire fuels, reducing the potential of infrastructure fire ignitions, coordinating and monitoring fire management, and reducing the risk of post-fire impacts. The SLVWD is already taking steps to implement these objectives by adopting a Post-fire Recovery, Critical Asset Hardening, Vegetation, and Fuels Management Plan (2021). This plan has led to fuel reduction grants and the SLVWD securing contracted bi-annual vegetation management work in and around critical infrastructure on its lands.

3.16.5 Significance

There are three issues related to fire in the subject watershed.

First and foremost, the absence of wildfire increases the chance of a major event which could seriously alter surface hydrology and sedimentation in any or all subject water supply streams. Elevated levels of turbidity are likely to persist from several months to several years following an extensive fire. Because turbidities persist much longer in reservoirs than in springs or run-of-the-stream diversions, post-fire turbidity persistence may prove to be more challenging for the City, which draws heavily upon Loch Lomond Reservoir during the summer and occasionally during the winter. Experience with major floods or fires has shown that reservoirs of similar size can remain turbid throughout the summer (or two) following an extensive burn or other disruptive event. Wildfires can also result in increased Total Organic Carbon which contribute to disinfection by product issues.

Second, fire suppression activities include creation of temporary roads and firebreaks that can be a source of persistent sedimentation and turbidity if not properly managed following fire events. Following the CZU Fire, the City commissioned the RCD to assist in implementing measures to prevent runoff from burned houses, especially in the karst areas. Recent philosophies with post fire restoration has avoided traditional reseeding of burned slopes and mulching exposed soils because of changes to the vegetation community that result in reduced biodiversity and potential for a more fire prone landscape in the future. Therefore, the use of erosion control techniques is balanced against the potential for significant erosion to occur following a wildfire.

Third, fire retardants can have adverse effects on water quality. Historically, retardants used by Cal Fire have included borate salts and bentonite clay in water. Borate salts are long lasting, but they are also phytotoxic and soil sterilants. Bentonite clay is less persistent. Use then shifted to ammonium-based fire retardants, which as a group accounted for nearly all chemical retardants used to control wildland fires. The retardant now used by CalFire is Phos-Chek, which is a dry powder made of diammonium sulfate and ammonium phosphate that gets mixed with non-potable water at the air attack base (Hollister, San Andreas, or Sonoma) and then dropped by fixed-wing airplanes along ridgelines or other control points to retard the fire from spreading. If the retardant is applied directly to stream surfaces, it may cause fish mortalities (Buhl and

Hamilton, 1998) by depleting oxygen and alter aquatic conditions by elevating phosphorus and causing eutrophication downstream (Camp and others, 1996). However, CalFire avoids drops along water courses. Phos-Check retardant was not used in response to the CZU Lightning Complex Fire in the San Lorenzo River watershed.

Fire suppressant foams applied by fire trucks and helicopters may have adverse impacts on water quality, and are more toxic to aquatic biota than the ammonium-based fire retardants (Gaikowski and others, 1996). Application requires leaving a buffer between the spray zone and live streams. Studies by the US Forest Service have shown that the water quality impacts of these materials vary with three elements: the characteristics of the application (i.e., how much dropped and where), the characteristics of the site (steepness, vegetation types, extent of riparian stream cover), and the characteristics of streamflow (higher, turbulent flows result in better mixing, dilution, and reduced toxicity to aquatic life). In general, adverse water quality impacts decrease as the distance of application from a stream increases. In response to the changing fire climate, there has been an emerging push by companies to sell rooftop and other retardant-based home defense systems. These retardants typically use the same foam to put out fires, with a similar chemical makeup as commercial retardants. The City is actively monitoring these trends and working closely with the County and State to ensure adequate reporting and to keep up with updated regulations to protect source water quality.

The inevitability of a major wildfire has been echoed by state, county, and local natural resource managers. When a major fire does occur, water resources may suffer immediately and significantly as homes, roads and infrastructure are rebuilt. In subsequent years, the water utilities will likely see a decrease in turbidity and sedimentation, as vegetation becomes re-established and reconstruction activity decreases. Hulda McLean, a former County supervisor and owner of Rancho Los Osos in lower Waddell Creek, emphasized the importance of turbidity persistence after the 1948 Pine Mountain fire by noting that it took five years before Waddell Creek ran clear at any time during the winter months – a lesson on the effects of a watershed-scale fire (Hecht and others, 2010).

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Section 4 Watershed Management and Control Practices

4.1 Introduction

This section summarizes existing policies and control measures of the various entities which manage, control or influence land and resource use in the San Lorenzo and North Coast watersheds. The control measures discussed in this section are those watershed management practices that may impact water quality of the San Lorenzo River and its tributaries, as well as the City's water supply on the North Coast.

The following sub-sections, which in large part follow the structure of the AWWA *Watershed Sanitary Survey Guidance Manual*, are included in Section 4:

- Water Utility Management Practices
- Inspection and Surveillance of the Watersheds
- Key County Watershed Management Activities
- Watershed Control Authority
- Open Space Policies
- Erosion Control/Soil Management Policies
- Fire Management
- Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance
- Pertinent State and Federal Legislation

Sub-sections of this chapter continue to evolve with the completion of each survey update but the chapter generally maintains the organization dictated by the AWWA manual referenced above. The details of several sub-sections have not changed since the previous reports and are thus only summarized in the present sanitary survey. Table 4-1 lists the general policies and practices that impact water quality in the project study area and summarizes their effectiveness. Generally, while there appears to be a comprehensive group of regulations, policies, and practices in place that can be used to manage watershed activities, more active input by the City as proposed in Section 6 could improve the effectiveness of these activities, especially in light of legalization of cannabis cultivation activities and associated state and local regulations.

Table 4-1: Updated Summary of Policies and Practices Which Impact Water Quality

Agency/Utility	Primary Watershed Objective	Policies or Controls Which Impact Water Quality	Effectiveness of Policies and Practices
Water Utilities – notably City of Santa Cruz Water Department and San Lorenzo Valley Water District	Protect drinking water supply. Protect water quality of drinking water sources and manage to minimize quality change. Manage to avoid microbiological and chemical contamination. Manage drinking water source areas for environmental quality.	Control or disallow public access to watershed lands. Manage secure intake structures. Implementation and growth of the City Watershed program. Advocacy and environmental review of proposed projects in. source watersheds. Conservation easements or licenses on private lands.	City Watershed program is resulting in the collection of valuable data which are used to plan for more effective lands management. Continued success in working with other agencies/groups on projects which enhance water quality protection measures including the multiagency efforts to improve the river and includes the Riparian Conservation Program to improve stream conditions in the County jurisdiction. Increased patrolling of source facilities is helping to minimize impacts associated with trespassing and illicit land use.
Santa Cruz County (e.g., Parks, Health Services Agency, Planning Department)	General Plan established a regulatory approach to plan future development. Regulate septic systems through LAMP. Protect riparian and wetland systems. Regulate erosion control practices. Regulate small water systems. Regulate cannabis cultivation Provides for open space access.	County General Plan. Ordinances for cannabis cultivation, erosion control, water quality control, riparian corridor/wetlands protection, sensitive habitat Surveillance of parks. Control illegal or mis-implemented grading, development and dumping. Reduce nitrates, pathogens, and sediment in streams. San Lorenzo River Watershed management plan. County Forest Practice Rules. Wastewater/Nitrate management plan.	Cannabis cultivation regulations Grading/erosion control ordinance can be too cumbersome to small homeowners or small projects. Exceptions to ordinances often granted and enforcement is limited. San Lorenzo River Watershed Management Plan was well thought out and presents tangible recommendations for betterment of water quality that could be revisited. Turbidity, nitrate, and pathogen monitoring in support of the 303(d) impairment listing is providing needed data to track trends and responses to implemented projects. Insufficient staffing has been exacerbated by budget cuts.
California Dept. of Forestry and Fire Protection (Cal Fire)	Suppress wildland fires (fire protection division). Control logging (resource management division). Fire preparedness	Prescribed burning to minimize impact of larger fires. Require Timber Harvest Plans for logging of more than 3 acres. Fuel management Monitor and enforce forest practice rules. Coordinate fire-fighting efforts.	Several wildfires have occurred in the area in 2008, 2009, 2017, and 2020 as discussed in Section 3.16. Excessive fuel levels and substantial urban/rural interface area could result in severe wildfire. Harvest Plans are comprehensive, though follow through, especially in critical years after the plan period to confirm that measures are maintained is often not sufficient. Some harvests cause roadway erosion. Timber harvest plan rules provide provisions for water quality protection.
California State Water	Adopt area-wide water quality	Enforcement power to issue	Regional Board is coordinating with County's efforts to reduce

Agency/Utility	Primary Watershed Objective	Policies or Controls Which Impact Water Quality	Effectiveness of Policies and Practices
Resources Control Board and the Regional Water Quality Control Board - Central Coast Region (SWRCB and RWQCB)	control plans (Basin Plans). Control/coordinate water quality issues. Control quality and quantity of discharges from wastewater treatment facilities, stormwater, and construction activities.	permits with specific water quality requirements. Enforcement power of State Water Code. Issue NPDES permits to specific entities for waters-of-the-state discharges. Establish water quality objectives. Impaired Water Body listings and Pathogen, Nitrate and Sediment TMDL for San Lorenzo River. Provide some funding for septic tank system improvements. Administering Phase II NPDES and Construction Stormwater regulations.	nitrates. Approved nitrate TMDL and Sediment TMDL in 2000 and 2003, respectively. Pathogen TMDL approved in 2009 and chlorpyrifos TMDL in 2014. Implementing programs to emphasize watershed protection from both point and non-point discharges. Regional Board was more active in the review of Timber Harvest Plans and attendance pre harvest inspections from a water quality perspective in the years prior to 2007 but activity appears to have declined in recent years. Implementation of Stormwater Management Plan by RWQCB for county and cities under Phase II NPDES permit
California Department of Fish and Wildlife (CDFW)	Protect fish and wildlife. Permit diversions from waterways.	Enforcement power of state code. Limit diversions from waterways. 1600 permits require CEQA review. Fisheries Restoration Grants Program is viable mechanism for drinking water source protection.	CDFW has specific regulations to control water quality that have been applied to homeless encampments along the riparian corridor. CDFW requires issuance of Section 1600 lake and streambed alteration agreement (LSA) or verification that LSA is not needed prior to the Department of Cannabis Cultivation issues an annual permit.;
Caltrans and County Public Works	Construct and maintain primary and secondary roadways. Respond to accidents and landslides. Design of drainage systems and in-stream habitat improvements	Minimize herbicide use. Avoid dumping debris into streams from roads projects. Quick response to chemical spills.	Storage, sidecast, and transfer of roadway debris can lead to increased sediment in streams. Endangered Species Act requirements may improve road practices. Implementing projects which improve in-stream salmonid habitat and riparian habitat in conjunction with roads projects.
National Marine Fisheries Services (NMFS or NOAA Fisheries) under US Department of Commerce	Protection-restoration of special status species (Coho Salmon and Steelhead Trout) in the San Lorenzo and North Coast watersheds.	Implement and enforce the Endangered Species Act (ESA).	City of Santa Cruz issued a final Operations and Maintenance HCP in 2021 for steelhead and coho to address ESA related issues related to operations of the City's water facilities. An Anadromous Salmond HCP is under preparation Sediment reduction which benefits listed salmonids will improve turbidity in raw water. Potential source loss from the North Coast surface sources through ESA compliance will result in a degradation of the City's raw water supply quality and limit production flexibility.

Agency/Utility	Primary Watershed Objective	Policies or Controls Which Impact Water Quality	Effectiveness of Policies and Practices
United States Fish and Wildlife Service (USFWS) under US Department of the Interior	Protection-restoration of special status species (Red-legged Frog, etc.) in the San Lorenzo and North Coast watersheds.	Implement and enforce the Endangered Species Act.	City of Santa Cruz is completed ESA related negotiations as a part of the City's 2021 Operations and Maintenance HCP

4.2 Water Utility Management Practices

The City, the SLVWD, the California Department of State Parks, Santa Cruz County Parks, and some private landowners of camps and timber properties are the largest watershed property managers in the project area as shown on Figure 2-1; however, several of the smaller water purveyors own and/or manage land adjacent to their wells, springs and surface water intakes. Watershed management practices vary for each utility agency. The City, for example, manages its lands to maintain optimal water quality and to limit recreation at the Loch Lomond Reservoir. SLVWD also manages its watershed lands, through administration of their Watershed Management Plan, to maintain optimal water quality, limit access, and minimize potential land disturbances.

4.2.1 Jurisdiction

The jurisdictional area of this sanitary survey is within Santa Cruz County. Within the sanitary survey watersheds, the City of Santa Cruz serves the Pasatiempo area with the majority of the City service area lying downstream of the Tait Street Diversion. The other water utilities participating in the Sanitary Survey are located in the San Lorenzo River watershed and are in unincorporated portions of Santa Cruz County, except for a portion of the middle Bean Creek watershed within the City of Scotts Valley. Most of the City of Scotts Valley drains to the San Lorenzo River via Carbonera Creek and Branciforte Creek, which flow into the San Lorenzo River below the City Tait Street Diversion. This portion of Scotts Valley shares most watershed management issues with the San Lorenzo Valley but was not part of the 2012 Watershed Sanitary Survey.

4.2.2 Watershed and Reservoir Management Practices

4.2.2.1 City of Santa Cruz Water Department

The City owns watershed land in the Newell Creek (2,880 acres), Zayante Creek (880 acres), and Laguna Creek (240 acres) watersheds.

The City has a Watershed Section comprised of the Water Resources Management and Recreation workgroups. The Section is responsible for the drinking water source protection, environmental regulatory compliance with applicable local, State and Federal regulations related to the source water watersheds, recreation area management and general natural resource management work that is an important part of drinking water source protection. While the City of Santa Cruz has a long history of proactive natural resource stewardship, watershed protection became an increasingly important part of the City’s operations in the late 90s with the 1996 amendments to the Safe Drinking Water Act and the Endangered Species Act listings of several local species such as steelhead, coho and the California red-legged frog. Supporting what is primarily a surface water drinking water agency, the Watershed Section not only oversees operations of the City’s nearly 4,000 acres of watershed lands, but also is an active stakeholder in management of the San Lorenzo, Laguna, Liddell and Majors watersheds – which comprise over 150 square miles of northern Santa Cruz County. The Section also occasionally engages in natural resource management planning beyond these limits to the extent that it supports the Department’s mission. The Watershed Section coordinates the activities at Loch Lomond with the Water Resources Management staff focusing on outreach and the Recreation staff assisting with interpretive events, watershed land patrols and watershed/creek sign programs. The City also retains a contract forester who is extensively involved in managing watershed lands.

The City of Santa Cruz has an existing Operations and Maintenance HCP finalized in January 2021 that permits covered activities (including but not limited to maintenance and rehabilitation of water supply and system facilities, operation and maintenance of municipal facilities, and management of City lands) provided that measures are taken for minimizing and mitigating adverse effects on covered species. The HCP lists the Ohlone tiger beetle, Mount Hermon June beetle, tidewater goby, Pacific lamprey, California red-legged frog, western pond turtle, Ben Lomond spineflower, Robust spineflower, Santa Cruz tarplant, and San Francisco popcornflower as covered species. This HCP includes minimum flow standards that have resulted in increased City reliance on Loch Lomond during the dry season and other times of the year when flows are reduced due to drought. City diversions are also currently conducted in alignment with a "Tolling Agreement" between City and the California of Department of Fish and Wildlife. Over the longer term, City diversions will be conducted in alignment with a more complex suite of conservation flows under the Anadromous Salmonid HCP that will result in additional reliance on Loch Lomond and groundwater, and overall increased use of winter water from the San Lorenzo River. This change in City operations will increase supply reliability and enable provision of conservation flows for special-status species in its source watersheds.

In 2012, a recreation area study to expand recreation at Loch Lomond was conducted; however, CalFire indicated that additional recreation is not advised because of the increased risk of fire and the inability to respond quickly. The City has conducted a watershed lands assessment of natural resources in order to make more informed decisions regarding management of watershed lands for water quality and quantity protection and protection of special status species and their habitats. Recreation activities include Loch Walks and Newell Jewell boat tours to increase watershed-related environmental literacy of local stakeholders and park visitors while educational outreach programs are presented to the San Lorenzo Valley, Bonny Doon and City schools. In addition, the City partnered with the Santa Cruz RCD in a program for watershed identification and signage at creek crossings.

The LLRRA is managed for water quality as well as recreational benefits. One of the most significant reservoir practices is management of blue-green algae (cyanobacteria) blooms at Loch Lomond Reservoir through the use of GreenClean a non-copper-based algaecide as discussed in Section 3.7.3. However, under Water Quality Order No. 2013-002-DWQ, General Permit No. CAG990005, the State Water Resources Control Board grants agencies like the City of Santa Cruz an exception for the use of copper-based algaecides, if the need arises. In addition to blue-green algae management which is important to minimizing HAB, wastewater is trucked out of the recreation area, human body contact recreation is not allowed at the reservoir, and no cattle or horses are permitted in the watershed.

4.2.2.2 San Lorenzo Valley Water District

The SLVWD service boundaries encompass 37,120 acres in the San Lorenzo Valley watershed, including a small portion of the Pescadero drainage which is northwest of the San Lorenzo River watershed. Watershed lands owned by the SLVWD include approximately 1,623 acres in one continuous piece on Ben Lomond Mountain, around the tributaries of the San Lorenzo River that supply the SLVWD's surface water (Clear Creek, Sweetwater Creek, Peavine Creek, Foreman Creek, and Silver Creek), and in the Malosky Creek and Harmon Creek drainages. The SLVWD also owns approximately 163 acres in the recharge area of its Olympia wellfield. Marked trails on these watershed areas are used by horse riders. SLVWD now has some deeded riparian lands from nearby private land owners on Lompico Creek that will not be developable and could protect Lompico Creek if it is used as a source in the future. In early 2012, SLVWD initiated a formal agreement with the Santa Cruz Land Trust to provide patrol service. The primary concerns continue to focus on trespassers and off-road vehicles. Public access is limited.

Timber harvesting continues to not be permitted on SLVWD watershed lands. No pesticide/herbicide use is permitted on SLVWD lands.

Watershed Lands Acquisition

The SLVWD purchased the 188-acre Malosky Creek property from Sempervirens Fund in 2006. This property had been on the District's list of most wanted watershed acquisitions for years. The District's 5-mile long pipeline crosses the property. As part of the transaction, the SLVWD agreed to retire the timber rights on the property. The SLVWD has had a no-commercial logging policy on its watershed lands since the 1980s, which is still in effect.

SLVWD acquired the Felton Water System from California-American Water Company in 2008 which also included about 252 acres in the Fall Creek watershed that supply the Felton water system. The 2016 acquisition of LCWD included about 500 acres of Lompico Creek watershed lands.

In addition, as discussed in the Executive Summary, the acquisition of the 8,532 acres of CEMEX lands on the North Coast watersheds by a number of land preservation organization has resulted in the potential for protection of habitat and water quality, particularly for the community of Davenport but, with additional public access, could increase the risk of fire and resulting water quality challenges. Future activities to acquire lands and easements to protect water quality are discussed in Section 6.

4.3 Inspection and Surveillance of the Watersheds

Inspection and surveillance of watershed lands in the project area are performed by numerous agencies, depending on ownership and type of use. For example, State Parks regulations are enforced by Parks staff. County Parks, like Quail Hollow County Park (about 300 acres), are managed by County Parks personnel. The water purveyors themselves conduct surveillance of the purveyor-owned watershed lands. In addition, the City staff has advocated for increased patrols in the areas adjacent to San Lorenzo River with no granted public access. Camping is not permitted in these areas, and patrols are conducted to remove any unauthorized campers, especially during the fire season. The City has also entered into agreements with private landowners in riparian areas to allow patrolling, which has expanded the ability to monitor and control activities on private lands upstream of the City's Tait Street Diversion. Efforts to prioritize limited patrol resources towards water quality remain a challenge. The remainder of the project area not under City, SLVWD, or State parks jurisdiction is regulated by Santa Cruz County and/or state agencies, but does not involve regular monitoring. All monitoring by the County is subject to provisions in the County Code.

Within the Loch Lomond subwatershed, the City has instituted a comprehensive security program that includes installing cameras with motion sensors and infrared capability, with photos downloaded on a regular basis. There are fences and gates installed at the Newell Creek Dam, and a majority of the City's land ownership has limited access. As of 2022, there are 5 full-time Rangers, one of whom lives at Loch Lomond, along with 2 full time Ranger Assistants, and 2 seasonal Ranger Assistants. The Ranger and Ranger Assistants conduct patrols by truck, all-terrain vehicle or on foot with a focus on high use and critical infrastructure areas.

The County of Santa Cruz's Planning Department, Health Services Agency, and Department of Public Works develop and enforce water-quality related county ordinances and provide review of development plans, timber harvest plans, erosion control plans, quarry plans, and maintenance of county roads. The Santa Cruz County Fire Department, CalFire and other local fire agencies participate in the development of fire-related development standards and post-fire restorations efforts, in addition to the review and updating of the countywide Disaster Contingency Plan and Critical Fire Hazard Maps, which is typically handled by the Office of Emergency Services (OES). Inspection and enforcement of codes and regulations is hampered by a lack of resources and prioritization at the local, state and federal level.

4.4 Key County Watershed Management Activities

As previously mentioned, Santa Cruz County developed a comprehensive management plan for the San Lorenzo River watershed in 1979. The San Lorenzo River Watershed Management Plan was updated in 2001 through a collaborative process with the Regional Board, a citizen and landowner group, and other agencies. The ongoing efforts by the County and the completed update to the watershed management plan underscore the continued efforts of the County to implement practices, programs and ordinances which aim to improve water quality in the San Lorenzo River watershed. Pertinent efforts and data from those efforts will be used for the purposes of this report to summarize water quality and watershed management activities in the San Lorenzo River watershed.

4.5 Watershed Control Authority

Policies and control measures adopted by governmental agencies are described in this subsection. All the watersheds in this area are located in Santa Cruz County, and are therefore subject to the policies adopted by the County *General Plan*. Key goals and policies outlined in the *General Plan* are described below.

4.5.1 The County General Plan and the Local Coastal Program

The *1994 Santa Cruz County General Plan* and the *Local Coastal Program (LCP)* is a combined planning document that serves two primary purposes. First, it establishes a regulatory framework against which all proposed development is measured. Second, it serves as a vision statement for the desired future of the county. The *General Plan* was prepared to meet the requirements of both the State Planning Laws and the Coastal Act and some sections have been updated as described below.

The *General Plan* sets up numerous goals, objectives, policies, and programs related to the protection of water resources and sensitive habitats. The County adopted an *ecosystem* approach while drafting ordinances pertinent to water quality concerns. In other words, there is a clear understanding that by preserving and enhancing the natural systems of the county, a secure and safe drinking water supply will most likely be obtained. *General Plan* elements that contain goals most pertinent to the protection of water resources are as follows: Chapter 5 – Conservation and Open Space, Chapter 6 – Public Safety and Noise, and Chapter 7 – Parks Recreation and Public Facilities. The *General Plan* Conservation and Open Space, Public Safety, and Parks and Recreation and Public Facilities elements have not been updated since 1994. The Housing element was updated in 2015, and the Noise, Land Use, and Circulation elements were updated in 2020.

As part of the Sustainability Policy and Regulatory Update of the County's General Plan/ LCP, the County published a draft Environmental Impact Report (EIR) in April 2022. The broad sustainability goals of this update include incorporating a new planning horizon for population, housing, and employment growth; ensuring compatibility with land use and transportation planning principles that support reduction of greenhouse gas emissions, updating County Code permit procedures and so on. The City continues to advocate for more focus on karst protection, riparian incentive programs, and coordination to develop riparian mitigation banks through the County's planning processes.

4.5.2 Wastewater Discharge

Wastewater discharge requirements for point source discharges from wastewater treatment plants or from industrial facility plants directly to receiving streams are established through NPDES permits administered by the Regional Board under the federal Clean Water Act. These NPDES permits control the discharge by establishing numerical effluent limitations for specific constituents and parameters which the treatment plant or industrial facility must meet. The constituents for which effluent limitations are established are specific to the type of discharge. Suspended solids and coliform bacteria may be regulated, depending on the type of plant or facility. Each NPDES permittee collects data which it reports to the Regional Board on a regular basis. This self-monitoring data demonstrates compliance status with the specific effluent limitations.

Wastewater discharges to septic systems are regulated by the County within guidelines established by the Regional Board. Although no changes have been made to the County Sewage Disposal Ordinance, policies have been adopted to provide for tighter oversight and maintenance of alternative technology systems. In addition, a State-revolving fund was historically used to promote the use of such systems through a low-interest loan program. However, while this specific loan program is no longer available, funding for wastewater projects are often available from the State of California.

The SWRCB adopted state-wide Onsite Wastewater Treatment (septic) policy in 2012 and renewed it in 2018, as required under AB 885, detailed in Section 4.9.2.4, will provide some strengthening of local septic regulations, particularly within the area 2,500 ft upstream from a surface water intake. The County currently has about 27,747 active OWTS systems and prepared a LAMP that was accepted by the RWQCB in October 2021; the LAMP is undergoing some revisions related to Point of Sale requirements prior to acceptance by the County. As a result of housing pressures, the City has concerns that the septic systems are not properly inspected and repaired prior to construction of ADUs or use by new owners.

4.5.3 Stormwater Regulations

Municipalities with populations greater than 100,000 and certain classes of industries (including construction sites which involve a land disturbance of more than 1 acre) are regulated under the NPDES Phase I permit program administered by the Regional Board. Municipal permits are specific and individual to the municipality in question, but all contain provisions for management of specific activities (e.g., construction, new development planning, industries, illicit discharges, public agency activities such as street sweeping and public education) and for monitoring. Certain classes of industries are required to file a NOI to comply with the provisions of the State General Industrial Stormwater NPDES Phase I Permit. The industry makes this notification to the SWRCB and, thereafter, is expected to comply with the general permit provisions which focus on pollution prevention and good housekeeping measures. Construction sites with a land disturbance greater than 1 acre must file a NOI with the SWRCB to comply with provisions of the state General Construction Activities Stormwater NPDES (Order No. 2009-0009 DWQ). This permit focuses on sediment control and waste management. The SWRCB maintains a database of industries and construction sites which have filed NOIs.

The County of Santa Cruz and the City of Santa Cruz have each completed and submitted a complete Phase II NPDES application to the Regional Board, and the Regional Board approved the County's 2010 SWMP and the City's 2013 SWMP. The County is currently in the eighth year of a 5-year NPDES permit, and is awaiting renewal of permits by the SWRCB. The County and City both require construction phase and post-construction phase erosion control plans for construction projects encompassing an area of less than 1 acre and for which grading is part of the construction plan. The plans typically must include BMPs which protect against illegal discharge of pollutants to the creeks and streams in the project area. The Phase II regulations provide support for existing County and City ordinances which establish the criteria for protection of water quality and natural resources.

The County adopted its current Stormwater Management Program in 2010 that meets the established requirements of the statewide NPDES Permit and serves as the Stormwater Pollution Prevention Plan for the County and the City of Capitola. Related to the Stormwater Management Program, County Ordinance No. 5117 added Chapter 7.79 Runoff and Pollution Control to the Santa Cruz County Code in 2012. The City completed a Stormwater Management Plan Guidance Document in July 2013 and has included an Ordinance for Stormwater and Urban Runoff Pollution Control as part of the municipal code since 2003 with updates through 2012.

4.5.4 Mines and Quarries

Surface discharges from both active and inactive mines to receiving streams are regulated by the Regional Board under the Waste Discharge Requirement permit program. Permit conditions for discharges from active mines usually allow only inert or non-hazardous waste releases. Mines typically meet these requirements by implementing various best management practices.

Regulation of mine and quarry operations in the watershed study area is covered under the County Mining ordinance. Mineral Resource Areas are designated by the State Geologist and State Mining and Geology Board. The County classifies these areas as within the County Mineral Zone Extraction District (M-3) and requires environmentally sound quarry operations and reclamation practices in accordance with the state SMARA, which emphasizes the primacy of post-reclamation uses and the need to plan and limit mining to be compatible with such uses. Development on M-3 lands is restricted to mining and other compatible uses. Compliance with the California Environmental Quality Act (CEQA) for mining operations is required. Mining operations adjacent to riparian corridors must be conducted in accordance with the Riparian Corridor and Wetlands Protection ordinance. Quarry operations are overseen by the County Planning Department Quarry Coordinator. There have been no changes made to the County Mining Ordinance since completion of the 2018 Sanitary Survey.

4.5.5 Animal Keeping Regulations in Santa Cruz County

The County of Santa Cruz does not currently have a specific ordinance regulating domestic and confined animals in residential and rural areas. General animal keeping and breeding regulations, however, are outlined in the County Code under Chapter 6.10 (Regulation of Animal Breeding). The Article provides regulations for animal enclosures (stables and paddocks), care of animals (animal hospitals and kennels), animal keeping (horses, cows, sheep, etc.) different types of animal raising (family raising, poultry, bird, turkeys, etc.) and biomedical animal treatment standards.

4.5.6 Recreational Activities and Policies

Agencies which administer the recreational and open space areas in the watershed study area include the County Parks Department, the Boulder Creek Recreation and Park Department, the California Department of Parks and Recreation, and the City. Management policies in the City's Loch Lomond Recreation Area were previously described in Section 4.2.2. In addition, the City prepared a draft Parks Master Plan 2030 in September 2017, which was approved in 2020. The Parks Master Plan focuses on recreation opportunities inside the City limits while acknowledging opportunities within the County. One element of the Parks Master Plan is creation of a legal, supervised campground for homeless to deter sleeping in parks and along the San Lorenzo River. Other measures include increasing ranger patrols to help address safety issues, and adding new restrooms to the parks.

Overall, recreational policies and open space policies in the watershed are described in the County's *General Plan*. Since the *General Plan* has not been updated since 1994, recreational policies and open space policies have not changed since completion of the 1996 Sanitary Survey. It should be noted that County Parks Department initiated a Strategic Planning process in 2017.

The County Health Services Agency continues to routinely monitor creek and river swimming areas in the San Lorenzo Valley for fecal coliform bacteria. This monitoring is conducted to obtain information on when to issue advisories avoiding swimming areas, and is part of larger County-wide program. The State parks in the watershed study area are essentially open spaces. The County *General Plan* promotes cooperation with state activities and specifically encourages expansion of state ownership at the Fall Creek and Henry Cowell park units.

4.6 Open Space Policies

The Santa Cruz County *General Plan* goals for open space protection are as follows:

"To retain the scenic wooded, open space and rural character of Santa Cruz County; to provide a natural buffer between communities; to prevent development in naturally hazardous areas; and to protect wildlife habitat and other resources."

Within the project watersheds, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz County. As a result, the area is rural in general character, heavily forested, and visually dominated by open and undeveloped space.

Henry Cowell Redwoods State Park, the Fall Creek unit of Henry Cowell, Castle Rock State Park, and Big Basin Redwood State Park are all managed as public open space. The water purveyors' watershed lands are managed for water resource protection, and to a limited extent, for recreation. Several land trusts, including the Santa Cruz County Land Trust and the Sempervirens Fund own and/or manage open spaces in the project area.

A portion of the University of California Santa Cruz - Upper Campus and the Pogonip Open Space are adjacent to Henry Cowell Redwoods State Park in the San Lorenzo Valley. Several summer camps, conference centers, and retreats operate small water systems and own watershed lands. Private owners hold the remainder of lands in the project area.

4.7 Erosion Control/Soil Management Policies

The County has an Erosion Control Ordinance with the purpose of eliminating and preventing conditions of accelerated erosion that may lead to degradation of water quality, loss of fish habitat, damage to property, loss of topsoil and vegetative cover, disruption of water supply, and increased danger from flooding. The policies in the ordinance that are intended to protect water supply are as follows:

- Streams or drainage courses shall not be obstructed or disturbed except for approved road crossings unless disturbance of a drainage course will improve overall site design and be consistent with the purpose of the ordinance.
- Erosion control measures specified in, or pursuant to, this ordinance, shall be in place and maintained at all times between October 15 and April 15.
- Runoff from activities subject to a building permit, land division permit, or development permit shall be properly controlled to prevent erosion and adequate for runoff from a ten-year storm.
- Prior to issuance of a building permit, development permit or land division permit (or for other types of applications where erosion is expected to occur), an erosion control plan indicating proposed methods for the control of runoff, erosion, and sediment movement shall be submitted and approved

- Land clearing shall be kept to a minimum and vegetation removal shall be limited to that amount necessary for building, access, and construction.

When no land development permit has been issued, the following types of land clearing require an erosion control plan:

- Any amount of clearing in a sensitive habitat.
- One-quarter acre or more of clearing in the Coastal Zone if also in a least disturbed watershed, a water supply watershed, or an area of high erosion hazard.
- One acre or more of clearing in all areas not included in the above items.

When a land development permit has been issued, land clearing may be done in accordance with the approved development plan; however, approval of land clearing requires that “all disturbed surfaces shall be prepared and maintained to control erosion and to establish native or naturalized vegetative growth compatible with the area.”

The Erosion Control Ordinance was updated in 2020 and currently includes project plans that incorporate erosion and sediment control prior to approval and issuance of a building or grading permit for a project. In addition, new stormwater discharge regulations under Phase II of the NPDES permitting system administered by the Regional Board are followed by both the City and the County through administration of various permits, including most notably construction permits. Both entities require erosion control plans covering the construction and post-construction phases of projects that are less than one acre in size. The erosion control plans are developed to protect against illegal discharge of sediment and other contaminants to creeks, streams, and other water bodies. Projects larger than one acre in size are regulated by the SWRCB, while the Region Boards and the local storm water jurisdictions (County or City) that issue development/building, grading and other permits implement sediment and erosion controls on projects less than an acre. Enforcement efforts remain limited by staff availability at all levels.

4.7.1 Roads

Caltrans and the County Department of Public Works are responsible for roadway maintenance on specific corridors. Both agencies have policies to truck roadway debris to designated dump sites. For example, they should not “broad-cast” or “side-cast” debris to the side of any road, especially roads near streams. However, significant winter storms such as occurred in 2017 can generate significant land slide material which can be difficult to move in a timely manner and can pose a water quality risk as a new storm comes into the area. Also, some county roads are owned jointly and shared among residents in rural areas. The County has established numerous roadway associations to tax residents and fund maintenance, culvert design and construction for these roads. This keeps the County in control of the maintenance activities and proper techniques are typically followed to mitigate erosion. Previously, the County used the 2004 “*FishNet 4C Roads Manual: Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance”* published by the Fishery Network of the Central California Coastal Counties as a Road Maintenance Manual which indicates the sensitivity to proper road maintenance activities to minimize water quality impacts.

In addition, when funding has been available, the SCCRCD has historically undertaken a private roads rehabilitation program aimed at identifying those private road segments (after being approached by private landowners or roads associations) which contribute sediment to creeks and streams and further identifying repair schemes for the sediment contributing road segments. RCD developed a Central Coast Private Road Maintenance Guide in 2013 to assist property owners. In addition, the SCCRCD applied for and obtained funding that allowed rural road erosion control projects from around 2008 through 2016. As of 2022, funding for rural roads is not available; however, SCCRCD maintains a web page for their Rural Roads Program with resources for private road owners including onsite technical assistance.

4.8 Fire Management

The *General Plan* fire management objective is "to protect the public from the hazards of fire through citizen awareness, mitigating the risks of fire, responsible fire protection planning, and built-in systems for fire protection and suppression."

The San Lorenzo Valley and North Coast watersheds are within the jurisdiction of Cal Fire, locally headquartered on Highway 9 in Felton. Cal Fire is equipped to suppress wildland fires throughout the project area. Local fire districts take primary responsibility for fighting domestic and commercial fires in their specific areas of jurisdiction. At the county level, the Santa Cruz County Fire Marshall is responsible for the coordination between neighboring fire districts, particularly during first alarm response. The Santa Cruz County Office of Emergency Services provides communication and warning services to area residents and fire districts.

In March 2021, the City prepared an *Opportunities and Constraints Report* for the evaluation of its forest management options. The overall management goals of the report include reducing the potential for catastrophic wildfire and protecting water quality, increasing resilience to climate change, contributing to the City's actions to address the climate crisis as well as providing limited recreational opportunities. The report addresses fire hazard mitigation planning through actions that reduce fuel loading, break up horizontal and vertical continuity of fuels and extend infrastructure to facilitate fire suppression. In addition, the City actively patrols open space areas during the fire season as well as conducting outreach to homeless encampments regarding ignition risk. Finally, the City is working on a Wildfire Resiliency Plan which will also address water supply reliability during a fire.

In 2021 the SLVWD developed the Post-Fire Recovery, Critical Asset Hardening, Vegetation, and Fuels Management Plan (plan) which is intended to address the need for vegetation and fuels management to lessen the presence of unnaturally high fuel loads on District-owned lands and around District-owned assets to reduce the intensity and harmful impacts of wildfires. The plan identifies a suite of recommended projects designed to reduce or maintain the lowered fuel loads, increase fire resiliency, and help reduce wildfire impacts to critical water infrastructure.

Prescribed burning by the California Department of Parks and Recreation at the perimeters of Henry Cowell Redwoods State Park and Big Basin State Park were conducted recently in 2022, to minimize the potential spread of a major conflagration either into or out of the parks. Prescribed burns are also used to promote fire-tolerant native vegetation threatened by invasive non-natives.

In addition, the City recommends maintaining fuel breaks and roads in the watershed, as well as mechanical treatment and hand work as potential fire hazard mitigation options. Maintenance has included the use of herbicides at the ridge top firebreaks as part of an IPM approach to fire preparedness. On a broader planning level, it is recommended that the City and SLVWD increase fire management involvement beyond vegetation management and fire response and into land use planning. Development within the WUI of the City's watersheds should also incorporate appropriate building standards for wildfire resiliency that considers post-fire water quality. If structures are constructed to be more resilient to wildfire, combustion of building materials may result in toxic runoff.

4.9 Other Local, State and Federal Regulations

In addition to the topic-specific watershed management practices, activities, and controls described in previous sections, other surface water quality environmental regulations exist that affect how water purveyors can meet drinking water quality regulations within the San Lorenzo River and North Coast watersheds.

4.9.1 Local Regulations

4.9.1.1 Santa Cruz County Water Quality Control Ordinance [1974]

Santa Cruz County developed a water quality ordinance in 1974 to manage the turbidity level of natural waters in relation to projects which may impact these turbidity levels. Numerical criteria were established in relation to the impact on natural water turbidity levels from the implementation of any project. If the criteria are exceeded due to activity of any permitted project, then the project is deemed to be in violation of the permit. The County criteria are valid unless more stringent permit criteria are established by the California Department of Fish and Wildlife or the Regional Water Quality Control Board.

4.9.1.2 Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance

The purpose of this ordinance Chapter 16.30 is to eliminate or minimize encroachment into the riparian corridors of Santa Cruz County to preserve, protect, and restore riparian corridors. No development activities are allowed within the riparian corridor other than those allowed through the following key exemptions and exceptions:

<u>Exemptions</u>

- The continuance of any pre-existing nonagricultural use, provided such use has not lapsed for a period of one year or more. This includes changes of uses which do not significantly increase the degree of encroachment into or impact on the riparian corridor as determined by the Planning Director.
- The continuance of any pre-existing agricultural use, provided such use has been exercised within the last five years.
- Control or eradication of a pest as defined in Section 5006, Food and Agriculture Code, as required or authorized by the County Agricultural Commissioner.

- Drainage, erosion control, or habitat restoration measure required as a condition of County approval of a permitted project.

Exceptions are granted on a case-by-case basis after a filing with the County and based on findings by the Zoning Administrator that include that there are special circumstances affecting the property; that the exception will not be detrimental to the public or injurious to other downstream properties and is in accordance with ordinance. Conditions may be imposed that include maintenance of a protective vegetated strip between the activity and the water body; installation and maintenance of water breaks, sediment and erosion control including reseeding and other surface treatments and sediment catch basins.

The ordinance has not been updated since the 2018 Sanitary Survey. The Santa Cruz County Fish and Wildlife Commission and NMFS have previously recommended to the Board of Supervisors that the County code regarding protection of riparian corridors be strengthened with new standards for streamside development and with targeted implementation and enforcement in water supply and coho salmon recovery watersheds and to receive periodic updates on environmental compliance topics at their meetings. The County Fish and Wildlife Commission also administers a Public Grants Program to support local conservation organizations to conduct small projects and outreach.

In addition, since 2003, a Stream Care Guide, which is in its third edition as of 2013, has been available by Santa Cruz County Planning Department that provides information for homeowners on maintaining and improving the riparian corridors.

4.9.1.3 Santa Cruz County Sensitive Habitat Protection Ordinance

The purpose of the Sensitive Habitat Protection Ordinance is to minimize the disturbance of biotic communities which are rare or especially valuable because of their special nature or role in an ecosystem. Lakes, wetlands, estuaries, lagoons, streams, rivers, and riparian corridors are among the habitats considered sensitive.

Sensitive habitat policies of interest to this survey include:

- No toxic chemical substance shall be used in such a way as to have deleterious effects on the habitat unless an emergency has been declared, or such use has been deemed necessary by the California Department of Fish and Wildlife to eliminate or reduce a threat to the habitat itself, or a substantial risk to public health will exist if the toxic chemical substance is not used.
- The Agricultural Commissioner, when reviewing an application to use a restricted material, shall consider the potential effects of the material on a sensitive habitat, and mitigation measures shall be required as necessary to protect the habitat. No approval shall be issued if adverse impacts cannot be mitigated.
- A biotic assessment shall be required for all development activities and applications in areas of biotic concern.
- No development activity shall commence until approved, unless such activity has been reviewed concurrently with the review of a development or land division permit.

Any development within any sensitive habitat area shall be subject to the following conditions:

- All development shall mitigate significant environmental impacts.
- Dedication of an open space, conservation easement, or equivalent measure shall be required as necessary to protect the portion of a sensitive habitat which is undisturbed by the proposed activity or to protect a sensitive habitat on an adjacent parcel.
- Restoration of any area which is a degraded sensitive habitat or has caused or is causing the degradation of a sensitive habitat shall be required, provided that any restoration required shall be commensurate with the scale of the proposed development.

No new development shall be allowed adjacent to marshes, streams, and bodies of water if such development would cause adverse impacts on water quality which cannot be mitigated or will not be fully mitigated by the project proponent. Development that has received a riparian exception according to the provision of the Riparian Corridor and Wetlands Protection Ordinance may be exempted from the provisions of this ordinance if the Planning Director has determined that the activity has received a review that is equivalent to the review required by the Sensitive Habitat Protection Ordinance.

Finally, the City and County has been working since 2010 to develop a Karst Protection Zone Policy with a formal request from the City to the County in late 2016. Karst is known to occur in several areas of Santa Cruz County, primarily in Bonny Doon, Felton, and the southeastern end of Ben Lomond Mountain in the vicinity of Pogonip and UCSC as shown on Figure 2-4. Since karst aquifers have unique recharge properties, current regulations designed for non-karst aquifers having fairly regular porosity, transmissivity, and hydraulic conductivity provide inadequate protection. Consideration of karst is included in recent updates to the Septic Ordinance as well as the County’s Sustainability Update that incorporates changes to the County's land use rules and regulations and creation of design guidelines to support sustainable development.

4.9.1.4 Santa Cruz County Cannabis Cultivation Ordinance

Santa Cruz County has adopted a Cannabis cultivation ordinance to provide specific, local regulation resulting from the statewide legalization of cannabis. Implementation of the ordinance in the watershed is discussed in Section 3.4. During the ordinance development, the City provided numerous comments and suggestion to the ordinance including support for requirement of metering and reporting of onsite water sources and/or valid water rights associated with surface water diversion; prohibitions on use of generators, licensing parcels with outstanding code violations, and manufacturing of concentrates on cultivation sites; adding grounds for revocation of licensing; and alignment with state requirements for water resource protection plans and/or adherence to site-specific environmental protection standards (especially with regard to activities in water bodies critical to anadromous fish) including adherence to existing County environmental codes.

4.9.2 California State Regulations

4.9.2.1 California Porter-Cologne Water Quality Act [1969]

The SWCRB and the nine California RWQCB have the authority in California to protect and enhance water quality, both through their designation as the lead agencies in implementing the Section 319 nonpoint source program of the federal Clean Water Act (CWA), and from the state's primary water-pollution control legislation, the Porter-Cologne Water Quality Control Act. The Porter-Cologne Water Quality Act is the state law governing nonpoint-source water quality regulation. The SWRCB has responsibility for the State's water quality and water rights programs. State policies set forth by the SWRCB are administered by nine RWQCB. The Porter-Cologne Act refers to the RWQCB as "principal state agencies with the primary responsibility for the coordination and control of water quality" (Section 13001). The RWQCB are also directed to adopt water quality control plans (Basin Plans) for all regions within the State. Santa Cruz County is within the Central Coast Region, which includes San Luis Obispo, Monterey, Santa Barbara, and San Benito Counties, along with small portions of Santa Clara, San Mateo, Kern and Ventura Counties.

CWA Section 303, discussed in Section 4.9.3 that follows, and the Porter-Cologne Water Quality Control Act establish water quality objectives for all waters in the State. These objectives are implemented locally through Water Quality Control Plans, the NPDES permits for discharges to receiving waters, and waste discharge requirements (WDRs) for discharges to land.

In addition to obtaining WDRs for wastewater treatment plant discharges, individual or NPDES permits must be obtained for stormwater discharges. The NPDES Municipal Stormwater Permit program is divided into Phase 1 regional permits for municipal separate storm sewer systems (MS4's) servicing populations greater than 100,000, and a statewide Phase 2 (Small MS4) program covering populations less than 100,000. Industrial dischargers in specific industries are required to obtain coverage under site-specific NPDES Industrial Stormwater Permits. Construction sites where disturbance to more than 1 acre is proposed must obtain coverage under the NPDES Construction General Permit.

Land management activities that have the potential to affect water quality and are not covered under the NPDES program are regulated by the Regional Boards under the authority of the Porter-Cologne Act. The Regional Board issued a general conditional waiver of WDRs for timber harvest activities that are not subject to individual conditional waivers or WDRs. The conditional waiver was renewed in 2012 under Order No. R3-2012-0008. The general conditional waiver boosts the role of the Regional Board in review of THPs during the Cal Fire approval process and requires notification by timber harvesters once the THP has been approved. In addition, the waiver's Monitoring and Reporting Program results in post-harvest inspections by Regional Board staff. The level of activity of Regional Board staff is limited by budget priorities.

Water quality impacts of cannabis cultivation has also become a focus of the Regional Board as a result of recent Cannabis legalization in California and a permitting process for commercial cannabis cultivators has been in place since about 2018.

4.9.2.2 California Environmental Quality Act (CEQA) [1970]

CEQA was modeled after the National Environmental Policy Act (NEPA) and establishes the state's basic framework for the environmental review of new development projects. CEQA provides the effected agencies and the public with a role in the review of proposed development and sets forth standards of significance when evaluating the potential effects of projects. CEQA requires that potential significant impacts be identified and mitigated

4.9.2.3 California Department of Fish and Wildlife

The California Department of Fish and Wildlife is responsible for the regulation of impacts to wetlands, rivers, and lakes through the mandate of Sections 1601-1603 of State Fish and Wildlife Code. The department is required to review projects with the potential to divert or obstruct natural flows of waters in streambeds and wetlands. Alteration of wetlands, rivers, streams and lakes must be done with the permission of the Department of Fish and Wildlife, which places conditions of approval on the proposed action to mitigate any adverse effects to the habitat to be altered. In addition, Section 5650 of California's Fish and Game Code states that it is unlawful to deposit, dispose of or permit the dumping of solids, liquids, or carcasses into state waters; this code section has been used to mitigate the effects of homeless encampments in riparian areas.

The Department of Fish and Wildlife also regulates the hunting and trapping of wild and feral pigs and geese on public and private lands. The Department of Fish and Wildlife developed a Memorandum of Understanding to control the pig population. The memorandum includes requirements for disposal of pig carcasses, reporting program results, and maintenance of specific records. DFW has also offered to oversee a managed hunt of Canada geese at Loch Lomond should the population there continue to expand.

4.9.2.4 Statewide Onsite Wastewater Treatment Policy Assembly Bill (AB) 885

In 2000, the California Legislature passed AB 885, which requires the State Water Quality Control Board to adopt regulations for the operation of OWTS. The policy took effect in May 2013 and was updated in 2018. Designed to ensure that surface waters and groundwater are not contaminated by septic systems, the policy provides minimum OWTS standards for local agency OWTS management programs and indicates that permits for OWTS in the same drainage as and within 1,200 feet of surface water intake be reviewed by the public water system owner. and the permit application also be provided to the CDDW Drinking Water Program. The policy indicates that these agencies shall have 5 days from receipt of the permit application to provide recommendations and comments to the permitting agency. As described in Section 4.5.2, the County prepared a LAMP that was accepted by the RWQCB in October 2021, and is currently being finalized for local implementation.

Several other key state acts affect the management of pollutants and the potential impacts to water quality that may result from their use:

- Pesticide Contamination Act [1967]
- Forest Practice Act [1973]
- Subdivision Map Act [1974]

- Hazardous Waste Control Act [1982]
- Underground Storage and Hazardous Waste Substances Act [1983]
- Safe Drinking Water and Toxic Enforcement Act [1986]
- Integrated Waste Management Act [1989]

4.9.3 Federal Regulation

Federal provisions pertinent to the sanitary survey are described below. Drinking water regulations are discussed in Section 5.

4.9.3.1 Clean Water Act – NPDES and TMDL

The Federal Water Pollution Control Act of 1972, also known as the CWA, was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." Some concerns exist that enforcement of the CWA could weaken under the 2017 presidential administration. The CWA established the NPDES permit program described above under California regulations; California's typically more stringent regulation may mitigate changes at the federal level.

The CWA also includes Section 303(d), which specifically requires states to identify those water bodies not meeting established water quality goals relative to a pollutant or a suite of pollutants. Once a water body is found to not meet applicable water quality goals, it must be added to the 303(d) list as an impaired water body and a TMDL must be developed for the specified pollutants. 303(d) listing recommendations are made by the Regional Board and approved by the State Board. The San Lorenzo River is 303(d) listed for nutrients (1996), pathogens (1998), sediment (1998), chlordane (2010), chlorpyrifos (2010), PCBs (2010) and fecal coliform (2011), and the Lower Newell Creek is listed for pH (2010). Based on the 303(d) listing for nutrients, pathogens, and sediment in the San Lorenzo River, TMDLs have been adopted for nitrate (2000), pathogens (2009), sediment (2003) and chlorpyrifos (2014); while the *E. Coli* listing was removed in 2019. The sources contributing chlordane, chlorpyrifos and PCBs to the San Lorenzo River and sources contributing pH to Lower Newell Creek have not been identified and adoption of TMDLs for these constituents is not anticipated until 2023 or later.

4.9.3.2 CWA 303d list and Total Mass Daily Loads

Table 4-2 that follows provides a summary of the Total Mass Daily Loads that have been approved or are in process through 303d impaired water body listing for the waterways in the watershed.

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Table 4-2: 303d List/TMDLs Summary Status and Drinking Water Relationship

TMDL	Status of Regulation	Relation to Drinking Water	Impact/Benefit to Water Treatment	Regional Implications
San Lorenzo River Pathogen TMDL	A pathogen TMDL was approved for the San Lorenzo River in May 2009 due to impairment of water contact recreation beneficial use. 2016 303d list added specific pathogens of Enterococcus and *E. Coli* with TMDL target date of 2027, Fecal coliform TMDL was approved 2011	Implementation of the TMDL will improve City's source water quality.	Improved water quality potentially reduces water treatment costs.	Implementation of the TMDL requires the County, City of Santa Cruz, and City of Scotts Valley to potentially invest additional resources in management of wastewater (especially for onsite systems), stormwater, and riparian-area homeless encampments.
San Lorenzo River Sediment TMDL	A sediment TMDL was approved for the San Lorenzo River in May 2003 due to impairment of fish and wildlife beneficial use. RWQCB staff recommend revision of the existing numeric targets to sediment and biological indicators.	Implementation of the TMDL will improve TSS and turbidity, which will improve City's source water quality.	Improved water quality potentially reduces water treatment costs.	Implementation of the TMDL requires the County, City of Santa Cruz, and City of Scotts Valley to invest additional resources in stormwater management improvements especially as they relate to upstream sediment discharge and hydromodification.
San Lorenzo River Nitrate TMDL	A nitrate TMDL was approved for the San Lorenzo River in September 2000 due to potential to adversely affect municipal and domestic water supply beneficial use and water contact and non-contact water recreation beneficial uses.	While nitrate is not violating the drinking water standard for nitrate, implementation of the TMDL will improve City's source water quality. Nitrate can create taste and odor problems through the promotion of biological growth. Biological growth is also a concern as it can lead to higher TOC concentrations and higher potential for DBP formation as well as increased growth downstream that results in a higher upstream regulatory burden for the City with respect to threatened and endangered species.	When taste and odor often associated with algae blooms, were a problem, City had to spend $60,000/year on treatment of the problem. Additional studies would be necessary to assess the connection between nitrate/biological growth and water treatment	There are likely secondary impacts (i.e. biological growth formation at the Lagoon) from nitrate concentrations; therefore, the river is still considered impaired for nitrate. Nitrate levels continue to vary year to year. To decrease nitrate levels will require additional investment in nitrate reduction measures.
San Lorenzo River Chlorpyrifos TMDL	TMDL adopted May 29, 2014 with impairments in San Lorenzo River (below Zayante Creek confluence near Felton), Branciforte and Zayante Creek and Arana Gulch.	Chlorpyrifos, if present, may not be removed by current treatment and may require additional treatment	Chlorpyrifos removal may be accomplished by adsorption onto activated carbon and potentially breakdown with strong oxidants like free chlorine and peroxide.	Chlorpyrifos may be detrimental to aquatic life.
San Lorenzo River 303d listings for Chlordane, Chloride, PCBs, Sodium	Regional Board 2016 303d list revisions include maintaining chlordane and PCBs on list, and addition of chloride and sodium based on sample of SLR at Laurel St downstream of Tait to 303d list; TMDL target date is 2027.	Like chlorpyrifos, chlordane, if present, may not be removed with current treatment and may require additional treatment; Chloride/sodium likely not a raw water issue	Chlordane removal may be accomplished by adsorption onto activated carbon and potentially breakdown with strong oxidants like free chlorine and peroxide.	Chlordane may be detrimental to aquatic life.
Proposed San Lorenzo River 303d Listing for Temperature	Regional Board 2016 response to comments indicated that temperature is a medium priority with a 2023 target TMDL Completion date	Temperatures are already elevated in some locations beyond tolerance for some salmonids, and can contribute to algae blooms	Increased temperature when combined with available nutrients can result in algae blooms with associated increases in TOC and result in DBP formation	Elevated temperatures will be exacerbated as effects of climate change are manifested with longer, hotter, dry seasons.
Proposed Newell Creek (Lower) 303d listing for pH	Regional Board 2016 Fact sheet indicate that a 2027 target TMDL completion date, based on 1971-2006 SC County data (although some elevated pH levels are noted; it is not clear if the data set is sufficient for the listing)	Nominal changes for pH adjustment may be required	Nominal impact	Potential impacts to cold freshwater habitat
Proposed Loch Lomond 303d List for Mercury	Regional Board Decision 51458 indicates that no listing is indicated at this time	Mercury could be associated with sediments that would likely be removed with current treatment	Limited water treatment impact anticipated	Mercury could bioaccumulate in downstream aquatic life

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4.9.3.3 Section 404 Wetland Filling and/or Dredging Permit Program

Section 404 of the CWA regulates the discharge of dredged and fill material into wetlands and water of the United States and establishes a permit program to ensure that such discharge complies with environmental requirements. The 404 permit process is administered by the U.S. Army Corps of Engineers and the U.S. EPA.

The activities regulated by Section 404 include channel construction and maintenance, filling wetlands to create development sites, transportation improvements, and water resource projects. Some activities that may adversely impact wetlands and rivers, such as drainage or groundwater pumping, are often conducted without discharging dredged or fill material and are not regulated under Section 404. The exemptions to Section 404 that are pertinent to the sanitary survey study area include: normal farming, ranching and silvicultural practices; maintenance and emergency repair of levees and bridges; construction or maintenance of farm or stock ponds; construction of temporary sedimentation basins; and construction or maintenance of farm and forest roads, if best management practices are followed.

4.9.3.4 Endangered Species Act Section 7 and Section 10

Compliance with the federal Endangered Species Act is required for all activities that have the potential to impact special status species identified as threatened or endangered and are a significant driver for local water purveyor diversions and maintenance activities. The Act provides for the conservation of species that are threatened or endangered throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Section 7 of the Act requires consultation by any federal regulator with the USFWS and NOAA fisheries prior to the approval of an authorization or permit. Section 10 of the Act allows for consultation to occur between non-federal entities and the federal regulators USFWS and NOAA fisheries without a nexus to a federal authorization or permit.

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Section 5 Water Quality Regulations and Evaluation

5.1 Water Quality Regulations

The U.S. EPA and/or state agencies regulate the water quality of drinking water systems. EPA delegates primary enforcement responsibility for drinking water program implementation and enforcement to the State. In California, the SWRCB, DDW (formerly Department of Public Health) is the primacy agency for drinking water regulations. To maintain primacy, the authority to enforce drinking water regulations, under the Safe Drinking Water Act (SDWA), DDW must adopt drinking water regulations at least as stringent as the Federal regulations and meet other relevant criteria. State drinking water regulations may be more stringent than the federal regulations, but not less stringent.

The City of Santa Cruz 1996 Watershed Sanitary Survey provides a detailed account of the development of water quality regulations in the United States. Subsequent updates to the 1996 Watershed Sanitary Survey in 2001, 2006, 2013, 2018 describe a number of regulations that were the most current at the time those documents were written. These regulations still apply. The paragraphs below provide a brief summary of the main surface water quality regulations. EPA and DDW 2022 regulations were reviewed, and no new regulations have been promulgated.

Table 5-1: Regulatory Schedule

	FEDERAL		STATE	
Rules	**Promulgation Date**	**Compliance Date**	**Promulgation Date**	**Compliance Date**
Revised Total Coliform Rule	February 2013	April 2016	February 2017	July 2021
Federal Groundwater Rule	November 2006	December 2009	April 2011	August 2011
Federal Long Term 2 Enhanced Surface Water Treatment Rule(1)	January 2006	October 2013	February 2013	July 2013
Stage 2 Disinfectants and Disinfection Byproducts Rule(1)	January 2006	October 2012	December 2011	June 2012
Drinking Water Arsenic Rule	January 2001	January 2006		November 2008
Radionuclides Rule	December 2000	December 2003		June 2006
Interim Enhanced Surface Water Treatment Rule	December 1998	January 2002		January 2008
Stage 1 Disinfectants and Disinfection Byproducts Rule	December 1998	January 2004	June 2006	June 2006
Surface Water Treatment Rule	June 1989	December 1990		

(1) Each of these two rules include data collection tasks with “early compliance dates” six months after the publication date for sampling plans, and 24 months after rule promulgation for both data collection and report submission.

5.1.1 Surface Water Treatment Rule

The SWTR was implemented to provide protection against Giardia cysts and pathogenic enteric viruses. The federal SWTR requires that the water treatment process achieve a minimum of 99.9 percent (3-log) removal and/or inactivation of Giardia cysts and 99.99 percent (4-log) removal and/or inactivation of enteric viruses. This must be accomplished through a combination of physical removal and disinfection. The DDW generally requires that the water treatment process provide the minimum removal and/or inactivation requirements for Giardia and viruses in the federal SWTR (99.9 percent [3-log] for Giardia cysts and 99.99 percent [4-log] for viruses).

The Department of Public Health, the agency name prior to becoming DDW, published a guidance document, “Surface Water Treatment Staff Guidance Manual” in May 1991 that summarizes the treatment requirements in the SWTR as adopted by the State in the California Code of Regulations (CCR). Appendix B of the DPH guidance manual establishes guidelines for determining when source waters will require more than the minimum levels of 3-log Giardia and 4-log virus removal. The guidance indicates that treatment can be based on total coliform levels and that for water sources with significant sewage, recreation, or agricultural hazards where median monthly total coliform concentration exceeds 1,000 MPN/100 mL, treatment must provide 4-log Giardia removal and 5-log virus removal.

Based on sampling performed during August 1996 through March 1998, DDW concluded that City should be required to meet the higher level of treatment of 4-log Giardia removal and 5-log virus removal as described in the July 13, 1998 letter to City. This requirement would be in effect at GHWTP until a watershed sanitary survey or continued monitoring could demonstrate that lesser levels of treatment should be required. A report was completed in 2013 documenting additional analysis conducted for the City found in Appendix A of the 2018 WSS Update, and DDW has accepted that the 4-log Giardia removal can be reduced to 3.0-log removal since the GHWTP filters were demonstrated to provide 1-log removal for Giardia through a combination of reducing the inactivation requirement and increasing the removal credits. The 5-log virus removal is not proposed to be changed. If necessary, additional chlorine contact time could be implemented at the risk of increased DBP formation with an associated expense on the order of $25—40 million to comply with BMP limits. Historic high raw water pathogen levels on Lompico Creek resulted in 4-log Giardia and 5-log virus removal requirements; this water source is not currently in use. In addition to further protect public health, significant effort has been made in identifying and managing pathogen sources.

As indicated in previous sections, a pathogen TMDL was established for the San Lorenzo River in 2009 and progress has been made in reduced pathogen levels. However, City recognizes that median monthly total coliform levels still exceed 1,000 MPN/100 mL at times as shown in Section 5.4.1. City is in the process of reviewing source water quality data to evaluate how often the median monthly total coliform level is consistently less than 1,000 MPN/100 mL; this information will enhance City’s Source Selection Procedure as another level of protection. The goal of the Source Selection Procedure is to guide when each of the source waters would be suitable for treatment to ensure that the total coliform MPN would be less than 1,000 MPN/100 mL (for each of the source waters and hence also for the blend). The City should be able to reliably select source water that only require 3-log Giardia and 5-log virus reduction.

5.1.2 Interim Enhanced Surface Water Treatment Rule

The final federal Interim Enhanced Surface Water Treatment Rule (IESWTR) was published in the Federal Register on December 16, 1998 and became effective in January 2002. California adopted the IESWTR in January 2008. The California IESWTR includes several additional monitoring requirements that create a more stringent filtered water performance standard. The IESWTR includes a 2-log *Cryptosporidium* oocyst removal requirement which can be achieved by maintaining filtered water turbidity less than or equal to 0.3 NTU in at least 95 percent of the filtered water samples collected during each month. As discussed in the 2016 filter performance study conducted (found in Appendix A of the 2018 WSS Update), 95^{th} percentile filter turbidity data are consistently less than 0.3 NTU which meets the IESWTR requirements.

5.1.3 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR was published in the Federal Register on January 5, 2006. The draft State LT2ESWTR was last revised on March 22, 2013. The State adopted the LT2ESWTR on July 1, 2013. Prior to State adoption of the LT2ESWTR, DDW was responsible for monitoring water suppliers for compliance with the rule, and the EPA was responsible for enforcement of the rule.

The LT2ESWTR requires that all water supplies collect source water data on Cryptosporidium, and it sets new treatment requirements that include treatment plant performance standards for each water supply based on the relative risk due to presence of Cryptosporidium in the source water.

5.1.4 Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts Rule

In conjunction with the federal IESWTR, the USEPA promulgated another new drinking water regulation on December 16, 1998: the Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 D/DBPR). The State of California adopted the Stage 1 D/DBPR in June 2006. The Stage 1 D/DBPR focuses on controlling production of DBPs, while also meeting disinfection requirements. It revised the THM maximum contaminant level (MCL), created a new MCL for HAA5, and also included MCLs for bromate and chlorite as part of the new regulations. The Total THM (TTHM) MCL was reduced from 0.1 mg/l (100 µg/l) to 0.080 mg/l (80 µg/l). The HAA5 MCL was set at 0.060 mg/l (60 µg/l). The bromate MCL was set at 0.010 mg/l (10 µg/l) and the chlorite MCL was set at 1.0 mg/l. In addition, the Stage 1 DBPR included maximum residual disinfectant levels (MRDLs) for chlorine at 4.0 mg/L (as Cl_2), chloramine at 4.0 mg/L (as Cl_2), and chlorine dioxide at 0.80 mg/L (as ClO_2). For City, D/DBPR1 requires that the system-wide running annual average (RAA) concentration based on the quarterly samples for TTHM be less than 80 µg/L and for HAA5 be less than 60 µg/L.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR) was published in the Federal Register on January 4, 2006. The THM and HAA5 MCLs remain at 80 µg/l and 60 µg/l, respectively, but the new Stage 2 D/DBP Rule differs from the Stage 1 Rule by requiring that each of the locations monitored meet the TTHM and HAA5 concentration limits based on its individual locational RAA. This approach, referred to as the locational running annual average

(LRAA), differs from current requirements, which determine compliance by calculating the running annual average of samples from all monitoring locations across the system. Given City's more stringent Giardia and virus reduction requirements, which are discussed in Section 5.1.1, it may be difficult to meet the LRAA DBP requirements in the Stage 2 D/DBPR. Moreover, the Stage 2 D/DBPR may be even more difficult to meet in the future if the City has to use a source water that is higher in DBP precursors because the other North Coast water sources are not available for environmental reasons; other regulatory forces that affect treatment are summarized in Table 4-2.

The State of California adopted the D/DBPR1 two and one-half years after the rule's compliance date (January 1, 2004), and 8 years after the rule was published in the Federal Register. During this two and one-half year period, the DDW was responsible for monitoring water suppliers for compliance with this rule, and the EPA was responsible for enforcement of the rule. The D/DBPR2 was adopted to be effective in June 2012.

5.1.5 Revised Total Coliform Rule

The Revised Total Coliform Rule (RTCR) was published by US EPA on 13 February 2013 as a revision to the 1989 Total Coliform Rule (TCR). Minor corrections were published on 26 February 2014. All public water systems must comply with the RTCR starting 1 April 2016. The State adopted the RTCR on July 1, 2021.

One of the main provisions of the RTCR is the setting of a treatment technique based on total coliforms and E. coli, and an MCL for *E. coli*. The RTCR also includes requirements for monitoring total coliforms and *E. coli*, provisions for allowing transition from the existing TCR to RTCR, requirements for seasonal systems, requirements for assessments and corrective actions, public notification requirements for violations and specific language to be included in Consumer Confidence Reports should a *E. coli* MCL violation occurs.

5.2 Water Quality Constituents of Concern

EPA, as well as DDW, has developed MCLs for over 100 organic and inorganic compounds, some occurring naturally in water supplies but many occurring as a result of contamination. Major sources of contamination include discharges from manufacturing processes, leaks from storage or disposal containers, and runoff from areas treated with pesticides. Treatment techniques are available for removing these contaminants from water supplies. Protecting source waters from contamination, however, is often more effective than treatment at eliminating contaminants. A list of MCLs for compounds regulated by EPA and DDW is included in Appendix A.

MCLs are developed based upon a number of factors including health risk, analytical detection limits, effectiveness of the best available treatment, and economic considerations. Federal maximum contaminant level goals (MCLG) are set at the level in which no adverse health effects are seen; in many cases, this is zero. In addition, California sets public health goals (PHG), which for carcinogens represents a 1 in 1,000,000 lifetime risk. Both MCLG and PHG are found in Appendix A. The City prepared a 2020 Public Health Goals Report that assessed City water quality relative to the 2019-2021 public health goals which can be found at: https://www.cityofsantacruz.com/home/showpublisheddocument/89495/637901296976770000.

5.2.1 Turbidity

The IESWTR strengthened previous turbidity performance regulatory requirements. The following are current regulatory standards for turbidity, which serve to demonstrate compliance with pathogen log removal requirements.

Individual Filter Effluent (IFE): Facilities are required to conduct continuous turbidity monitoring for each individual filter and submit an exceptions report to DDW if:

- IFE has a turbidity level greater than 1.0 NTU based on two consecutive measurements taken 15 minutes apart
- IFE turbidity is greater than 0.5 NTU at the end of the first 4 hours of filter operation, based on two consecutive measurements taken 15 minutes apart.
- Combined Filter Effluent (CFE): The turbidity level of the filtered water is required to be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month and not to exceed 1.0 NTU at any time. Compliance is based on measurements taken at four-hour intervals.

5.2.2 Disinfection and Disinfection Byproducts

The current Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR) for TTHMs and the HAA5 MCLs are 80 µg/L and 60 µg/L, respectively. The Stage 1 D/DBPR compliance is based on a system-wide RAA. The Stage 2 D/DBPR includes more stringent regulatory requirements for TTHM and HAA5. The Stage 2 D/DBPR requires that each water purveyor perform an Initial Distribution System Evaluation (IDSE) to identify locations in their distribution system that are most vulnerable to DBP formation. The RAA MCLs will remain in effect and an additional limit of 80 µg/L of TTHMs and 60 µg/L of HAA5, based on a (LRAA at sites identified in the IDSE, will be instituted. The IDSE plan prepared by City was submitted by April 1, 2007, and identified monitoring and other actions necessary to comply with the Stage 2 D/DBPR; the monitoring was completed, and the report submitted in July 2009.

The Stage 1 D/DBPR set MCLs for bromate (10 µg/L), and chlorite (1.0 mg/L). The Stage 2 D/DBPR does not change the existing MCLs for these DBPs. Since the water purveyors do not use ozone or chlorine dioxide at their WTPs, these two MCLs should not impact treatment operations. DBPs are of concern primarily in the distribution system but DBP precursors, discussed below, are related to source water quality.

5.2.3 Total Organic Carbon (TOC)

The Stage 1 D/DBPR requires applicable systems that use conventional filtration treatment to remove a certain target level of TOC (DBP precursor) by enhanced coagulation. The required removal level is based on Source Water alkalinity and TOC concentration.

There has been no further significant regulatory change associated with this constituent since 2010. While there have been no water treatment regulatory changes, other surface water quality regulations discussed in Section 4 may have the potential to restrict City to source water with higher concentrations of TOC, which may require changes to City operations.

5.2.4 Perchlorate

Perchlorate is a regulated contaminant of concern with a respective, enforceable, MCL of 0.006 mg/L in the state of California. As of July 1, 2021, the perchlorate DLR is 0.002 mg/L.

5.2.5 Arsenic Rule

The final federal Arsenic Rule, published by EPA on January 22, 2001, established the MCL for this constituent at 0.010 mg/L (10 µg/L). The Rule was to become effective on March 23, 2001, 60 days after publication. The rule established that the revised MCL for arsenic is 0.010 mg/l (10 ug/l) and became enforceable on January 23, 2006.

The State of California completed drafting the Revised Drinking Water Standard for Arsenic, which became effective on November 28, 2008, and officially adopted an MCL equivalent to the EPA standard of 0.010 mg/l.

5.2.6 Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

Since 2018, there has been a high focus on regulation of PFAS chemicals, primarily in groundwater, such as new monitoring requirements for PFAS as of July 31, 2019, updated notification levels for PFOA and PFOS on August 22, 2019, and updated response levels for PFOA and PFOS on February 6, 2020. In addition, a notification level was issued for PFBS on March 5, 2021, and a notification level for PFHxS was added on October 31, 2022.

5.3 Groundwater Regulations

Although these regulations do not apply to the surface water sources directly within the City's control, they may be applicable to well sources within the Santa Cruz system (e.g., Beltz wells) and SLVWD's Manana Woods wells and are thus included here for completeness.

5.3.1 Radionuclides Rule

The Federal Radionuclides Rule was promulgated on December 7, 2000 and the MCLs published therein became effective in December 2003. Additionally, by the end of 2007, four quarters of initial monitoring are required for each entry point to the distribution system of agencies treating groundwater. The state Radionuclide Drinking Water Regulations became effective June 11, 2006.

5.3.2 Groundwater Rule

On August 9, 2000, EPA proposed a rule specifying the appropriate use of disinfection in groundwater and addresses other components of groundwater systems to assure the protection of public health. The Groundwater Rule (GWR) establishes multiple barriers to protect against bacteria and viruses in drinking water obtained groundwater sources and will establish a targeted strategy to identify groundwater systems at high risk for fecal contamination. The GWR provides four elements that target risks to the system. The rule requires regular sanitary surveys, source water monitoring when a positive sample occurs its TCR monitoring, corrective actions upon evidence of fecal contamination, and compliance monitoring.

The California Groundwater Rule became effective on August 18, 2011.

5.3.3 Groundwater Replenishment using Recycled Water

The federal government does not regulate the use of recycled water, and leaves regulation up to the state. The California Groundwater Replenishment using Recycled Water Rule was promulgated and adopted in 2014 and establishes requirements for Groundwater Replenishment Reuse Projects (GRRPs), which are projects that involve the use of recycled water for the replenishment of a groundwater basin for use as a source of water supply. Requirements include sampling of the aquifer prior to operation of the GRRP, retention of recycled water prior to recharge, maps of the GRRP and area of effects, a hydrogeological assessment of the GRRP's setting, and a plan to mitigate the potential effects of contamination on water supply due to the GRRP. Permits to operate a GRRP must be approved by both the DDW and the Regional Board.

5.4 Water Quality Evaluation

The following subsections summarize the key water quality concerns in the San Lorenzo River and North Coast watersheds based on review of data available from City databases. Generally, the discussion focuses on microbiological parameters, turbidity and sediment, and nitrates. Other parameters discussed are odors, organic contamination and general mineral and metals content.

A major reason for emphasizing total coliform, turbidity, and nitrate is because of the findings from previous studies and field surveys and because the San Lorenzo River is listed as impaired for each of these parameters, with TMDLs already being implemented (pathogens, sediment, and nitrate). Coliform bacteria are the primary microbial group measured to determine the health of a drinking water supply. Total coliform bacteria are considered a good general indicator of contamination but do not indicate specific contamination sources. The turbidity parameter is used commonly in drinking water treatment to quantify water quality, primarily because it is easily measured and provides virtually instantaneous results. Also, high turbidity has been correlated with high protozoa (and bacteria) concentrations in some waters. Nitrate has been a targeted parameter in the subject watersheds, mostly because of the predominance of septic tanks as the domestic wastewater treatment technique, especially from systems located on or near highly permeable soils. Elevated nitrate levels promote algal growth which, upon decay, produces taste and odor compounds that increase water treatment costs. Nitrate-rich water also favors growth of cyanobacteria, some of which produce harmful toxins.

5.4.1 Coliform Bacteria

Coliform bacteria data are evaluated in this subsection. The City water department analyzes San Lorenzo River source water weekly, with other surface water sources sampled 2 to 3 times per month and groundwater sources sampled once a month when in use. In addition, the City wastewater department monitors fecal indicator bacteria, from stormwater sources in the City, at several locations on the San Lorenzo River on a weekly basis. This monitoring will sunset in 2023 and stormwater best management practices are currently being explored. SLVWD samples raw water monthly. Each sample is analyzed for total coliform and *E. coli* data, but City does not measure fecal coliform, a subset of total coliform bacteria, also known as thermotolerant coliforms but uses *E. coli*, enterococci, and microbial source tracking for indicators of mammalian waste. The County has measured, among other microbiological parameters, total and fecal coliform bacteria, but discontinued fecal coliform in favor of *E. coli*.

Drinking water and sanitary microbiological experience has established the presence or absence of coliform bacteria as an indicator of the sanitary quality of drinking water supplies. The significance of coliform tests and the interpretation of results are well authenticated and have been used as a basis for standards of bacteriological quality of water supplies (Standard Methods for the Examination of Water and Wastewater, 22nd Edition).

Most drinking water purveyors determine the most probable number (MPN) of total coliform and *E. coli* bacteria present in the drinking water sources of supply. All purveyors are also required to determine the presence or absence of total coliform and fecal coliform bacteria in the distribution system.

Total coliform bacteria are a relatively broad group, which includes species that can live for extended periods outside a host body. These sometimes-termed “environmental” coliform bacteria are present in waters exposed to urban development and wildlife activities. Drinking water utilities are required to resample the distribution system in areas where detectable total coliforms are found and eliminate any fecal coliform in the distribution system, as described in the water quality regulation portion of this section. The presence of fecal coliform in the distribution systems can indicate contamination or an improper disinfection process at the treatment works.

Thermotolerant (formerly fecal) coliform bacteria can be present in the gut and feces of warm-blooded animals, soil, and organically enriched waters and are detected in the laboratory by the characteristic of fermenting lactose to produce gas at 44.5˚C. This differentiation yields valuable information concerning the possible source of pollution in water sources.

The fecal coliform to fecal streptococci (FC:FS) ratio has been used to determine if the contamination source originated from human wastes. A ratio greater than 4 was considered indicative of human contamination. Conversely, a ratio less than 0.7 suggested the contamination was non-human related and most likely livestock, poultry, or wildlife. This tool has been questioned of late because of variable survival rates among the fecal streptococcus species, and some researchers do not recommend the use of the FC:FS ratio to evaluate bacteria origin.

Current efforts to differentiate sources of bacterial contamination focus on use of QCPR (quantitative polymerase chain reaction) analysis. The County of Santa Cruz previously used ribotyping, a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli*, to assess the source and causes of elevated bacteria levels at local beaches (Ricker and Peters, 2006). Overall, of 1200 bacterial isolates tested between 2002 and 2004, only 15 percent could not be attributed to a particular source. Study results relevant to this sanitary survey update include findings that: contamination by birds was a dominant source of bacteria in both upstream and urban (lower River) locations; cracks in storm drains and sewer pipes, as observed by videography, could facilitate cross-contamination; storm drains and sumps appear to promote incubation and multiplication of bacteria; bacteria loadings from human, pet and livestock wastes, while significant, are much lower than avian loadings; and human contributions in the San Lorenzo River were much higher in wet weather, when runoff scours storm drains and mobilizes waste from developed areas, encampments and the occasional failing septic system as well as exacerbating high groundwater levels that can come into septic leach lines. *E.coli*, cryptosporidium and giardia are discussed in Section 5.4.6.14.

5.4.1.1 City Surface Water Sources

As discussed in Section 4 earlier, on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region, where fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL (for the San Lorenzo River and Estuary, Branciforte Creek, Camp Evers Creek, Carbonera Creek and Lompico Creek). As noted earlier, the City Water Department does not measure fecal coliform, while the City Wastewater Department monitors fecal indicator bacteria..

The results of an analysis of total coliform data for City's San Lorenzo River and North Coast sources are presented on Figures 5-1 and 5-2. Figure 5-1 shows the annual geometric mean of total coliform since calendar year 2017 for City's San Lorenzo River sources (Loch Lomond, Felton Diversion, and Tait Street Diversion).[15] Average values along the San Lorenzo River (Tait Street and Felton Diversions) are greater than 1,000 MPN/100 mL, and slightly increase over time. Values from Loch Lomond are less than 1,000 MPN/100 mL but seem to be fluctuating since 2017. These values suggest that the type of water year can influence total coliform in Loch Lomond, where drier years or years following a dry year have lower values, and very wet years, like 2017, have higher values, potentially as a result of pumping water from the San Lorenzo River at the Felton Diversion into Loch Lomond.

Figure 5-2 shows the annual geometric mean of total coliform since calendar year 2017 for City's North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). Values for North Coast sources are generally lower than the Felton Diversion or Tait Street Diversion sources, with Laguna Creek and Liddell Spring almost one and two orders of magnitude lower, respectively. The plotted averages for Laguna Creek and Majors Creek during Calendar Year 2021 were unexpectedly high, though these stations were out of service/not in use during Water Year 2021, so the data for these locations are skewed towards wet weather trends (end of Calendar Year 2021). The City prefers the use of the North Coast sources, when available, because of the lower coliform levels and therefore higher source water quality. However, as discussed earlier, other regulations related to fisheries recovery restrict access to North Coast water sources.

5.4.1.2 SLVWD Surface Water Sources

The Annual Geometric Mean of Total Coliform for sources from the SLVWD is graphically represented on Figure 5-3. The data presented is from 2017 to 2021. In 2013, SLVWD modified their coliform analytical method to be one that reports in Colony Forming Units (CFUs) which reports a definitive number, while MPN reports the probability of occurrence. Results seem to be rather consistent from year to year, however the 2021 calendar year results are elevated in Foreman Creek and Fall Creek which is being investigated. The annual geometric mean was calculated from monthly data collected over the separate calendar years. Periods where data

[15] A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which is helpful since levels may vary anywhere from 10 to 10,000 over a given period.

were unavailable or simply labeled as “Present” or “Absent” were left out of the geometric mean calculations. The following raw water sources were included in the graph: Bennett Springs, Bull Springs-1, Bull Springs-2, Clear Creek, Fall Creek, Foreman Creek, Peavine Creek, and Sweetwater Creek.

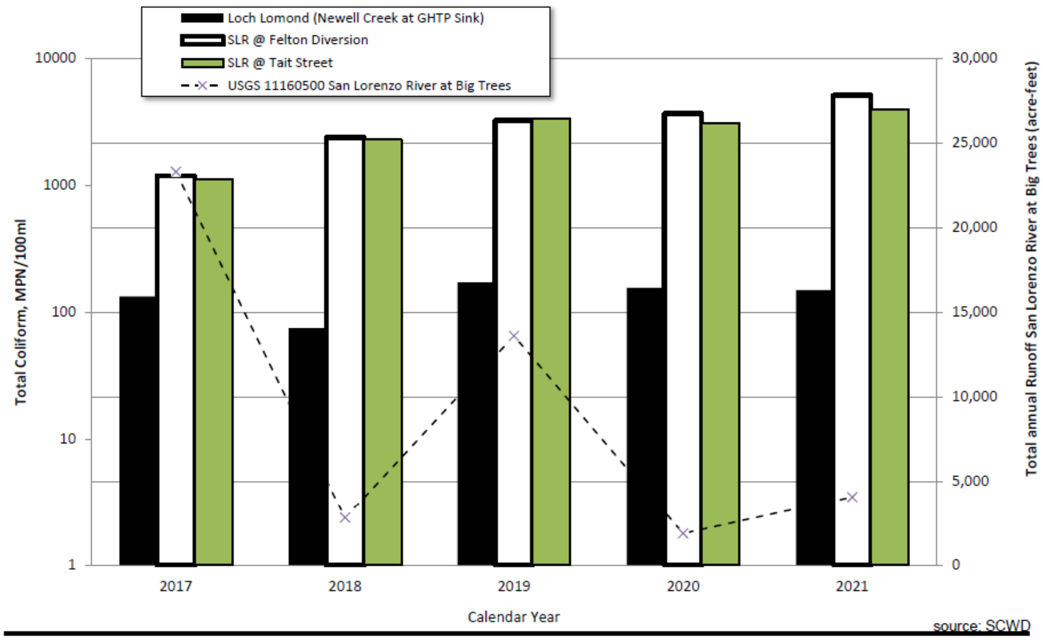


Figure 5-1 **Annual geometric mean of total coliform in the SCWD's San Lorenzo River Sources, 2017-2021**
SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions.

Figure 5-1: Annual Geometric Mean of Total Coliform in the City's San Lorenzo River Sources, 2017-2021

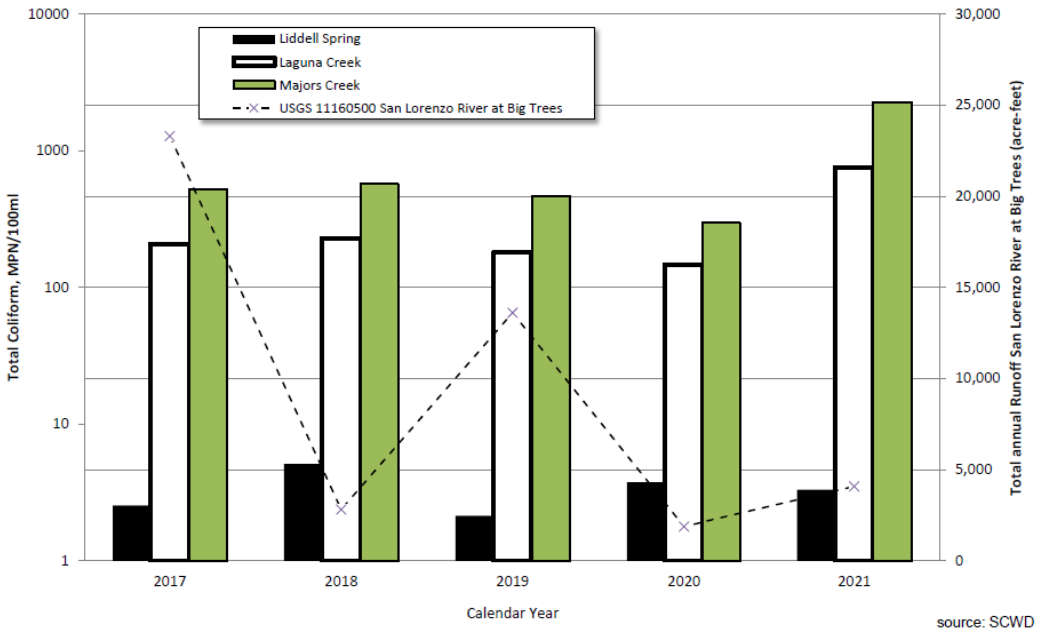


Figure 5-2 **Annual geometric mean of total coliform in the SCWD's North Coast Sources 2017-2021**
SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions.

Figure 5-2: Annual Geometric Mean of Total Coliform in the City's North Coast Sources, 2017-2021

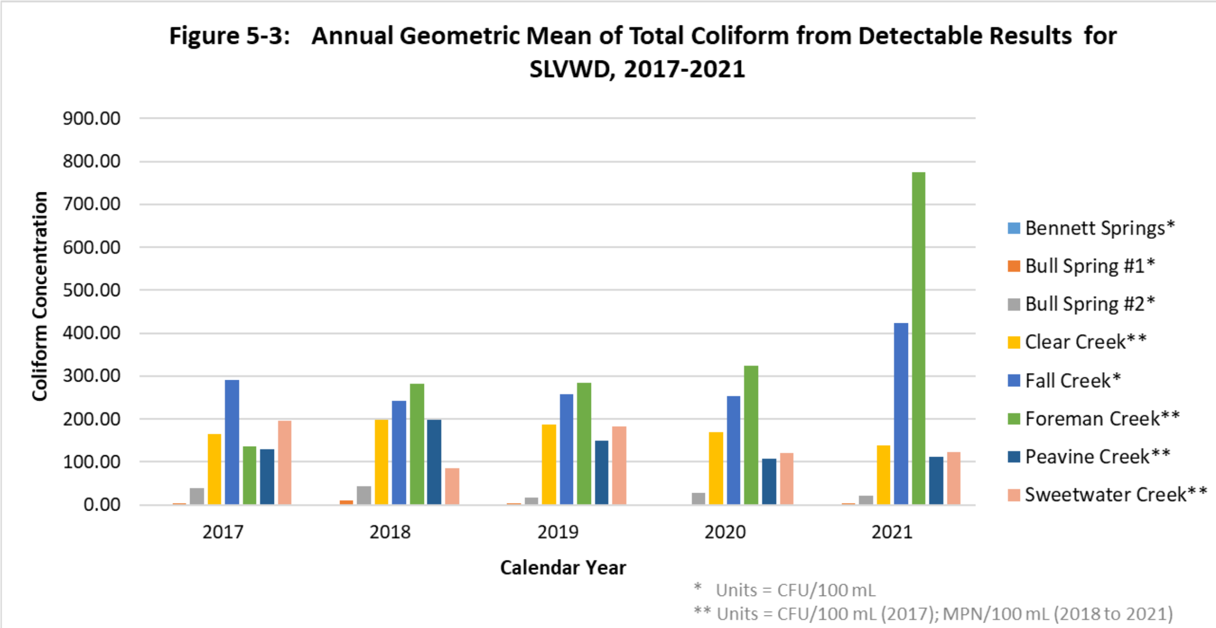


Figure 5-3: Annual Geometric Mean of Total Coliform from Detectable Results for SLVWD, 2017-2021

5.4.2 Turbidity

Disruption of the river and creek beds, small to large landslides, and runoff from barren earth areas tend to extend high turbidity events, especially in high rainfall/runoff years. These events are common occurrences in California caused by the geology, topography, and climate. Many of the water utilities experience treatment problems during the initial few days of high stormwater runoff periods. It is often useful to distinguish ‘persistent turbidity’ as a set of issues with different causes and likely responses. The definition of persistent turbidity as accepted by the County for quarry facilities is turbidity which precludes diversions for more than about 3 days for smaller streams, and up to 5 days for the San Lorenzo River after a significant storm. In Liddell Spring, according to the 1964 County-CEMEX contract, persistent turbidity increases in turbidity over the baseline which exceed 2 units for 48 hours following the storm event. Usually, persistent turbidity occurs in streams receiving a continuing supply of fine-grained sediment from banks, tributaries, or cut slopes. The continuing sediment supply often can be traced to a particular disturbance, such as a landslide, poorly executed timber harvest, road failure, or large wildfire. In addition, review of long-term turbidity data during active quarry operations at Bonny Doon in the Liddell Springs watershed indicated blast-related turbidity spikes have ceased since closure of the quarry in 2009.

Because high turbidity has correlated with increased protozoa concentrations in some surface waters, it is prudent to have some contingency treatment plan during the initial “flush” of the wet year. Avoiding highly turbid water and relying on alternative sources in the short-term seems to be good, well-practiced policy and is implemented in the City’s Source Selection Policy to the greatest extent possible.

Streams which experience extensive disturbances (such as might be caused by a major landslide or fire) are often 10 to 100 times as turbid as baseline, or best-case conditions, at least for the first year or two following the event. The same streams, which take longer to clear after a storm, are usually also affected by excess turbidity persisting into late spring or early summer. These include creeks downstream from large impoundments which can continue to be turbid for a year or longer.

As summarized earlier in Section 4, on May 16, 2003, the RWQCB Central Coast Region adopted a TMDL for sediment for the San Lorenzo River, Carbonera Creek, Lompico Creek and Shingle Mill Creek and incorporated the TMDL and associated Implementation Plan into the Basin Plan. The RWCQB documented various actions implemented by the City, County, and RCD to reduce sediment loading over the past decade, namely reducing the risk of culvert failure and road erosion (Rose, 2011).

The City has previously completed culvert removals/improvements in the Newell Creek watershed while the County has completed similar improvements eight projects in the San Lorenzo River watershed; these improvements, if maintained, should provide sediment reduction that will moderate turbidity peaks.

Parke and others (2010) monitored streamflow and suspended-sediment in water year 2009 and 2010 and used sequential rating-curve analysis[16] to compare sediment–transport rates over the past three decades for Zayante Creek, the San Lorenzo River, and Soquel Creek. A substantial decrease in transport at a given flow can be seen in each case, although lumping all the 1970s and 1980s data probably d[17] With possible load reductions between 464 and 106 percent, it is important to note that these differences are large relative to the 24- to 27-percent reductions sought as part of the San Lorenzo Sediment TMDL staff report. This may be extremely challenging as winters with significant rainfall, such as occurred in 2017, can trigger landslides throughout the County which are associated with large sediment loads.

To demonstrate progress towards achieving load-based allocations and beneficial use protection, RWQCB staff recommended revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst et al. (2011) (Rose, 2011) although no action has been taken as of 2022.

5.4.2.1 City Surface Water Sources

City currently has some capability to use different water sources if turbidity increases for one or more of the sources for reasons other than rainfall (e.g., landslides) and is also making treatment improvements to allow treatment of higher turbidity sources as described in Section 2.8.3.1. This source water and treatment flexibility can be helpful to meet fish flow requirements, particularly in the North Coast sources. During heavy rain events, however, all surface sources are often not used due to elevated turbidity, leaving Loch Lomond Reservoir and Liddell Spring as the only sources with which to meet customer demands. During moderate events, Liddell and Laguna can be available for use. T

Figure 5-4 and Figure 5-5 show the turbidity measurements from January 2017 to December 2021 for the San Lorenzo River and North Coast sources, respectively. There is no apparent overall increasing or decreasing trend over the entire period and variations appear to be storm-related, as expected. Majors Creek was offline from mid-2020 through all of 2021 and therefore there is no data.

Figures 5-6 and 5-7 show similar data as above but is a 10-sample running average to clarify the trends over the past 5 years. Generally, Loch Lomond shows relatively lower storm-related increases in turbidity than the other sources. All other sources, except Majors Creek (lack of data) and Laguna Creek, show relatively higher storm-related increases in turbidity in normal and wet years as compared with dry years, e.g., 2017 vs 2021. The North Coast sources experience significantly less turbidity than the San Lorenzo River sources. Overall, these North Coast sources provide consistent low turbidity, treatable water.

[16] An increase in sediment transport at a given flow generally means that more sediment is readily available on the bed for transport, and (generally) that habitat conditions have deteriorated; conversely, less transport at a given flow is usually associated with improvements in bed conditions and in the relative success of erosion-control efforts.
[17] Episodic events do increase sediment yields and do temporarily move sediment-rating curves ‘upward’, or to the left (Hecht, 2007), sometimes substantially.

5.4.2.2 SLVWD Surface Water Sources

Table 5-2 below, shows the turbidity results taken from eight raw surface water sources within SLVWD, from 2017 to 2021. Most of the data was sampled in the month of March.

Table 5-2: Turbidity Results for SLVWD (Unit: NTU)

Year	Bennett Spring	Bull Spring #1	Bull Spring #2	Clear Creek	Fall Creek	Foreman Creek	Peavine Creek	Sweetwater Creek	Lompico Creek
2017	0.28	0.31	1.1	3.2	4.7	< 0.10	1.1	5	NR
2018	0.31	0.38	0.68	N/A	0.61	N/A	N/A	N/A	NR
2019	0.25	0.35	0.4	0.4	1.3	0.3	0.5	0.9	NR
2020	0.4	0.7	0.4	0.1	2.125	3.92	0.4	0.45	NR
2021	0.15	< 0.10	0.1	0.4	0.7	0.875	0.3	0.45	NR

Source[1]: SLVWD
Note: NR = Not Recorded; N/A = Data not available

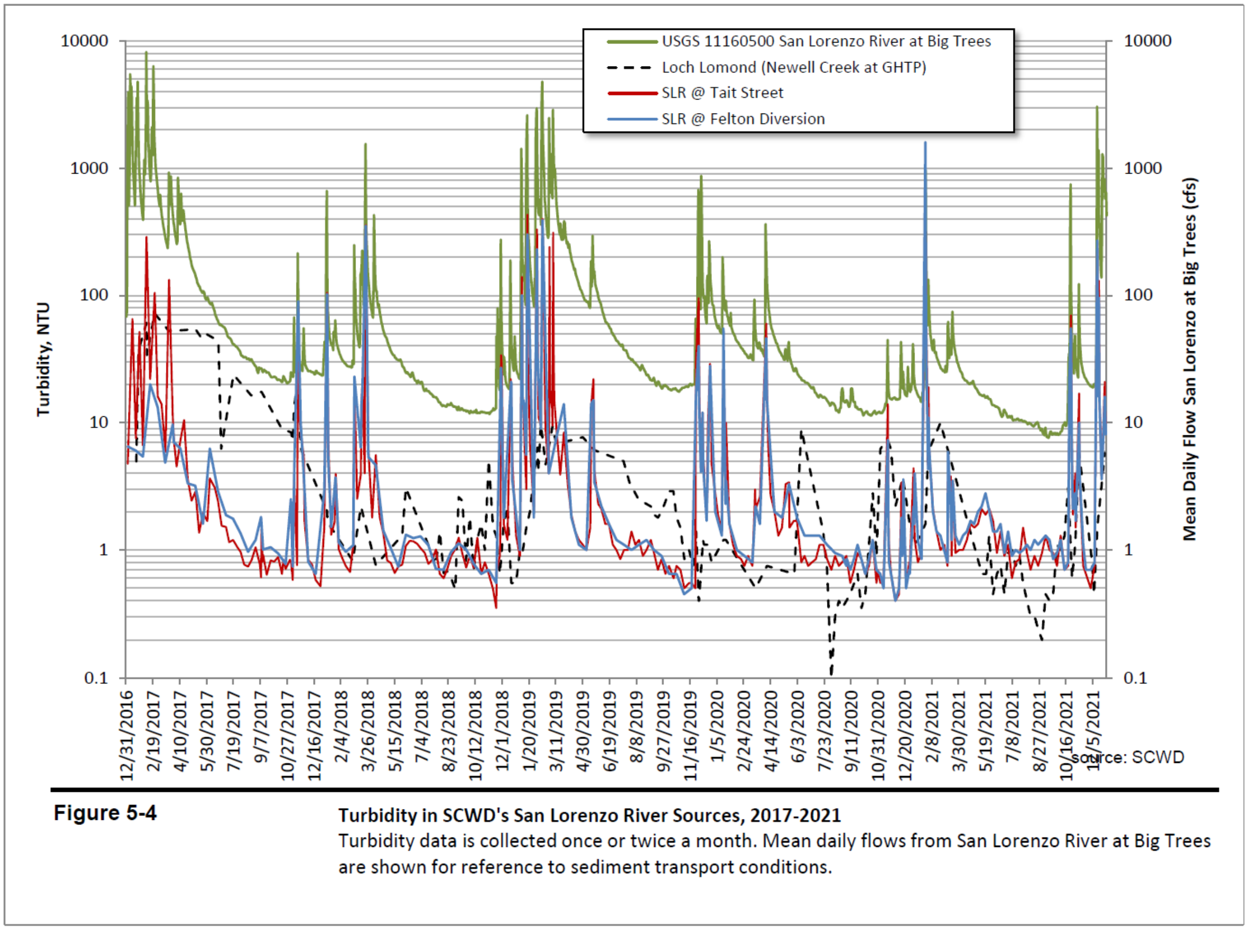


Figure 5-4: Turbidity in City's San Lorenzo River Sources, 2017-2021

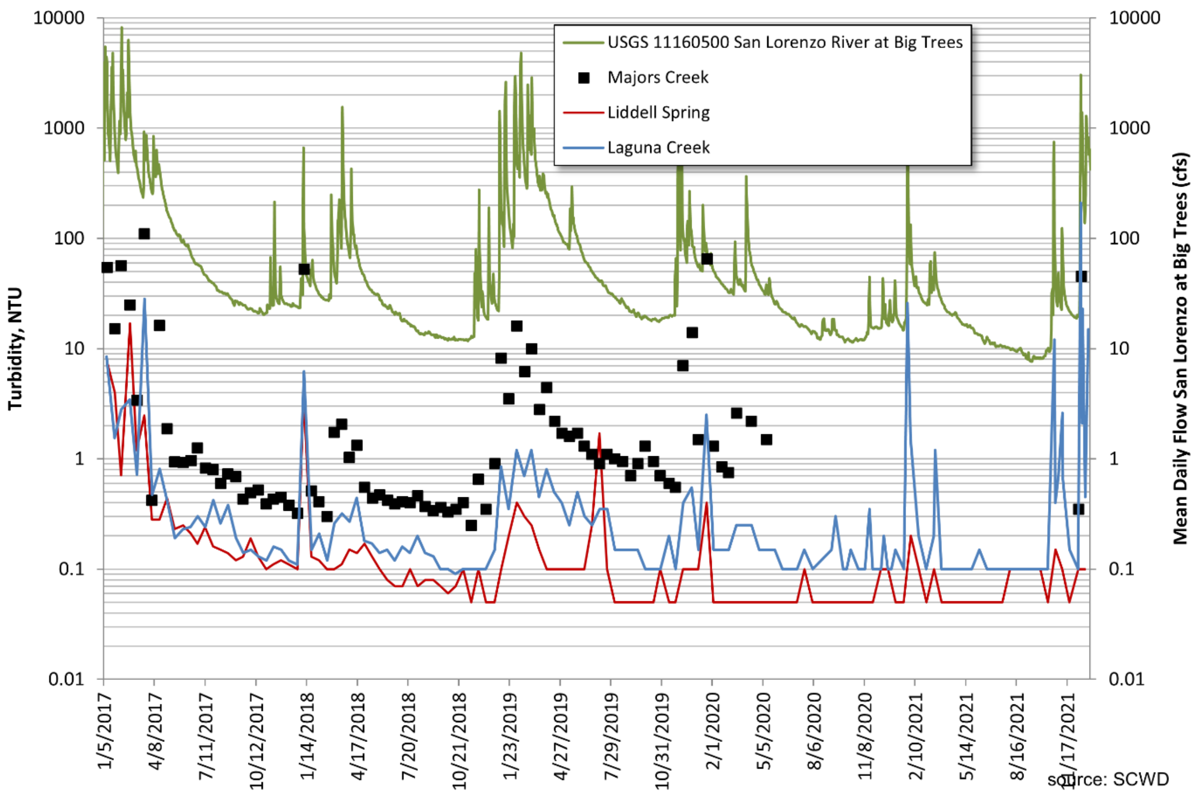


Figure 5-5 **Turbidity in SCWD's North Coast Sources, 2017-2021**

Turbidity data is collected at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions. Majors Creek was off line from May 2020 - November 2021.

Figure 5-5: Turbidity in City's North Coast Sources, 2017-2021

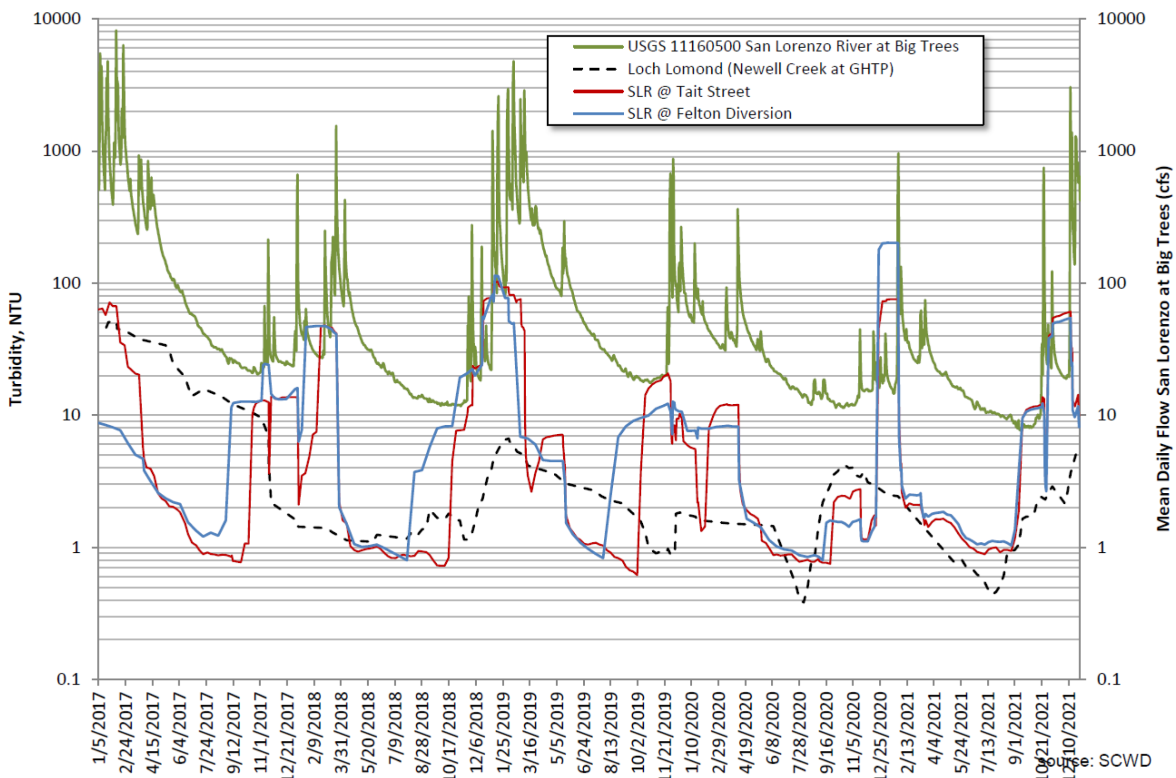


Figure 5-6 **Turbidity in SCWD's San Lorenzo River Sources, 2017-2021**

Ten point running average shown for clarity; data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.

Figure 5-6: Turbidity in City's San Lorenzo River Watershed Sources, 2017-2021 (10 point running average shown for clarity)

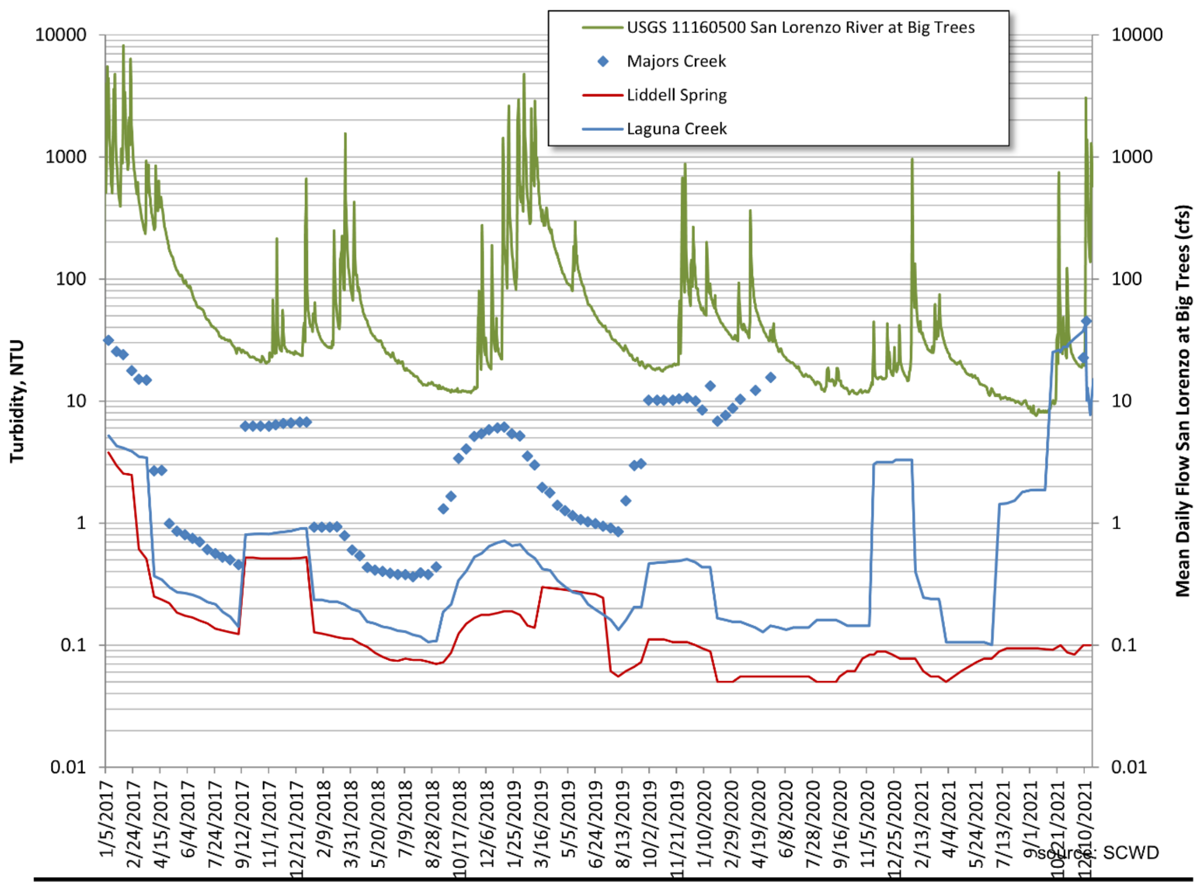


Figure 5-7 **Turbidity in SCWD's North Coast Sources, 2017-2021**

Ten point running average shown for clarity; data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions. Majors Creek was offline from May 2020 - November 2021.

Figure 5-7: Turbidity in City's North Coast Sources, 2017-2021 (10 point running average shown for clarity)

5.4.3 Nitrate

The MCL for nitrate in drinking water is 10 mg/L as nitrogen, or 45 mg/L as nitrate. The nitrate concentrations in the surface water systems located within the watersheds do not approach this limit. However, in response to the 303(d) listing for nutrient impairment and implementation of the resulting nitrate TMDL, the County and the Regional Board have implemented numerous management and regulatory actions to reduce nitrate loadings to the river and tributary creeks. The primary source of nitrate is from septic leach fields located in sandy soil areas (Santa Margarita sandstone), mostly located east of the San Lorenzo River. Other key sources are septic systems near waterways, a community leach field at the Boulder Creek Country Club, and the Scotts Valley nitrate plume. Table 5-3 provides a summary of the nitrate data provided. Additional graphs and narrative for each water purveyor follows.

Table 5-3: Summary of Nitrate Data Evaluated

	Nitrate (mg/L as N)					Water Year	
Utility/Location	**Average**	**Median**	**Low**	**High**	**No. of Samples**	**From**	**To**
Santa Cruz Water Department[1]							
Liddell Spring	0.3	0.2	0.2	0.3	32.0	2017	2021
Laguna Creek	0.0	0.0	0.0	0.2	36.0	2017	2021
Majors Creek	0.2	0.3	0.0	0.4	18.0	2017	2021
Loch Lomond	0.2	0.2	0.0	0.4	31.0	2017	2021
SLR @ Tait Street	0.3	0.3	0.0	1.2	78.0	2017	2021
SLR @ Felton	0.5	0.5	0.0	1.2	77.0	2017	2021
San Lorenzo Valley Water District[2]	**YEAR**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	< 0.10	0.13	< 0.10	N/A	0.13	< 0.10	< 0.10
Bull Springs-1	0.11	< 0.10	< 0.10	N/A	0.15	< 0.10	0.12
Bull Springs-2	NR	NR	< 0.10	N/A	0.12	< 0.10	0.25
Clear Creek	< 0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	< 0.10
Fall Creek	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Foreman Creek	< 0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	< 0.10
Peavine Creek	< 0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	< 0.10
Sweetwater Creek	< 0.10	< 0.10	0.15	N/A	0.14	0.17	0.13
Lompico Creek	ND	ND	NR	NR	NR	NR	NR

[1]Source: City

[2]Source: SLVWD, 2017 data is 6 months Note: NR = Not Recorded; N/A = Data not available; ND = Non-detectable

SLR = San Lorenzo River

5.4.3.1 City Surface Water Sources

City has monitored the nitrate levels in its water sources since the late 1960s. The following paragraphs describe the key findings of the nitrate evaluation.

Figure 5-8 shows the nitrate data over calendar years 2017–2021 for the City's San Lorenzo River sources. In early 2017, which saw record-level rain events, values for all three sources were significantly lower compared to subsequent years. While values are higher for the two river sources compared to Loch Lomond, values for Loch Lomond reached closer to the same levels as the other two sources [18]. Overall, sample concentrations for the last 5 years have been less than 1.0 mg/L as N and have not changed much since early 2017.

Figure 5-9 shows the nitrate trend over the past five years for the City's North Coast sources. While Laguna Creek has the lowest concentrations, values for Laguna Creek spike in early 2017 during the record rain events, while values for Majors Creek are significantly reduced. Liddell Spring does not have any nitrate spikes since CEMEX ceased operation of the quarry in 2010. Values are slightly lower for the North Coast sources than the San Lorenzo River sources.

Figure 5-10 provides an additional historic perspective on nitrate concentrations as a single plot at in both the San Lorenzo River locations as well as at Loch Lomond followed by individual plots on Figures 5-11 – 5-13 for individual sources. For each plot, four time-based lines of best fit and an overall time series line of best fit have been provided for the data with the first-time period from 1967 to 1990 that indicates potential increasing trend in nitrate, a second-time period from 1991 to 2010 that shows levelling of nitrate, a third from 2011 to 2016 that indicates a potential decreasing trend, and finally a fourth from 2017–2021 which indicates increasing trends at San Lorenzo River sources and a decreasing trend at Loch Lomond. The overall time series indicates slowly increasing nitrate levels at all three locations. Long-term evaluation of nitrate data should be continued in the future to assess the continued focus on water quality, and particularly onsite wastewater management, which has occurred since about 1995.

5.4.3.2 SLVWD Surface Water Sources

The summary of nitrate data for the SLVWD surface water sources is included in Table 5-3. The nitrate results were often found to be below reporting limits, and for this reason no graph illustrating these results was provided.

[18] Groundwater typically has a higher dissolved ion concentration than direct runoff, which presumably enters the channel shortly after precipitation with little residence time in the groundwater reservoir and limited contact with soil or vegetation.

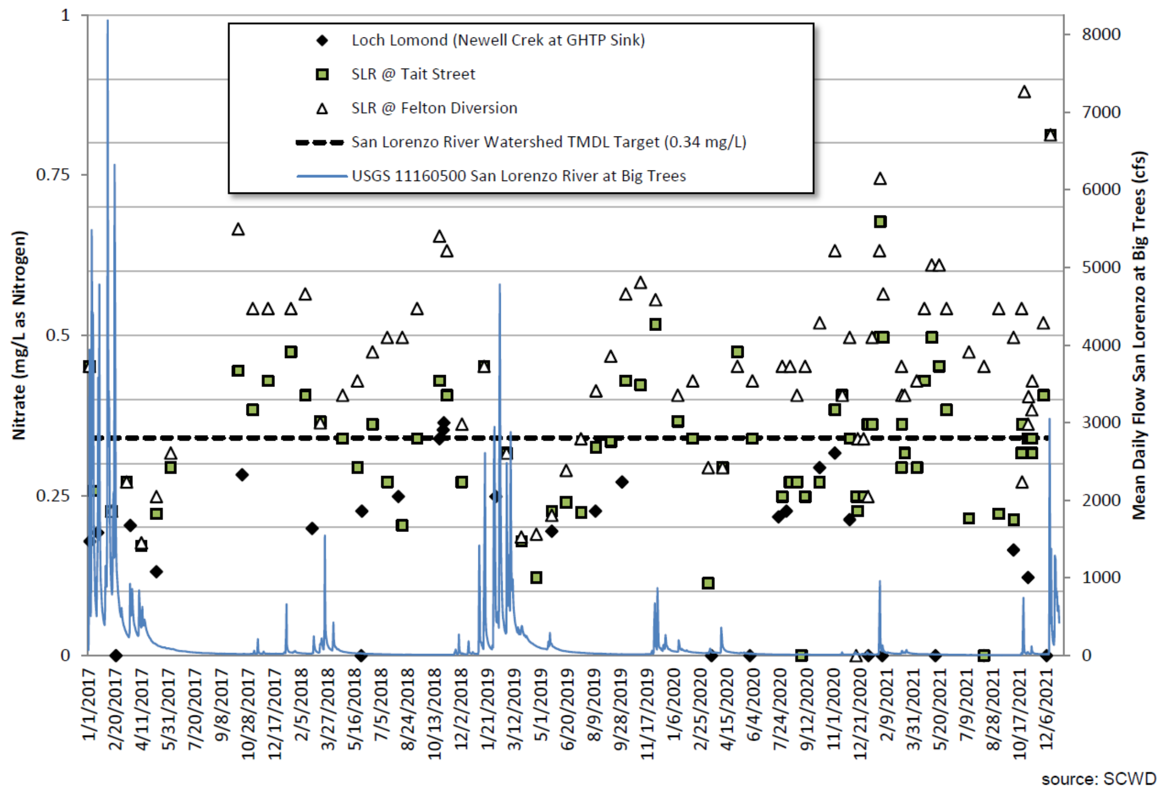


Figure 5-8 **Nitrate Concentrations in the SCWD San Lorenzo River Sources, 2017-2021**
Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions

Figure 5-8: Nitrate Concentrations in the City's San Lorenzo River Watershed Sources, 2017-2021

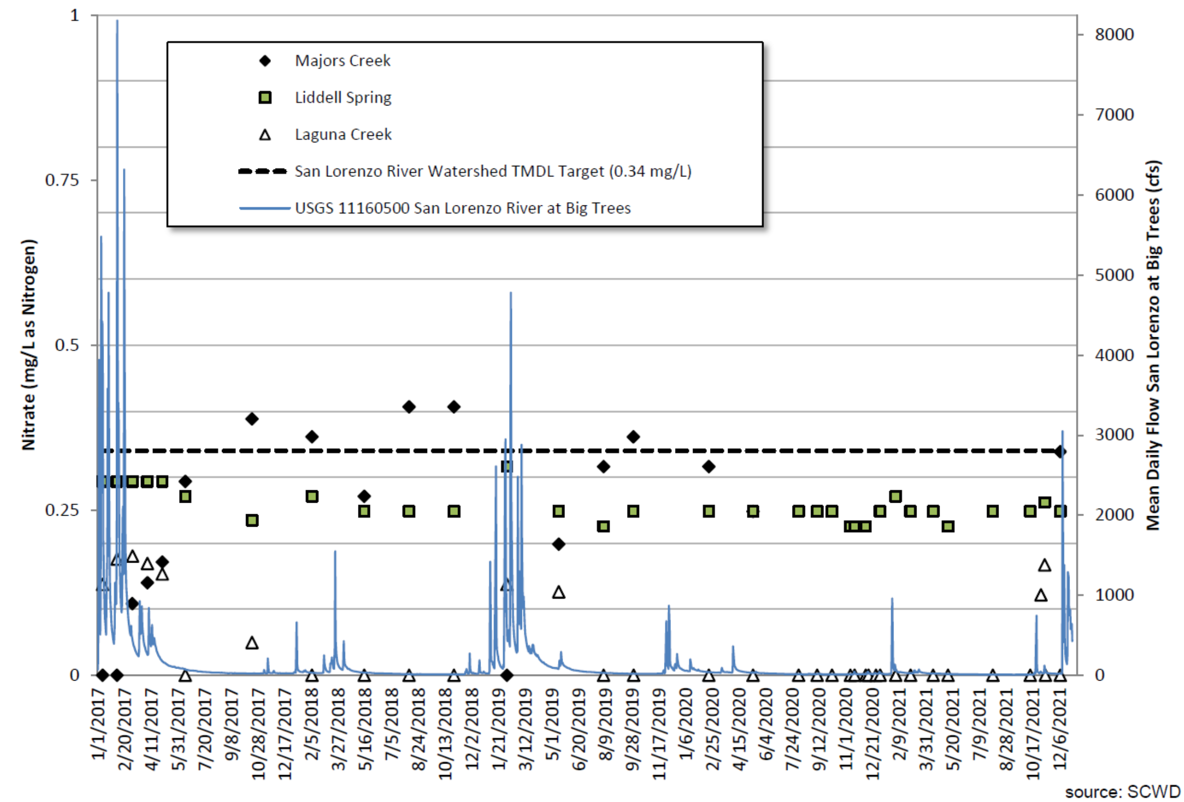


Figure 5-9 **Nitrate Concentrations in the SCWD North Coast Sources, 2017-2021**
Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions

Figure 5-9: Nitrate Concentrations in the City's North Coast Sources, 2017-2021

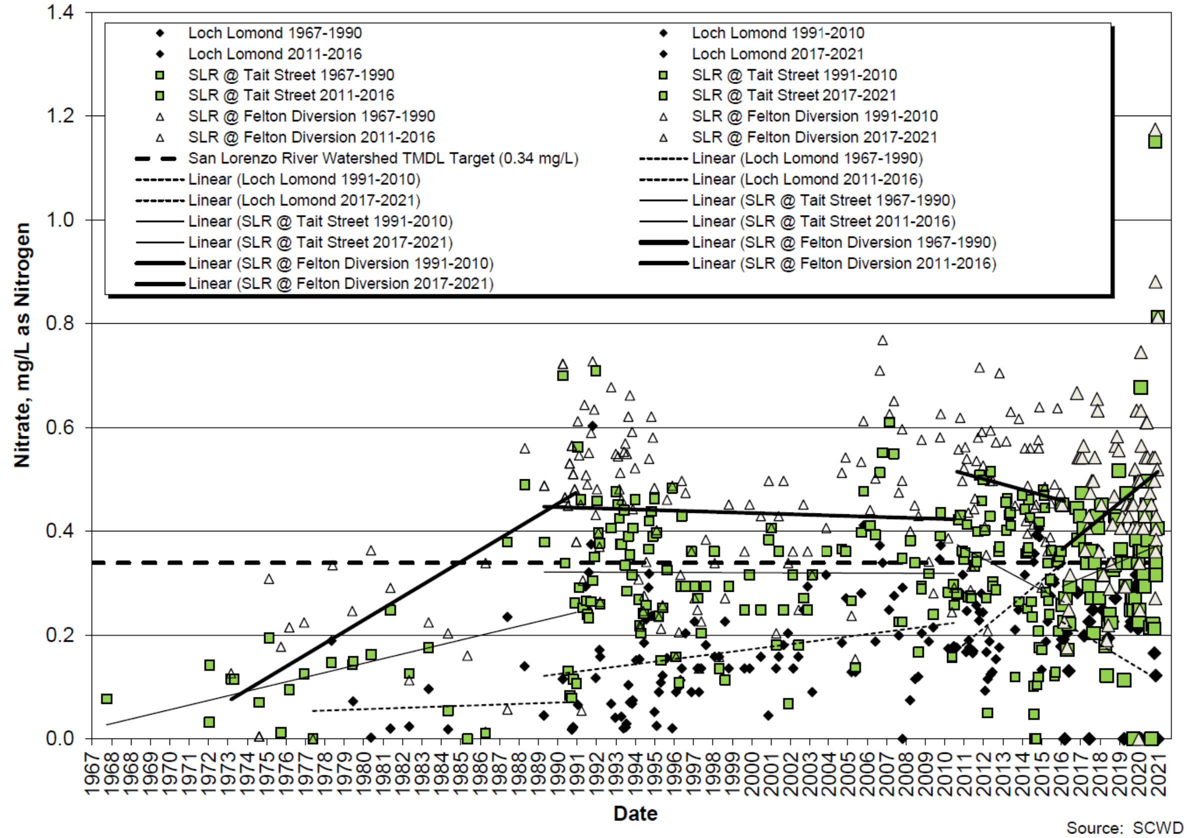


Figure 5-10 **Nitrate Concentrations in the SCWD San Lorenzo River Sampling Sites, 1967-2021**
Numbers in parenthesis are median values.
Trend lines drawn for each site based on a linear best fit.

Figure 5-10: Nitrate Concentrations in the City San Lorenzo River Sampling Site 1967-2021

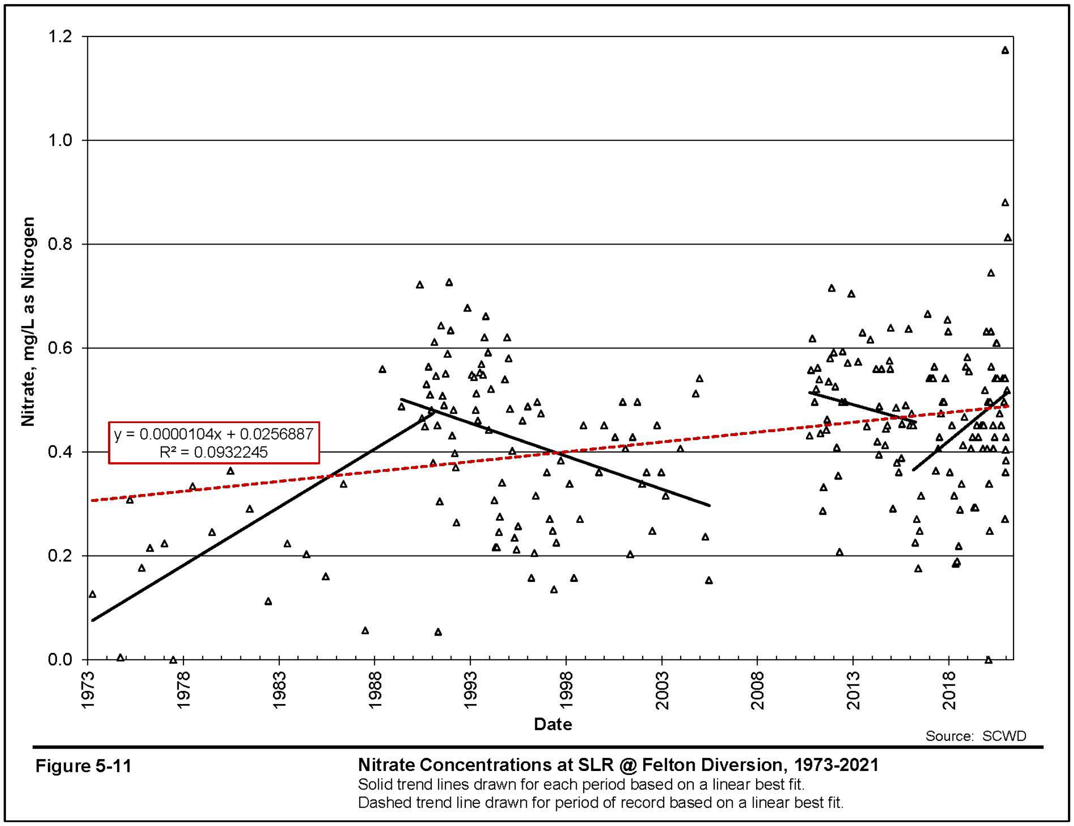


Figure 5-11: Nitrate Concentrations at SLR at Felton Diversion 1973-2021

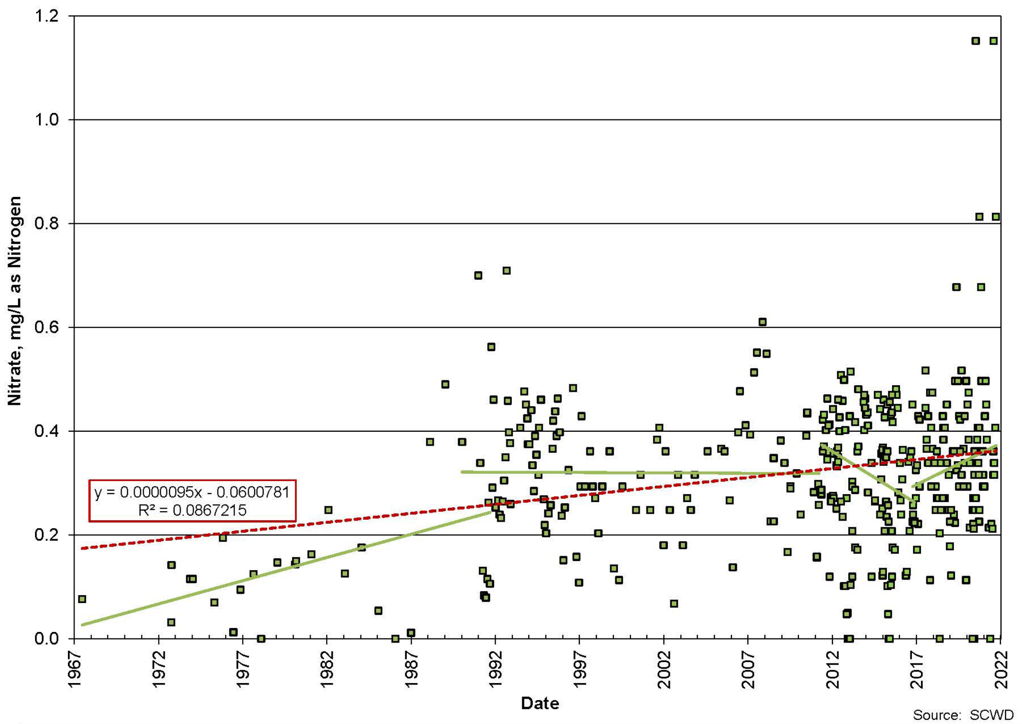


Figure 5-12 **Nitrate Concentrations at SLR @ Tait Street, 1967-2021**
Solid trend lines drawn for each period based on a linear best fit.
Dashed trend line drawn for period of record based on a linear best fit.

Figure 5-12: Nitrate Concentrations at SLR at Talt Street 1967-2021

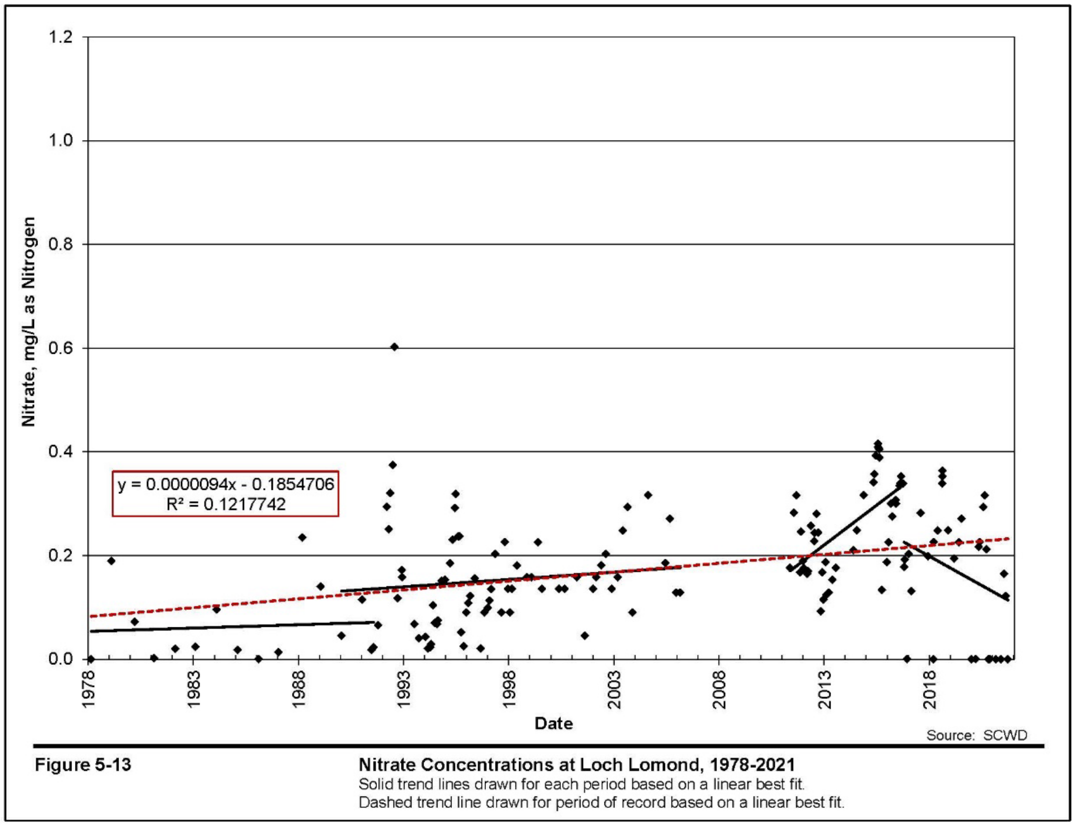


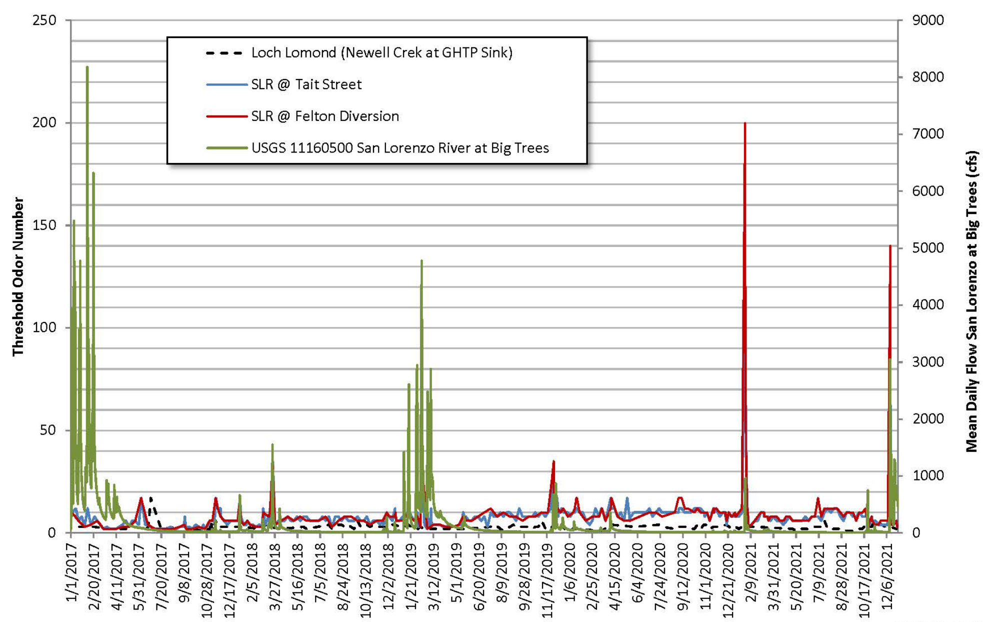
Figure 5-13: Nitrate Concentrations City's San Lorenzo River at Felton Diversion, Tait Street Diversion, and Loch Lomond, 1967-2021

5.4.4 Odors

Odors of raw water typically relate to natural organic matter and algae degradation products. The City has extensive data on the Threshold Odor Numbers (TON) parameter. Raw and treated TONs were monitored more aggressively starting in the mid-1980s, primarily because of customer complaints.

Figure 5-14 shows TON values for the City's San Lorenzo River sources for calendar years 2017-2021. TON at Loch Lomond, Tait Street Diversion, and the Felton Diversion appear relatively constant, which may align with both a focus on algae control and a stabilizing in the nitrate concentrations and therefore a relatively lower algae production rate. Significant spikes in 2021 for Felton Diversion may be attributed to the first significant rain events to occur in over a year. Values following that event for all sources dropped to lower values immediately after.

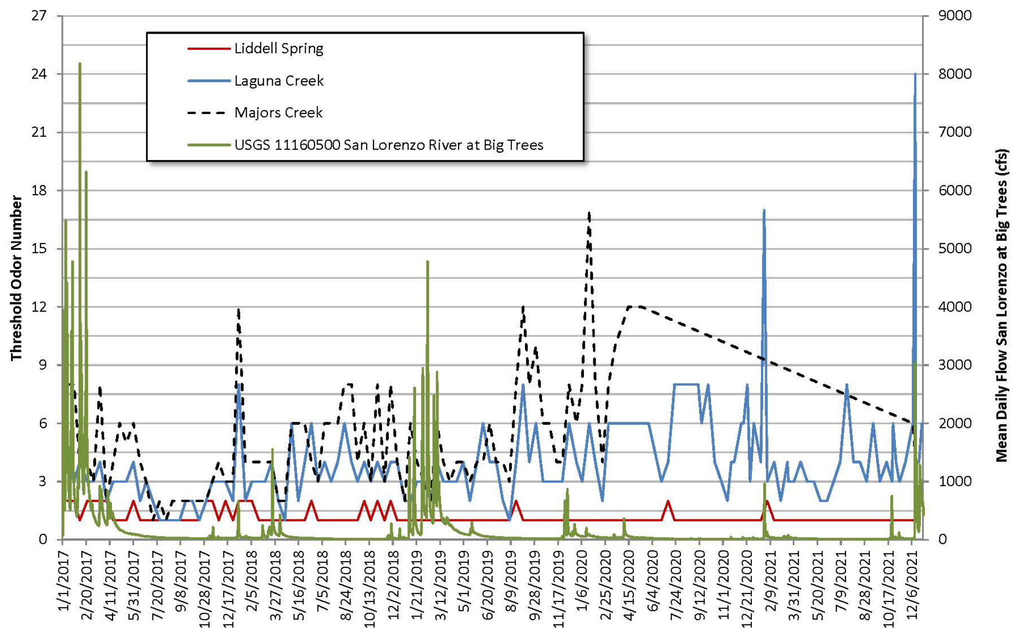
Figure 5-15 shows TON values for City's North Coast sources over the same 5-year period. TON at Liddell Spring is much lower than at Laguna and Majors Creeks. Generally, values for the San Lorenzo River and North Coast sources are about the same, but the spikes for the San Lorenzo River during significant rain events are more dramatic.



Source: SCWD

Figure 5-14 **TON measured in SCWD's San Lorenzo River Sources, 2017-2021**
Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions. Values greater than or equal to 20 correspond with significant rainfall, with the highest numbers during severe storm events.

Figure 5-14: TON Measured in City's San Lorenzo River Watershed Sources, 2017-2021



Source: SCWD

Figure 5-15 **TON measured in SCWD's North Coast Sources, 2017-2021**
Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions. Values greater than or equal to 20 correspond with significant rainfall, with the highest numbers during severe storm events.

Figure 5-15: TON Measured in City's North Coast Sources, 2017-2021

5.4.5 Organic Contaminants

5.4.5.1 Synthetic Organic Compounds (SOCs)

City conducts triennial monitoring of SOCs at all raw sources and consists of 12 man-made carbon-based compounds such as pesticides, defoliants, and fuel additives. Table 14 of the City Source Water Monitoring Study Report Water Year 2021 (October 1, 2020 – September 30, 2021) (WY2021 Report), prepared after the CZU Lightning Complex Fire, provides a list of the SOC compounds analyzed during WY 2021 and their associated primary MCLs as can be found in Appendix B. Historically, SOCs have not been detected in the source water or in the GHWTP finished water.

The City (WY2021 Report) increased the monitoring of SOCs following the CZU Lightning Complex Fire to include monthly and storm event sampling and added 2,3,7,8-TCDD. TCDD, commonly referred to as dioxin, is a chemical that is mainly a byproduct of industrial and manufacturing processes such as chlorine bleaching of paper, uncontrolled waste incinerators, and manufacturing of some herbicides and pesticides. TCDD can also result from natural processes including volcanic eruptions and forest fire. In a wildfire or structure fire setting, the volume of building materials, chemicals, pesticides, cleaners, automotive components, electronics, appliances, and other household items manufactured with chlorinated products such as polyvinyl chloride (PVC) can create immense amounts of TCDD. The City previously analyzed for a larger SOC list, including TCDD, but was granted a waiver from the SWRCB-DDW to reduce the list by removing compounds that were not detected.

During WY 2021, all SOC results were non-detect except for one result of 0.12 µg/L 2,4-D at SLR Highlands Park on January 27, 2021.

5.4.5.2 Volatile Organic Compounds (VOCs)

City and SLVWD conducts annual monitoring of VOCs at all surface sources and consists of 27 compounds primarily of carbon and hydrogen which are predominantly used as solvents, degreasers, cleaning solutions, dry cleaning fluids, and components of pesticides and plastics.

The City added monthly, quarterly, and storm event monitoring for VOCs to evaluate potential impacts from the CZU Lightning Complex Fire as documented in the WY2021 Report. The source water locations that were monitored include Laguna Creek, SLR Felton Diversion, and SLR Tait Street Diversion. The GHWTP finished water was also monitored for VOC compounds as well as Upper Laguna and SLR Highlands Park. All VOC compounds collected from the GHWTP finished water, source water and upper watershed locations were non-detect for WY 2021.

The SLVWD added daily, monthly, and quarterly monitoring for VOCs beginning in November of 2020 in response to the potential impacts of the CZU fire. The District followed a thorough testing plan that began with daily sampling during the first few months of the fire before shifting to a monthly then finally to a quarterly water sampling schedule. Because the samples did not detect VOCs above the maximum contaminate level, the District returned to the standard once-a-year VOC monitoring plan beginning in December 2022.

5.4.5.3 Dioxin and Furan

As previously discussed in Section 5.4.5.1, TCDD was not detected during WY 2021. Table 18 of the WY2021 Report summarizes the sixteen unregulated dioxin and furan chemicals that were analyzed from the City source water and upper watershed locations. Three unregulated dioxin and furan chemicals were detected during WY 2021 at Laguna Creek, SLR Tait Street Diversion, and SLR Highlands Park during the January 27, 2021, storm

5.4.6 Other Water Quality Parameters/

Tables 5-4 through 5-17 summarize the recent historical data for other water quality parameters in the general mineral category. The data includes summary tables for Total Hardness, calcium, magnesium, sodium, potassium, alkalinity, sulfate, chloride, fluoride, pH, Total Dissolved Solids (TDS), conductivity, color, and Methylene Blue Active Substances (MBAS), which are indicative of soaps/detergents:

5.4.6.1 Total Hardness

Table 5-4: Total Hardness — The majority of the data indicate that most area surface waters are moderately hard, with values around 115 to 255 mg/l as CaCO3. One City source, Liddell Spring, has average and median hardness values of above 250 mg/l as CaCO3. This hardness is most likely caused by the extensive limestone (karst) geology in the spring vicinity. SLVWD samples were generally one time per year. Most SLVWD creek waters have significantly lower hardness than City waters, while spring waters are similar to Liddell Spring.

Table 5-4: Total Hardness Summary of Available Data (mg/L as CaCO3)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	255	244	224	400	130	2017	2021
Laguna Creek	127	136	44	176	142	2017	2021
Majors Creek	116	126	44	154	88	2017	2021
Loch Lomond	150	150	110	184	151	2017	2021
SLR @ Tait Street	137	147	58	180	352	2017	2021
SLR @ Felton Diversion	139	148	64	210	236	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	220	NR	NR	N/A	230	220	230
Bull Springs-1	280	300	260	N/A	290	270	280
Bull Springs-2	260	220	210	N/A	210	240	260
Clear Creek	68	44	38	N/A	40	63	73
Fall Creek	110	92	91	100	87	N/A	120

Utility/Location	Average	Median	Low	High	No. Samples	Sample Dates (WY)	
Foreman Creek	71	46	42	N/A	42	65	77
Peavine Creek	85	68	50	N/A	54	83	90
Sweetwater Creek	94	63	68	N/A	69	77	96
Lompico Creek	200	180	NR	NR	NR	NR	NR

[1]Source: City
[2]Source: SLVWD, NR = Not Recorded, N/A = Data not available

5.4.6.2 Calcium

Table 5-5: Calcium — This table lists similar results as for hardness; moderate values for most sources (e.g., about 40 mg/l) except for Liddell Spring -. SLVWD samples were generally one time per year. Several of SLVWD's calcium values that were analyzed are lower than those of City.

Table 5-5: Calcium Summary of Available Data (mg/L)

Utility/Location	Average	Median	Low	High	No. Samples	Sample Dates (WY)	
Santa Cruz Water Department[1]							
Liddell Spring	88.2	84.0	78.0	130.0	31	2017	2021
Laguna Creek	38.3	42.0	15.0	54.0	44	2017	2021
Majors Creek	39.7	42.0	12.0	86.0	19	2017	2021
Loch Lomond	44.8	45.5	30.0	52.0	26	2017	2021
SLR @ Tait Street	41.1	44.0	21.0	50.0	84	2017	2021
SLR @ Felton Diversion	42.0	45.0	21.0	62.0	83	2017	2021
San Lorenzo Valley Water District[2]	Year						
	2015	**2016[3]**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	77	NR	NR	N/A	81	76	80
Bull Springs-1	80	86	73	N/A	82	78	81
Bull Springs-2	NR	NR	63	N/A	62	71	76
Clear Creek	NR	NR	NR	N/A	10	16	19
Fall Creek	34	31.53	28	31	27	N/A	28
Foreman Creek	NR	NR	NR	N/A	9.6	14	18
Peavine Creek	NR	NR	NR	N/A	13	20	22
Sweetwater Creek	NR	NR	NR	N/A	16	18	22
Lompico Creek	50	43	NR	NR	NR	NR	NR

Source[1]: SLVWD
Source[1]: City, * Median based on 2017-2021 values
Source[2]: SLVWD: NR = Not Recorded; N/A = Data not available; ND= Non-Detectable
[3] Average of March and April 2016 values

5.4.6.3 Magnesium

Table 5-6: Magnesium — Magnesium concentrations are low compared to calcium. This indicates most of the total hardness is from calcium, as expected considering the geologic formations throughout the watershed area. SLVWD's Bull Springs and Lompico Creek sources were slightly higher in magnesium than those of City.

Table 5-6: Magnesium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	9.6	8.9	8.2	16.0	31	2017	2021
Laguna Creek	4.8	5.0	2.8	6.4	44	2017	2021
Majors Creek	5.1	3.4	2.8	35.0	19	2017	2021
Loch Lomond	9.3	9.5	7.4	12.0	26	2017	2021
SLR @ Tait Street	8.6	8.7	5.8	12.0	84	2017	2021
SLR @ Felton Diversion	8.9	8.9	6.3	22.0	83	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	7.4	NR	NR	N/A	7.5	7.0	7.1
Bull Springs-1	19	21	18	N/A	20	18	18
Bull Springs-2	18	15	13	N/A	13	16	17
Clear Creek	6.1	4	3.2	N/A	3.6	5.6	6.3
Fall Creek	6.6	5	5.1	5.8	4.7	N/A	6.6
Foreman Creek	6.9	5	4.4	N/A	4.4	7.2	7.8
Peavine Creek	8.6	6.85	5	N/A	5.2	8.1	8.5
Sweetwater Creek	7.6	5.5	6.2	N/A	7.0	7.8	10.0
Lompico Creek	17	17	NR	NR	NR	NR	NR

Source[1]: City, * Median based on 2017-2021 values
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available

5.4.6.4 Sodium

Table 5-7: Sodium — The average sodium content in City waters ranges from about 10 to 24 mg/l. Lompico Creek had sodium analyses in the range of 18 to 28 mg/L, which are higher than the other SLVWD's sources and more similar to most of City's sources.

Table 5-7: Sodium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	11.4	11.0	10.0	14.0	31	2017	2021
Laguna Creek	10.6	10.0	6.3	14.0	44	2017	2021
Majors Creek	15.6	16.0	8.6	40.0	19	2017	2021
Loch Lomond	18.1	18.0	0.0	25.0	26	2017	2021
SLR @ Tait Street	22.5	24.0	10.0	29.0	84	2017	2021
SLR @ Felton Diversion	23.1	24.0	9.7	30.0	83	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	6.7	NR	NR	N/A	6.8	6.3	7.0
Bull Springs-1	9	8.9	7.7	N/A	7.7	8.6	8.5
Bull Springs-2	11	9.4	8.7	N/A	9.4	9.8	11.0
Clear Creek	10	6.9	6.9	N/A	7.4	9.8	10.0
Fall Creek	10	9.25[3]	8.4	9.8	8.4	N/A	10.0
Foreman Creek	9.8	6.7	7.4	N/A	7.4	9.9	10.0
Peavine Creek	11	8.7[3]	7.6	N/A	8.1	11.0	11.0
Sweetwater Creek	11	8.6	9.2	N/A	9.5	11.0	12.0
Lompico Creek	28	24	NR	NR	NR	NR	NR

Source[1]: City* Median based on 2017-2021 values
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available [3] Average of March and April data

5.4.6.5 Potassium

Table 5-8: Potassium — The typical potassium content in City waters is about 2 mg/l. Lompico Creek had potassium in a range from 1.1 to 1.4 mg/L, which is slightly lower than SLVWD and City values.

Table 5-8: Potassium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	1.7	1.6	1.4	2.3	31	2017	2021
Laguna Creek	1.8	1.7	1.4	4.0	44	2017	2021
Majors Creek	1.8	1.5	1.2	3.7	19	2017	2021
Loch Lomond	2.0	1.9	1.7	2.8	26	2017	2021
SLR @ Tait Street	2.3	2.1	1.5	6.3	83	2017	2021
SLR @ Felton Diversion	2.2	2.0	1.5	11.0	83	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	2	NR	NR	N/A	1.6	1.7	1.9
Bull Springs-1	1.8**	1.7**	1.6**	N/A	1.5	1.5	1.6
Bull Springs-2	1.6**	1.5**	1.5**	N/A	1.1	1.4	1.4
Clear Creek	2.0**	1.6**	1.5**	N/A	1.2	1.6	1.8
Fall Creek	1.9**	1.9**	2.0**	1.8	1.3	N/A	1.8
Foreman Creek	2.2**	1.6**	1.8**	N/A	1.4	1.8	2.3
Peavine Creek	2.7**	2.45**	2.2**	N/A	1.9	2.5	2.7
Sweetwater Creek	2.2**	1.7**	2.1**	N/A	1.6	1.8	2.1
Lompico Creek	2	1.3	NR	NR	NR	NR	NR

Source[1]: City * Median based on 2017-2021 values
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available ** indicates Intraday Average

5.4.6.6 Alkalinity

Table 5-9: Alkalinity — Alkalinity varies widely in City, presumably because of high runoff periods. The average value for Liddell Spring is 196 mg/l as CaCO3, due to karst bedrock geology, and about 92 to 118 mg/l as CaCO3 for the other sources. Lompico Creek had an alkalinity range from 180 to 190 mg/L during 2015-2016, which is in the mid-range of SLVWD's other water sources; again, highlighting that the spring sources with their contact to karst (limestone) have higher alkalinity compared to the creeks.

Table 5-9: Alkalinity Summary of Available Data (mg/L as CaCO3)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	196	194	176	226	130	2017	2021
Laguna Creek	118	126	30	152	142	2017	2021
Majors Creek	92	101	32	118	88	2017	2021
Loch Lomond	101	100	70	126	151	2017	2021
SLR @ Tait Street	103	114	34	132	352	2017	2021
SLR @ Felton Diversion	105	116	34	128	236	2017	2021
San Lorenzo Valley Water District[2]	Year						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	220	NR	NR	N/A	210	210	210
Bull Springs-1	280	280	250	N/A	250	270	260
Bull Springs-2	260	210	210	N/A	190	240	250
Clear Creek	78	47	43	N/A	46	71	78
Fall Creek	120	90	89	100	84	N/A	120
Foreman Creek	82	51	48	N/A	48	72	81
Peavine Creek	100	71	58	N/A	60	94	98
Sweetwater Creek	110	72	70	N/A	80	86	100
Lompico Creek	190	180	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available

5.4.6.7 Sulfate

Table 5-10: Sulfate — The secondary MCL for sulfate is 250 mg/l. The maximum value measured in annual samples of City water was 210 mg/l in Liddell Spring. Averages range from 15 to 70 mg/l. Lompico Creek had sulfate in the range from 25 to 29 mg/L during 2015-2016, while the other SLVWD sources had sulfate values are lower than both City and Lompico Creek.

Table 5-10: Sulfate Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	67.4	57.5	42.0	210.0	32	2017	2021
Laguna Creek	15.1	15.0	5.7	28.0	35	2017	2021
Majors Creek	28.4	31.0	10.0	44.0	18	2017	2021
Loch Lomond	69.4	71.0	52.0	75.0	31	2017	2021
SLR @ Tait Street	48.5	48.0	30.0	69.0	73	2017	2021
SLR @ Felton Diversion	49.5	49.5	32.0	69.0	72	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	12	16	NR	N/A	14	9.8	11
Bull Springs-1	10	9.6	7.4	N/A	8.1	9.3	9.8
Bull Springs-2	11	8.6	6	N/A	7.2	9.2	12
Clear Creek	4.1	2.8	2.2	N/A	2.4	3.4	5.1
Fall Creek	11	9.1	5.9	8.9	7.1	N/A	11
Foreman Creek	4.7	3.7	2.7	N/A	2.5	5.4	6.9
Peavine Creek	3.8	2.75	2	N/A	2.1	3.4	4.2
Sweetwater Creek	4.4	4.2	2.8	N/A	3.7	4.4	4.7
Lompico Creek	29	25	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.8 Chloride

Table 5-11: Chloride — The secondary MCL for chloride is 250 mg/l. The maximum value measured in City water was 34 mg/l (at Felton Diversion). Averages range from 10 to 23 mg/l. Lompico Creek had chloride in the range of 16 to 25 mg/L, which is lower than the other SLVWD sources but similar to Majors Creek and Loch Lomond.

Table 5-11 Chloride Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	10.1	10.0	8.5	12.0	32	2017	2021
Laguna Creek	10.3	10.0	7.1	13.0	35	2017	2021
Majors Creek	15.1	16.0	9.2	17.0	18	2017	2021
Loch Lomond	11.5	11.7	7.3	15.8	31	2017	2021
SLR @ Tait Street	22.1	24.0	9.1	29.0	73	2017	2021
SLR @ Felton Diversion	22.6	24.0	9.9	34.0	72	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	7.1	6.8	NR	N/A	7.1	7.5	7.5
Bull Springs-1	9.5	9	8.7	N/A	8.7	9.8	
Bull Springs-2	10	8.8	9.6	N/A	9.2	11	11
Clear Creek	6.6	5.1	5.5	N/A	4.6	6.5	7.3
Fall Creek	7.9	6.8	7.5	8.4	6.8	N/A	9
Foreman Creek	6.2	4.5	5.7	N/A	4.3	5.5	6.6
Peavine Creek	5.7	5.15	6.1	N/A	4.8	6.1	6.6
Sweetwater Creek	6.6	5.6	6.3	N/A	5.9	7.2	6.9
Lompico Creek	25	16	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available

5.4.6.9 Fluoride

Table 5-12: Fluoride — The primary MCL for fluoride is 2.0 mg/l (see Appendix A). The maximum value measured in annual samples of City water is 0.32 mg/l in Loch Lomond. Averages range from 0.08 to 0.26 mg/l, with the North Coast sources having lower levels than the San Lorenzo River. Lompico Creek had fluoride in the range from 0.15 to 0.29 mg/L, which is higher than most of the SLVWD and City sources but similar to Loch Lomond.

Table 5-12: Fluoride Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	0.09	0.09	0.08	0.14	32	2017	2021
Laguna Creek	0.08	0.09	0.00	0.11	35	2017	2021
Majors Creek	0.08	0.08	0.00	0.10	18	2017	2021
Loch Lomond	0.26	0.26	0.22	0.32	31	2017	2021
SLR @ Tait Street	0.17	0.18	0.10	0.22	73	2017	2021
SLR @ Felton Diversion	0.18	0.18	0.10	0.23	72	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	0.1	NR	NR	N/A	0.12	0.09	0.1
Bull Springs-1	0.12	0.11	0.15	N/A	0.11	0.1	0.1
Bull Springs-2	0.12	0.11	0.14	N/A	0.13	0.1	0.1
Clear Creek	0.08	0.06	0.07	N/A	0.06	0.08	0.08
Fall Creek	0.08	0.06	0.08	0.08	0.07	N/A	0.08
Foreman Creek	0.08	0.09	0.08	N/A	0.07	0.1	0.09
Peavine Creek	0.09	0.08	0.07	N/A	0.08	0.08	0.08
Sweetwater Creek	0.09	0.06	0.06	N/A	0.06	0.06	0.09
Lompico Creek	0.24	0.29	NR	NR	NR	NR	NR

Source[1]: SWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.10 pH

Table 5-13: pH — The pH values for City waters have ranged from 7.3 to 7.9 units, with median values between 7.2 and 8.0. Lompico Creek had pH levels in the range of 7.6 to 8.0 which is similar to the other SLVWD sources waters but at the upper end of pH for the City source waters.

Table 5-13: Summary of Available pH Data (units)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water[1] Department							
Liddell Spring	7.3	7.3	7.0	7.6	130	2017	2021
Laguna Creek	7.9	8.0	7.3	8.2	142	2017	2021
Majors Creek	7.8	7.8	7.3	8.1	88	2017	2021
Loch Lomond	7.3	7.2	6.6	7.8	151	2017	2021
SLR @ Tait Street	7.8	7.8	7.2	8.3	352	2017	2021
SLR @ Felton Diversion	7.7	7.7	7.3	8.2	236	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	7.6	7.4	7.4	7.5	7.6	7.6	7.6
Bull Springs-1	7.4	7.3	7.5	7.1	7.4	7.3	7.5
Bull Springs-2	7.5	7.5	7.7	7.3	7.5	7.5	7.6
Clear Creek	7.7	7.8	7.7**	N/A	7.8	8.0	8.0
Fall Creek	8.1	8.1	8.1	8.1	8.0	8.1	8.1
Foreman Creek	7.9	9.0	7.7**	N/A	7.8	7.9	7.9
Peavine Creek	8.0	8.1**	7.9**	N/A	7.9	8.1	8.1
Sweetwater Creek	7.8	8.0	7.9**	N/A	7.9	8.1	8.2
Lompico Creek	7.6	8.0	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available ** indicates Intraday Average

5.4.6.11 TDS and Conductivity

Tables 5-14 and 5-15: TDS and Conductivity — The secondary MCL for TDS is 500 mg/l. The maximum value measured in annual samples of City water is 540 mg/l at Liddell Spring, with averages ranging from 184 to 338 mg/l. Lompico Creek had TDS values in the range from 190 to 280 mg/L which is in the middle of the TDS range of the other SLVWD sources and lower than many values in the City watersheds. Conductivity (or specific conductance) can be used as a surrogate parameter for TDS. The secondary MCL for specific conductance is 900 umhos/cm, while the maximum value observed was 785 umhos/cm at Liddell Spring. Median values from all City sources have ranged from 310 to 510 umhos/cm.

Table 5-14: Total Dissolved Solids Summary of Available Data (mg/L)

Utility/Location	***Average***	***Median***	***Low***	***High***	***No. Samples***	***Sample Dates (WY)***	
Santa Cruz Water Department[1]							
Liddell Spring	338	320	270	540	31	2017	2021
Laguna Creek	184	190	80	240	31	2017	2021
Majors Creek	191	210	90	240	18	2017	2021
Loch Lomond	239	240	180	280	25	2017	2021
SLR @ Tait Street	246	250	190	290	60	2017	2021
SLR @ Felton Diversion	249	250	200	290	59	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	280	NR	NR	N/A	270	280	260
Bull Springs-1	350	350	280	N/A	320	310	320
Bull Springs-2	320	280	250	N/A	250	290	300
Clear Creek	120	90	88	N/A	78	100	110
Fall Creek	180	140	140	150	130	N/A	170
Foreman Creek	130	98	94	N/A	76	110	110
Peavine Creek	140	115	110	N/A	92	130	120
Sweetwater Creek	150	110	110	N/A	110	130	120
Lompico Creek	280	280	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD Note: NR = Not Recorded, N/A = Data not available

Table 5-15: Conductivity Summary of Available Data (µmhos/cm)

Utility/Location	Average	Median	Low	High	No. Samples	Sample Dates (WY)	
Santa Cruz Water Department[1]							
Liddell Spring	530	510	455	785	130	2017	2021
Laguna Creek	294	310	100	430	142	2017	2021
Majors Creek	302	325	120	380	88	2017	2021
Loch Lomond	381	385	290	440	151	2017	2021
SLR @ Tait Street	372	400	145	455	352	2017	2021
SLR @ Felton Diversion	381	405	140	470	236	2017	2021
San Lorenzo Valley Water District[2]							
Bennett Spring	NR	NR	NR	NR			
Bull Springs-1	533	540	510	550	3	2019	2021
Bull Springs-2	467	470	420	510	3	2019	2021
Clear Creek	153	170	110	180	3	2019	2021
Fall Creek	240	250	200	270	3	2018	2021
Foreman Creek	160	170	120	190	3	2019	2021
Peavine Creek	187	200	140	220	3	2019	2021
Sweetwater Creek	207	200	190	230	3	2019	2021
Lompico Creek	NR	NR	NR	NR			

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.12 Color

Table 5-16: Color — Apparent color of City source waters has been as high as 3,000 units , with the higher values from the San Lorenzo River sources, although this high result is during a storm event and is not typical. Median values range from 1 to 16 units. Treated water typically has very little or no detectable color. SLVWD sources are very low by comparison. For the 2018 to 2021 reporting period, data was only available for SLVWD's raw water sources in the northern portion of the watershed, i.e., Clear Creek, Foreman Creek, Peavine Creek and Sweetwater Creek. Data for the Felton sources was unavailable for that period.

Table 5-16: Apparent Color Summary of Available Data (units: CU)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	1.6	1.0	1.0	28.0	130	2017	2021
Laguna Creek	9.9	4.0	1.0	400.0	142	2017	2021
Majors Creek	20.0	8.0	3.0	200.0	88	2017	2021
Loch Lomond	22.8	16.0	6.0	120.0	151	2017	2021
SLR @ Tait Street	36.9	15.0	8.0	800.0	352	2017	2021
SLR @ Felton Diversion	49.0	16.0	8.0	3000.0	236	2017	2021
San Lorenzo Valley Water District[2]	**Year**						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Bennett Spring	< 3.0	< 3.0	< 3.0	N/A	N/A	N/A	N/A
Bull Springs-1	< 3.0	< 3.0	< 3.0	N/A	N/A	N/A	N/A
Bull Springs-2	< 3.0	< 3.0	< 3.0	N/A	N/A	N/A	N/A
Clear Creek	< 3.0	NR	< 3.0	N/A	3.0	< 3.0	< 3.0
Fall Creek	< 3.0	< 3.0	< 3.0	N/A	N/A	N/A	N/A
Foreman Creek	< 3.0	< 3.0	< 3.0	N/A	3.0	24.5[3]	11.5[4]
Peavine Creek	< 3.0	< 3.0	< 3.0	N/A	6.0	< 3.0	< 3.0
Sweetwater Creek	< 3.0	< 3.0	< 3.0	N/A	4.0	< 3.0	< 3.0
Lompico Creek	190	180	NR	NR	NR	NR	NR

Source[1]: City
Source[2]: SLVWD, Note: NR = Not Recorded, N/A = Data not available
[3] Average of March, October, and November
[4] Average of February and March

5.4.6.13 MBAS

Table 5-17: MBAS (Foaming Agents) — The MCL for MBAS, or foaming agents, in drinking water is 0.5 mg/l. There were no MBAS measurements found to be above the detection limit in City waters. Of the SLVWD values measured, the MBAS values were very low.

Table 5-17: MBAS Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	ND	ND	ND	ND	6	2017	2021
Laguna Creek	ND	ND	ND	ND	13	2017	2021
Majors Creek	ND	ND	ND	ND	5	2017	2021
Loch Lomond	ND	ND	ND	ND	16	2017	2021
SLR @ Tait Street	ND	ND	ND	ND	50	2017	2021
SLR @ Felton Diversion	ND	ND	ND	ND	48	2017	2021

Source[1]: City

5.4.6.14 E. Coli

The concentration of *E. coli* provides an indication of the extent of human and animal fecal contamination of a watershed, as it is more specific than total coliform. For drinking water supplies, the common guidance is that fecal coliform levels above 200 MPN/100 mL signifies a source with potentially large contamination from human sources (NRC 2004). However, the distribution system is frequently sampled for the presence of *E. coli*, and should it be detected, extensive customer and agency notifications are required, along with flushing and disinfection of the affected area of the distribution network.

Data for *E. Coli* values from 2017-2021 in the San Lorenzo River Sources and North Coast Sources indicate an increasing trend in *E. Coli* at Laguna Creek, though all values still remain under 200 MPN/100 m. *E. Coli* levels for the rest of the sources seem to be generally constant from 2017-2021 and under 200 MPN/100 mL, though SLR @ Tait Street Diversion and SLR @ Felton Diversion sees large *E. Coli* spikes above this limit concurrent with rain events.

5.4.6.15 Microbial Source Tracking (MST)

As reported in the WY 2021 Report, MST is the process of identifying the particular source (e.g., human, cattle, and bird) of fecal contamination in water. In December 2016, the City began MST monitoring in the SLR in order to gain a better understanding of the source of the fecal contamination in the SLR. The four MST analyses performed include Universal Bacteroides, Human Bacteroides (HF-183), MS2 Coliphage, and Somatic Coliphage. Universal Bacteroides tests for fecal contamination from all sources including animals, birds, and humans, while Human Bacteroides (HF-183), MS Coliphage, and Somatic Coliphage are fecal indicators of human influence particularly from wastewater. Human Bacteroides (HF-183) are a genus of bacteria that predominantly thrive in the lower gastrointestinal tract of humans and are therefore directly associated with fecal contamination. MS2 and Somatic Coliphage are bacteriophage viruses that infect *E. coli* bacterial cells. There are no current regulations for MST as they are primarily used as indicators of human influence in recreation and source water. Storm event MST analysis was added to WY 2021 to further evaluate storm water quality for treatment at the GHWTP. MST results were found to be variable throughout the year with Human Bacteroides, MS2 Coliphage, and Somatic Coliphage concentrations were generally higher during the wet season, suggesting that there is a greater human microbial influence during winter storms, potentially from septic systems in the San Lorenzo Valley located along the SLR. Universal Bacteroides concentrations were found to be high during the dry season when there are lower rates of flow and an increase in animal activity, as well as human recreation occurring in the SLR.

5.4.6.16 PFAS

As part of the Water Year (WY) 2020 source water monitoring program, the City began PFAS monitoring at source water locations. In WY 2021, PFAS monitoring was increased to evaluate potential impacts from the CZU Lightning Complex Fire as reported in the WY 2021 Report. A summary of the source water and finished water detected PFAS results for calendar years 2019-2021 is shown in Table 5-18 as reported in the WY2021 Report. PFAS were detected in three City's source waters including Laguna Creek, SLR @ Felton Diversion, and SLR @ Tait Street Diversion, as well as in the GHWTP finished water. PFAS were detected in small amounts throughout the WY in the SLR but were only detected during storm events at Laguna

Creek. The highest PFAS result of 46.0 ppt Perfluorobutanoic acid (PFBA) was detected at Laguna Creek during the first storm of the year (November 18, 2020). PFBA does not have a California NL. PFAS were not collected at Loch Lomond and were not detected in Liddell Spring. Out of the twenty-five PFAS compounds analyzed, only two were detected in the GHWTP finished water. With the exception of the high PFBA result from Laguna Creek in November 2020, all other results are considered low, and below their respective NLs.

Storm event PFAS monitoring was conducted at two upper watershed locations including Upper Laguna and SLR Highlands Park. A summary of the detected PFAS results for Upper Laguna and SLR Highlands are shown in Table 21. PFAS were only detected during the November 18, 2020, and January 27, 2021 storms and all results were below their NLs.

Table 5-18: Summary of Unregulated PFAS Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021[1]

Sample Location	*Date*	*Analyte*	*Acronym*	*California Notification Level (ng/L)*	*Result (ng/L)*
Laguna Creek (20 sampling events)	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.8
	11/18/20	Perfluorobutanoic acid	PFBA		46
	11/18/20	Perfluorohexanoic acid	PFHxA		3.6
	11/18/20	Perfluoropentanoic acid	PFPeA		3.1
	12/14/20	Perfluorobutanoic acid	PFBA		6.6
	01/27/21	Perfluorobutanoic acid			4.7
	10/25/21	Perfluorobutanesulfonic acid	PFBS	500	2.5
	10/25/21	Perfluorobutanoic acid	PFBA		3.1
SLR Tait Street Diversion (32 sampling events)	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.7
	11/18/20	Perfluorobutanoic acid	PFBA		4.1
	11/18/20	Perfluorohexanoic acid	PFHxA		3.5
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	6.1
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	3.7
	11/18/20	Perfluoropentanoic acid	PFPeA		4.2
	12/14/20	Perfluorobutanoic acid	PFBA		4.3
	12/14/20	Perfluorohexanoic acid	PFHxA		2.3
	12/14/20	Perfluorooctanesulfonic acid	PFOS	6.5	2.8
	12/14/20	Perfluorooctanoic acid	PFOA	5.1	2.3
	12/14/20	Perfluoropentanoic acid	PFPeA		2.8
	12/28/20	Perfluorobutanesulfonic acid	PFBS	500	2.2
	12/28/20	Perfluorobutanoic acid	PFBA		2.1
	12/28/20	Perfluoropentanoic acid	PFPeA		2
	01/05/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.4
	03/10/21	Perfluorooctanesulfonic acid			3.5
	03/10/21	Perfluorooctanoic acid	PFOA	5.1	2.2
	03/15/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.7
	04/07/21	Perfluorooctanesulfonic acid			2
	05/05/21	Perfluorooctanesulfonic acid			2.2
	06/02/21	Perfluorooctanesulfonic acid			2.3
	07/14/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	07/14/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.4
	07/14/21	Perfluorooctanoic acid	PFOA	5.1	2.1

Sample Location	Date	Analyte	Acronym	California Notification Level (ng/L)	Result (ng/L)
	07/14/21	Perfluoropentanoic acid	PFPeA		2
	09/08/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.1
	10/06/21	Perfluorooctanesulfonic acid			2.2
	10/21/21	Perfluorobutanoic acid	PFBA		2.5
	10/21/21	Perfluorohexanoic acid	PFHxA		2.6
	10/21/21	Perfluorooctanesulfonic acid	PFOS	6.5	4.2
	10/21/21	Perfluorooctanoic acid	PFOA	5.1	2.6
	10/21/21	Perfluoropentanoic acid	PFPeA		2.5
	10/27/21	Perfluorobutanesulfonic acid	PFBS	500	3
	10/27/21	Perfluorobutanoic acid	PFBA		5.7
	10/27/21	Perfluorohexanoic acid	PFHxA		3.3
	10/27/21	Perfluorooctanoic acid	PFOA	5.1	2.5
	10/27/21	Perfluoropentanoic acid	PFPeA		3
	11/02/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	11/02/21	Perfluorobutanoic acid	PFBA		3.8
	11/02/21	Perfluorohexanoic acid	PFHxA		3
	11/02/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.1
	11/02/21	Perfluorooctanoic acid	PFOA	5.1	2.9
	11/02/21	Perfluoropentanoic acid	PFPeA		3.2
	11/03/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	11/03/21	Perfluorobutanoic acid	PFBA		2.5
	11/03/21	Perfluorooctanesulfonic acid	PFOS	6.5	2
	11/03/21	Perfluoropentanoic acid	PFPeA		2.5
	11/09/21	Perfluorobutanoic acid	PFBA		2.8
	11/09/21	Perfluorohexanoic acid	PFHxA		2.6
	11/09/21	Perfluorooctanesulfonic acid	PFOS	6.5	4
	11/09/21	Perfluorooctanoic acid	PFOA	5.1	2.5
	11/09/21	Perfluoropentanoic acid	PFPeA		2.4
	12/01/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.3
SLR Felton Diversion (31 sampling events)	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	2.4
	11/18/20	Perfluorobutanoic acid	PFBA		4.5
	11/18/20	Perfluorohexanoic acid	PFHxA		3.2
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	5
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	3.9
	11/18/20	Perfluoropentanoic acid	PFPeA		3.5
	12/14/20	Perfluorobutanesulfonic acid	PFBS	500	2.9
	12/14/20	Perfluorobutanoic acid	PFBA		3.8
	12/14/20	Perfluorooctanesulfonic acid	PFOS	6.5	2.2
	12/14/20	Perfluoropentanoic acid	PFPeA		3
	02/03/21	Perfluorobutanoic acid	PFBA		2
	03/10/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.6
	03/10/21	Perfluorooctanoic acid	PFOA	5.1	2
	03/15/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.3
	04/07/21	Perfluorooctanesulfonic acid			2.1
	06/02/21	Perfluorooctanesulfonic acid			2.5
	07/14/21	Perfluorohexanoic acid	PFHxA		2
	07/14/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.3
	07/14/21	Perfluorooctanoic acid	PFOA	5.1	2.4

Sample Location	Date	Analyte	Acronym	California Notification Level (ng/L)	Result (ng/L)
	07/14/21	Perfluoropentanoic acid	PFPeA		2
	09/08/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.1
	10/06/21	Perfluorooctanesulfonic acid			2.3
	10/21/21	Perfluorobutanesulfonic acid	PFBS	500	2.2
	10/21/21	Perfluorobutanoic acid	PFBA		5.2
	10/21/21	Perfluorohexanoic acid	PFHxA		3.8
	10/21/21	Perfluorooctanesulfonic acid	PFOS	6.5	4.7
	10/21/21	Perfluorooctanoic acid	PFOA	5.1	3
	10/21/21	Perfluoropentanoic acid	PFPeA		3.8
	10/27/21	Perfluorobutanesulfonic acid	PFBS	500	2.6
	10/27/21	Perfluorobutanoic acid	PFBA		4.5
	10/27/21	Perfluorohexanoic acid	PFHxA		2.5
	10/27/21	Perfluorooctanoic acid	PFOA	5.1	2.1
	10/27/21	Perfluoropentanoic acid	PFPeA		3
	11/02/21	Perfluorobutanesulfonic acid	PFBS	500	2.2
	11/02/21	Perfluorobutanoic acid	PFBA		2.5
	11/02/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.3
	11/02/21	Perfluorooctanoic acid	PFOA	5.1	2
	11/02/21	Perfluoropentanoic acid	PFPeA		2.1
	11/03/21	Perfluorobutanesulfonic acid	PFBS	500	2
	11/03/21	Perfluorobutanoic acid	PFBA		2.5
	11/03/21	Perfluorohexanoic acid	PFHxA		2
	11/03/21	Perfluorooctanesulfonic acid	PFOS	6.5	2
	11/03/21	Perfluorooctanoic acid	PFOA	5.1	2
	11/03/21	Perfluoropentanoic acid	PFPeA		2.8
	11/09/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	11/09/21	Perfluorobutanoic acid	PFBA		2.6
	11/09/21	Perfluorohexanoic acid	PFHxA		2
	11/09/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.2
	11/09/21	Perfluorooctanoic acid	PFOA	5.1	2.3
	11/09/21	Perfluoropentanoic acid	PFPeA		2.2

[1]Source: WY2021 Report; Notification levels have been updated since publication of the WY 2021 Report.

Table 5-19: Unregulated PFAS Parameters Measured in Upper Watershed Waters from 2020-2021

Sample Location	*Date*	*Analyte*	*Acronym*	*California Notification Level (ng/L)*	*Result (ng/L)*
Upper Laguna	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	10.0
	11/18/20	Perfluorobutanoic acid	PFBA		12.0
	11/18/20	Perfluorohexanesulfonic acid	PFHxS		4.9
	11/18/20	Perfluorohexanoic acid	PFHxA		4.5
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	2.7
	11/18/20	Perfluoropentanoic acid	PFPeA		4.0
	01/27/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	01/27/21	Perfluorobutanoic acid	PFBA		3.4
SLR Highlands Park	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.3
	11/18/20	Perfluorobutanoic acid	PFBA		7.0
	11/18/20	Perfluorohexanoic acid	PFHxA		2.7
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	3.8
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	2.0
	11/18/20	Perfluoropentanoic acid	PFPeA		2.6

Source: WY2021 Report

5.4.6.17 Constituents of Emerging Concern (CEC)

In 2015, City initiated quarterly sampling at five locations including raw and treated water sampling locations as well as a first flush sampling of the San Lorenzo River at Felton and at Tait and analyzed them for 96 CEC including herbicides, artificial sweeteners, personal care products, and pharmaceuticals. Most of the CECs (76) were never detected in source water, while the remainder were detected at very low levels. Table 22 of the WY 2021 Report, which is attached as Appendix B, provides results of additional routine and storm event CEC monitoring that was implemented to evaluate potential impacts from the CZU Lightning Complex Fire.

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Section 6 Conclusions and Recommendations

This section begins by discussing conclusions related to the SWTR and AWWA/DHS *Guidance Manual*, then presents specific conclusions related to contaminant sources, monitoring programs, and overall watershed management. Section 6.5 provides a summary of activities, some of which are detailed in Section 6.4, that City and SLVWD can focus on over the next five years that contribute to maintaining and improving source water quality.

6.1 SWTR Disinfection Compliance Requirements

The SWTR requires a minimum of 4-log (or 99.99 percent) virus and 3-log (99.9 percent) Giardia cyst removal/inactivation. DDW requires utilities that report monthly median total coliform concentrations greater than 1,000 MPN/100 mL to increase the minimum level of pathogen inactivation at their treatment plant. Previously, there was a 13 July 1998 letter from DDW's predecessor agency DHS, to City requiring a 5-log (or 99.999 percent) virus and 4-log (99.99 percent Giardia) cyst removal/inactivation because the City's August 1996 to March 1998 median monthly total coliform concentrations exceeded 1,000 MPN/100 mL in 12 out of 16 months. The City has collected bi-monthly total coliform samples from the intakes of each water source and since 1996, and has also monitored total coliform and *E. coli* in the blended water as well as *E. coli* in the individual sources entering the GHWTP. As discussed earlier, in 2012 and 2013, City submitted to DDW an evaluation of GHWTP filter performance data that resulted in a 1-log Giardia treatment credit that remains today.

As shown in Section 5.4.1, raw water total coliform for the utilities have ranged in the moderate to high (> 1,000 MPN/100 mL) concentrations, particularly in areas downstream of urbanization. It also should be noted that crypto and Giardia data presented in the 2018 WSS update indicate very low presence of these pathogens, relative to the total coliform. The waters sources that generally have stream intake structures located upstream of human developed areas (e.g., SLVWD) or downstream from open space areas typically have lower total coliform. The higher total coliform in raw water indicates that removal and inactivation of 4-log viruses and 3-log Giardia cysts is appropriate. The utilities continue to collect and evaluate total coliform data to verify the log removal and inactivation requirements for each system. As improvements are made to the upstream watershed, the data may suggest that review of the requirements are merited.

The one raw water source of most concern is the City San Lorenzo River Intake in Santa Cruz. Between 2017-2021, the highest annual median values of total coliform continue to be measured at the San Lorenzo River sources as shown on Figure 5-1. Felton Diversion water is not pumped directly to GHWTP, rather is pumped to Loch Lomond Reservoir on Newell Creek for storage before use at GHWTP. Loch Lomond water, which is piped directly to the GHWTP, has relatively lower coliform levels; therefore, meriting higher concern regarding the diversion at Tait Street as a source water.

The San Lorenzo River sources are not usually used during the first seasonal rains when turbidity, color and coliform counts can be significantly increased. The San Lorenzo River sources are put back into service after turbidity and color return to baseline levels. When used, San Lorenzo River Intake is usually blended with North Coast and/or water from the Tait Wells, both of which contain significantly lower total coliform and *E.coli* concentrations. The City continually evaluates the need to modify the required level of treatment and disinfection, especially if in-stream flow requirements for fisheries result in source adjustments that do not allow the source blending that currently occurs. Upgrades to treatment at GHWTP as described in 2.8.3 will allow for reliable treatment of higher turbidity water.

6.2 Significant Contaminant Sources

From the survey findings, there are several sources of contaminants, detailed in Section 3, that are potentially significant to the drinking water sources (especially the San Lorenzo River). These sources, in order of relative priority, include:

- wastewater, including discharges from failing septic systems that can contribute pathogens and nutrients;
- unauthorized activity such as homeless encampments that can contribute microbial contaminants, and illegal mountain bike trails contributing erosion and sediments;
- wildfire;
- urban runoff;
- confined animal facilities/stables;
- agriculture including cannabis cultivation (now regulated) which can contribute pollutants including sedimentation from soil disturbance for roads and cultivation, increased nitrate, pesticides/herbicides, and increased water diversions from cultivation; monitoring for unpermitted operations also continues;
- geologic hazards which can contribute sediments.

While a TMDL for chlorpyrifos has been developed for the lower San Lorenzo River, USDA sampling does not indicate this constituent continues to occur very frequently, if at all.

The contaminants on the Regional Board listings extend beyond the constituents found in the drinking water regulations. Not all these contaminants are under the control of the water purveyors, creating complexities in managing them. Table 6-1 associates the existing and proposed TMDLs found in Table 4-1 with the contaminants associated with these sources and the management actions currently undertaken in the watershed to address the TMDL sources. Discussion of individual sources of contamination follow in the sections that follow.

Table 6-1. Total Mass Daily Load (TMDL) Projects and Primary Sources: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds and Associated Management Activities								
		Potential Contaminant Sources and Associated Management Activities						
	Target	***Wastewater*** *(septic systems)*	***Livestock/ stables***	***Urban runoff***	***Timber harvests/ logging*** *(including THP roads)*	***Geologic Hazards and Fires***	***Unauthorized activity*** *(e.g., small-scale grading and homeless encampments)*	*Other Management Activities and Comments*
				Includes Public/Private Roads				
San Lorenzo River Watershed[1]								
Pathogen TMDL *(May 8, 2009)* ***Fecal Coliform TMDL*** *(July 20, 2011)*	Fecal coliform 30-day log mean < 200 MPN, where 10-percent of samples < 400 MPN	•Continued implementation of the County Wastewater Management Program which may further improve meeting nitrogen and pathogen TMDLs.	•Ecology Action's Livestock and Land program has reduced manure loads.	•City adopted a stormwater ordinance •City, County and Scotts Valley have stormwater management plans	not applicable	not applicable	•City has ordinance to obtain conservation easements on private lands in the County adjacent to creeks in order to limit unauthorized activities •City has increased funding for patrols of riparian corridors upstream of the Tait St. •Sheriffs department conducts homeless camp cleanups on an as needed basis	•City partnered with the Santa Cruz RCD to improve community awareness of the watershed by installing signs identifying the creeks and watersheds throughout the County.
Sediment TMDL *(May 16, 2003)*	The sediment TMDL target is currently based on numeric targets for pool volumes for fish habitat and particle size and percent of fines for spawning gravel. RWQCB staff recommends revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst and others (2011).[2]			•County and City previously implemented 8 culvert repairs/retrofit projects which reduce sediment load •RCD implemented a rural roads erosion control assistance program. •County riparian, grading, erosion control ordinances •City stakeholder and school outreach including signage on creek crossings •City regulatory interaction including timber harvest review, County code violations, etc. •City retains certified erosion control specialist for road mgmt				
Nitrate TMDL *(September 15, 2000)*	Nitrate as nitrate levels <1.5 mg/L. (Nitrate as nitrogen levels < 0.34 mg/L)	• Continued implementation of the Wastewater Program has resulted in significant declines in on-site wastewater system failure rates and stopped the rise of nitrate. •SWRCB has adopted policy for on-site wastewater treatment systems pursuant to AB885. • Sewering of areas close to sanitary sewer collection systems has occurred on a periodic basis.						
Chlorpyrifos TMDL *(May 29, 2014)*	TMDL adopted with impairments in San Lorenzo River (below Zayante Creek confluence near Felton), Branciforte and Zayante Creek and Arana Gulch. 2010/2011 data indicate that numeric targets are currently being met			Urbanized areasand roadways are likely contributors				
Chlordane TMDL	TMDL to be developed by 2027							*Sources unknown*
PCBs TMDL	TMDL to be developed by 2027							*Sources unknown*
Temperature TMDL	TMDL to be developed by 2023							*Many factors including sedimentation, nutrients, loss of vegetation, loss of baseflow*
Newell CreekWatershed								
pH 303d List	TMDL to be developed by 2027							
Loch Lomond								
Proposed Mercury 303d List	No TMDL date indicated at this time							

Notes

[1] Date approved by RWQCB

[2] Studies conducted by various authors have concluded erosion rates were two to four times the natural rates … Desired conditions taken from values published in scientific literature were 27% lower on average for the San Lorenzo River than measured values. Parke and others (2010) compared sediment transport in WY 2009 and 2010 to rates in the 1970s and 1980s, and note possible load reductions between 464- and 106-percent.

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6.2.1 Significance of Contaminants

Distinguishing between significant and less-than-significant contaminant sources is often difficult but is important, especially in Santa Cruz County, which is 100 percent reliant on local streams and aquifers for its water sources – a relatively rare situation in most of California. As described in the Watershed Sanitary Survey Guidance Manual, the significance of a potential contaminant source is intended to be comparative within the watershed and can be evaluated on a case-by-case basis. The relative significance of a contaminant source can be based on the relative health significance, the distance to the intake, the magnitude of the contaminant source as well as other factors. Microbial contaminants may result in acute illnesses while many chemical contaminants result in chronic illnesses.

Another burden in assigning contaminant significance is that some sources become significant only during years of extreme conditions or following episodic events. An additional threshold in establishing significance is the possibility that one or more sources may be permanently lost or lost long-term to any number of causes. Within this context of significance, a discussion of each contaminant source and potential recommendations are provided in the following paragraphs. Table 6-2 summarizes the significant contaminant sources and their relevance to the City's water sources.

Table 6-2. Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds

Contaminant Source	*San Lorenzo Valley*	*Loch Lomond Reservoir and upper Newell Creek*	*North Coast*	*Information supporting significance*	*Recommendations*
	✓ denotes significance				
Wastewater (septic systems)	✓	✓		Elevated/increasing nitrate in streams, downstream of more densely populated areas	- Continue Implementation of LAMP for AB885 implementation - Evaluate water quality data from City and County to assess need for updated study on nitrate and microbial contributions especially in sandy soils and karst - Review proposed development plans near intakes
				Elevated coliform counts downstream of urban areas.	- Continue to support County implementation of LAMP Wastewater activities and additional requirements, if any, of AB885 Septic system regulations especially as they relate to accessory dwelling units in the watershed - Continue collection and review of water quality data on short-term basis and notify if elevated coliform or nitrate is detected and conduct a more detailed long-term data evaluation to determine if a updated nitrate load and/or nitrate management plan is merited - Coordinate with County and RWQCB on monitoring and assess which portions of the watershed are still considered impaired -The County should work with SLVWD to consolidate its Bear Creek Estates Wastewater System into the County's CSA7 sewer system and future projects
Unauthorized Activity	✓	✓	✓	Homeless encampments adjacent to waterways can be a source of human waste. Small-scale grading and timber harvests frequently use poor practices, which increases sediment loading to the surface water streams. Trespass by vehicles and mountain bikes also results in erosion and sedimentation. Illicit methamphetamine laboratories and cannabis cultivation occur in the watershed.	- Continue to advocate and support homeless encampment relocation away from waterways -Continue past recommendations of homeowner outreach; collaboration with DFW, RCDs and other organizations; County enforcement of grading/clearing violations; patrolling and enforcement of existing ordinances for unauthorized activity that can result in water quality impacts[2] -Continue active involvement/coordination in cannabis related regulation in the watershed - Continue to develop conservation easements on key riparian properties[2]
Geologic Hazards and Fires	✓	✓	✓	▪Elevated sediment loading during the wet season, frequently caused by landslides or slumping of roads. ▪Persistent turbidity may be experienced for several months to several years following a major watershed-scale fire.	▪Continue past recommendations to manage fuels and reduce wildfire hazards; ▪Enhance collaboration with CalFire on supporting CWPP priority projects. -Lobby for the CWPP to recognize Loch Lomond as an asset at risk. -Complete the City's fire protection plan for watershed properties. -Maintain fuel breaks on watershed lands -Continue Integrated Pest Management Program that addresses herbicide application for maintenance of fuel breaks for fire preparedness; and -Monitor water quality after fires and if needed, develop plans to augment water supply/restrict water used during and after fires
Urban Runoff[1]	✓	✓		-Elevated coliform bacteria downstream of urban areas. Reduced coliform through open space areas. Baseline fecal coliform bacteria mostly attributed to non-human sources; in the San Lorenzo River no human contributions were identified in dry season sampling. Microbial Source Tracking found wildlife account for the majority of bacterial contamination, especially in dry season. - Urban runoff is also associated with other pollutants as well as increased erosion. Urbanization over sandy soils is particular concern because they are prone to substantially more sedimentation than other soils and reduced recharge can increase concentration of constituents in groundwater.	-Evaluate development of sandy soil BMP guidelines with a focus on implementing LID measures in new and redevelopment which reduces sediment production as well as other water quality benefits[2] -Continue SWMP implementation and stormwater management including sediment/erosion control from roads, and LID conversion on areas of urbanization[2] -Coordinate with IRWM Program on stormwater management -Review applicaiton and enforcement of County riparian ordinance. - Evaluate water quality data from City and County to assess need for updated study on nitrate and microbial contributions especially in sandy soils and karst
Concentrated Animal Facilities	✓		✓	Horses are considered a major source of pathogens and nitrogen and can also contribute to persistent turbidity in the water supply watersheds. Hecht and others (1991) estimated that horses in the San Lorenzo Valley contributed nitrogen equal to one fifth or more of the amount released from septic systems.	-Support funding for RCD Livestock and Land Program and owner outreach to continue its success. - Conduct targeted enforcement of problem facilities especially those in the vicinity of diversions; attempt to leverage the Regional Board in enforcement and site visits. - Water purveyors should continue to investigate opportunities for acquisition/conservation easements/partnerships with lands trusts/alternative funding.
Public/Private Roads and Timber Harvests	✓		✓	The primary potential problem arises with erosion resulting from the roads constructed to access residences and logging areas. Another major regional challenge especially specific to the San Lorenzo watershed is to reduce sediment delivery from erosion of road treads. Deep, multi-branched gully systems tend to develop on roads cut into weathered slopes within (especially) the Vaqueros and Butano sandstones. The gullies are left to continue growing, or are temporarily filled during spring re-opening of harvest areas only to re-erode with the next wet season.	-Continue past recommendation of coordinating locations to stabilize and dispose of landslide material. -Continue to support RCD rural private roads evaluation and maintenance training programs. - Develop road density analysis using County GIS information for key water supply watersheds. -Continue past recommendations of monitoring proper road abandonment after logging; enforcement of existing requirements, where applicable; lobby for notification of timber harvest permits and inspections2 - Monitor RWQCB implementation of 2012 updated conditional waiver of waste discharge requirements for timber harvest2 -Emergency exemptions, which enable landowners to do salvage logging following wildfires should be revised to require pre-harvest inspections for areas with an erosion hazard rating of "high" or "extreme" - Salvage logging should be prohibited in municipal and public water district watersheds. -Water purveyors should continue to lobby to be included as official review team members for harvests which have the potential to impact supply. -Water purveyors should investigate opportunities for acquisition/conservation easements/partnerships with lands trusts/alternative funding.
Quarries	✓		✓	Of the 4 quarries in the San Lorenzo River Watershed, Felton and Quail Hollow Quarries are still active. Reclamation at Hanson Quarry is presently underway, while reclamation at Olympia Quarry is stalled due to endangered species issues. Mining ceased at the CEMEX Bonny Doon Quarry in the Liddell Springs Watershed, and reclamation is underway. Cclosed mines can still impact water supplies until reclamation is complete or by post-quarry land uses.	- Continue efforts to obtain water quality and quantity data monitored by quarry operator on an informal basis. - Continue past recommendations of tracking and review of staff and EIR reports including closure and post-closure water quality monitoring reports[2] -Monitor regulatory oversight of industrial operation at Bonny Doon Quarry.
Vehicle Upsets and Spills (LUSTs)	Potential		Potential	▪ Valeteria Dry Cleaners LUST monitoring results in downstream San Lorenzo River show occasional PCE detections in 2012 and 2013 and ongoing groundwater detection in 2017 suggesting wastes released at the site have migrated, and may continue migrating downgradient - remediation is ongoing; while Chevron and Sturdy Oil sites have closed; and, Watkins-Johnson show no indication of contamination within the stream network; and ▪The potential exists for significant chemical spills caused by traffic accidents and in recent years several accidents have affected local waterways. City staff report that timely notification from the County is an ongoing area of concern and is not consistently performed in a functional manner.	-Continue raw water testing for testing of chemical contaminants especially those from fire retardants and combustion products -Continue to improve collaboration with County Hazardous Materials Section -Improve communication with dispatchers at 911/NetCom (Santa Cruz Consolidated Emergency Communications Center) by meeting annually with dispatchers at regularly scheduled meetings
Pesticide and Herbicide Use	✓			-RWQCB TMDL for chlorpyrifos and recommendation to list San Lorenzo River for chlordane although water quality sampling has not confirmed presence -City has continued its herbicide use to maintain fuel breaks on ridge tops for fire preparedness. -When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Newell Creek Reservoir to protect against degradation of beneficial uses	-Continue Integrated Pest Management Program that addresses herbicide application for maintenance of fuel breaks for fire preparedness. -Coordinate with the RWQCB/CalFire/Law Enforcement to identify sources, especially as related to illegal/legal cannabis cultivation. -Continue periodic pesticide/herbicide scans of raw water, especially in alignment with timing of application for cannabis cultivation -Monitor Caltrans' preparation of a Vegetation Control Plan

Notes

[1]Point source discharges regulated by the RWQCB do not exist in the watershed areas.

[2]These recoemmendations are supportive of the draft Habitat Conservation Plan for Steelhead and Coho Salmon that has been prepared by the City

6.2.1.1 General Land use and Urbanization Conclusions

As discussed in Section 3.2, the San Lorenzo Valley has a large number of septic systems on both sandy and non-sandy soils, with some systems that overlie karst; septic systems are recognized as a major source of nitrate to the river and its tributary streams. Wastewater, urban runoff including from homeless encampments, and horses, other domestic animals and pets also contribute to elevated nitrate levels. Microbial contaminants are associated with failing septic systems, urban runoff, and horse stables.

The County's wastewater management program endeavors to address problem septic systems, promoting system upgrades where feasible, requiring alternative systems where appropriate, and encouraging connection to wastewater treatment/disposal systems that discharge outside the watershed as has occurred at the Rollingwoods subdivision. The Bear Creek Estates package plant, serving 54 homes, was upgraded in 2005 yet still experienced spills during the heavy rains of 2017. SLVWD is reaching out to the County to consolidate Bear Creek Estates into the County's CSA7 sewer system. The package plant at Boulder Creek Golf and Country Club was upgraded to reduce nitrates and wastewater spills from the force main. Implementation of the San Lorenzo River Nitrate TMDL and the County's Nitrate Management Plan shows short-term (5-year) variability in nitrate concentrations but evidence of long-term (50-year) increases in nitrate concentrations per Figure 5-10. The effectiveness of current water quality improvement activities and the need for additional control actions may require further study.

Previous studies have indicated that septic systems, wildlife, livestock and pets, and urban runoff are all significant sources of microbial contaminants in the San Lorenzo River. More recently, homeless encampments adjacent to the rivers and tributaries have also been identified as a source of microbial contamination.

As described in 5.4.6.15, the City's microbial source tracking monitoring, which uses four analytical methods, identified that human microbial influences, potentially from septic systems, appear generally higher in the winter. The findings contrast with the dry season results with higher animal influences when flows are lower and animal activity is higher.

The San Lorenzo Valley does not have a system of curbs, gutters, and storm drains to convey runoff to the River; roadways with curbs, etc can also have unintended consequences of concentrating runoff if not well maintained, especially during storms. Water quality impacts of road runoff can be mitigated by protecting existing open space areas near stream banks to filter runoff, focusing public education on source control, and preventing contamination of runoff, and maintaining the water treatment plants in optimal working condition.

Previous WSS Updates have noted contaminant reduction in the six stream miles in Henry Cowell Redwoods State Park between southern Felton and northern Santa Cruz. One reason why nitrate and bacterial loadings have historically remained at lower levels than experts predicted may be due to the reaches of undeveloped stream between communities in many areas of the San Lorenzo Valley. A more comprehensive evaluation of microbial data from the City's sampling as well as stormwater sampling with septic system installations/improvements and stormwater improvements may be merited.

6.2.1.2 Water Utilities Influenced

Utilities that obtain surface water from an urbanized watershed area are influenced by both septic system and urban runoff discharges to area streams. These utilities include primarily the Santa Cruz Water Department and selected areas of the San Lorenzo Valley Water District including Lompico Creek.

6.2.1.3 Wastewater Discharge Recommendations

To minimize the impacts from wastewater treatment discharges, primarily septic systems, recommended actions include:

- The County should continue implementation of the LAMP, the successor to the 1995 Wastewater Management Plan which was prepared in accordance with AB885 as discussed in Section 4.9.2.4, especially as they relate to accessory dwelling units. Inspection frequency should be increased. Records of inspections and upgrades should be kept in both tabular and in map form, preferably on the County's GIS system, to allow focus on problem areas, especially those overlying sandy soils and/or karst.

- Purveyors should continue to collect, tabulate, and review the water quality data on a frequent basis (e.g., annually) and to review long-term data to evaluate the effectiveness of ongoing wastewater and stormwater management programs. These data should be reviewed in collaboration with the County Environmental Health and the Regional Water Quality Control Board so that appropriate follow-up action can be taken by the appropriate agency.

- Drinking water purveyors should inform County Environmental Health when elevated coliform or nitrate levels are detected in raw water sources. While there have not been nitrate levels in exceedance of the maximum contaminant level, the need for a more detailed data evaluation to corroborate the long-term gradual increases of nitrates in the San Lorenzo River on Figure 5-10a–d should be considered to assess whether an update of the nitrate load estimate and, if appropriate, the County's 1995 Nitrate Management Plan is merited.

- Water purveyors should review development plans for sites upstream of source water intakes to verify that measures are in place that will address key issues such as septic system discharges and urban runoff. Specifically, City (and secondarily, SLVWD) should work with County Environmental Health and Planning to review proposed developments upstream of their intakes to verify that acceptable control measures planned and that mitigation measures have been appropriately implemented and maintained.

- The County should work with SLVWD to consolidate its Bear Creek Estates Wastewater System into the County's CSA7 sewer system and future projects. The current Bear Creek Wastewater system is unable to meet the 50 percent nitrogen reduction set by the California RWQCB Central Coast WDRs and has been out of compliance since 2012. The costs determined in a 2020 feasibility study to upgrade to the system to meet the permit requirements ranged from $67,000 to modify existing trickling filters to $4,135,000 to construct a new collection system and packed bed filter. Costs to serve the 57 connections resulted in monthly wastewater rates ranging from approximately $345-$857 per month per connection, dependent on the treatment system upgrades selected. Consolidation with the County may facilitate moderating a sudden increase in operations and maintenance costs while reducing nitrogen into the SLR.

6.2.1.4 Urban Runoff Recommendations

Recommendations to control water quality impacts from urban runoff include:

- In coordination with 6.2.1.3, evaluate surface water quality data to evaluate effectiveness of ongoing wastewater and stormwater management programs.
- Evaluate development of best management practices such as low impact development (LID), and management measures directed at the unique properties of sandy soils and karst within watersheds, which call for a common set of measures to minimize nutrient loads, maintain aquifer recharge and the resulting baseflow, minimize erosion, sedimentation, and channel incision, and protect springs/seeps/wetlands and riparian-zone resilience during dry months and dry years.
- The County should implement the SWMP in the watersheds as accepted by the Regional Board. Implementation should include conversion of existing urbanized areas to LID, especially in areas of high water quality benefit.
- Coordinate with Santa Cruz Integrated Regional Water Management (IRWM) program on stormwater management including implementing public education/involvement program to minimize contaminant loading from stormwater runoff. The IRWM program can be used to supplement efforts by the purveyors and the County to inform customers and watershed residents of the ongoing water quality and supply issues. Many residents are not aware or do not appreciate the dual nature of the San Lorenzo Valley – a rural residential area, locally approaching urban densities, and the central water-supply source for the region.
- The County should improve its enforcement of ordinances (e.g., grading, riparian corridor and wetlands protection, sensitive habitat protection, and water quality control) as well as increase coordination efforts with the City and others in riparian protection incentive and mitigation bank opportunities in coho recovery and water supply watersheds to maximize and protect riparian setbacks from drainageways and streams.
- The County should review how and when the ordinance has been applied and its effectiveness and review whether strengthening of the riparian ordinance, discussed in Section 4.9.1.2., is merited.

6.2.2 Confined Animal Facilities

6.2.2.1 Conclusions

Horses, the main confined animals in both the North Coast and San Lorenzo River watersheds, can be a major source of wet season nitrate and bacteria levels in surface waters, and a contributor to persistent turbidity as well. Nutrients and pathogens can be mobilized from uncovered manure piles. Trails which cross stream channels degrade stream banks and facilitate direct contamination of surface waters. Similar effects are observed where paddocks adjoin waterways and horses traverse stream banks to reach the water. While the County, the NRCS, the RCD, Ecology Action and various equestrian and watershed groups have developed programs to educate horse owners and assist them; funding has been limited to promote and implement design and installation of measures to control pollution from horsekeeping. The County requires that manure management programs are developed for all new permittees and that it is able to apply its riparian ordinance to provide the buffers and access management required to minimize nutrient, bacterial, and sediment loadings to surface waters. Although substantial improvements have been realized since the original 1996 Watershed Sanitary Survey, primarily through voluntary methods that are discussed in Section 3.6.2, continued sustained effort is needed on both education regarding voluntary programs and enforcement of existing ordinances by the County.

6.2.2.2 Water Utilities influenced

Utilities that draw surface water downstream from bankside stables or areas intensively used by horses can observe higher turbidity and coliform counts. These entities include the Santa Cruz Water Department and the San Lorenzo Valley Water District.

6.2.2.3 Confined Animal Facilities Recommendations

It is recommended that the voluntary measures such as the RCD's Livestock and Land Program, with particular focus on horse owners near the waterways, be continued and supported. In addition, it is recommended that the County track complaints and permit violations as well as conduct periodic inspection and monitoring targeting those stables closest to the streams and river. The County has a Livestock Property Regulation document for landowners. Prior to enforcement, it is suggested that these stable owners should be made aware of the voluntary programs, and only if non-compliance consistently and broadly occurs should enforcement (including referral to the RWQCB) or development of an ordinance be considered. If developed, an ordinance should include simple and effective control measures coordinated through user groups and/or non-regulatory entities with stricter enforcement reserved for significant non-compliance. As an alternative to enforcement, opportunities to develop conservation easements and/or partnerships with land trusts and alternative funding should be considered. Horse stable runoff control practices should be implemented regularly, but particularly emphasized during the fall months in order to minimize contaminant loading during the next rainy season.

6.2.3 Unauthorized Activity

6.2.3.1 Conclusions

Activities, such as non-permitted grading and mountain biking outside of designated areas, cause significant sediment loading to streams as well as posing a fire threat, drawing valuable first responder resources, and introducing invasive species. Homeless encampments can contribute microbes. As discussed in Section 3.13.1, illegal cannabis cultivation in the watershed has declined with legalization; the County conducts flyovers to identify illegal cannabis. Some cultivation may be moving indoors, which has fewer water quality impacts but produces more greenhouse gas as a result of the energy usage for lighting and ventilation, and could be subject to fire hazards from non-compliant electrical systems. Legal cannabis cultivation, discussed in 3.4.2 is regulated by the County and other agencies. Illegal cannabis cultivation can contribute a range of contaminants including sediments from tree removal and grading, chemicals/nutrients, sanitary waste as well as diverting water valuable to ecosystems. Unauthorized water diversions can limit City source availability and result in lower raw water quality. The cumulative impact of such activities in and near channels can significantly increase turbidity and other water quality threats in streams.

Changes to the City municipal code have facilitated code enforcement by authorizing City rangers to take enforcement actions on City-managed lands that may be outside of the City limits (e.g. Loch Lomond and the San Lorenzo River). In addition, a conservation easement/license program has been established to expand the City's enforcement area to private lands between the San Lorenzo River Intake and Sycamore Grove and is part of the City's Riparian Conservation Program. Coordination with other officials in the watershed, e.g., the County, CDFW, and CalFire has occurred and should continue.

6.2.3.2 Water Utilities Influenced

Utilities that use surface water collected from developed and undeveloped watershed areas are influenced by unauthorized activities. These utilities include the Santa Cruz Water Department and San Lorenzo Valley Water District as well as smaller purveyors throughout the survey area.

6.2.3.3 Unauthorized Activities Recommendations

As discussed in Section 3.13, unauthorized activities are considered a chronic and ongoing source of contamination. It is recommended that:

- The City and SLVWD should continue to patrol and advocate for and support removal of homeless encampments, education of the mountain biking community regarding water quality impacts of illegal trails, as well as developing conservation easements/licenses on riparian properties; mitigation banks for making riparian improvements and other incentives for riparian property owners.

- Outreach to homeowners regarding negative impacts of grazing should be continued, perhaps through reinvigorating past programs such as RCD's Lands and Livestock.

- Collaboration with State Parks, CDFW, CalFire, and/or NGOs regarding other threats should be improved so that water utilities can be prepared for potential contaminants.

- Seeking compliance with existing ordinances and providing education and enforcement should be prioritized, with water-quality protection in mind.

6.2.4 Roads

6.2.4.1 Conclusions

As discussed in Section 3.3 Urban Runoff and Section 3.15 Geologic Hazards, roadways are a source of a range of contaminants including sediments and chemicals. Roadways that contribute contaminants include roads maintained by private landowners, as part of roads associated with residences and timber harvest and management, as well as public roads maintained by the County Public Works Department, and by Caltrans. Clearing of landslide debris on roadways and poor maintenance of public and private roads increase erosion and sediment loading to local streams. Roads which require recurrent replacement due to failure of the underlying slopes disproportionately contribute to sedimentation, turbidity, and persistent turbidity.

6.2.4.2 Water Utilities Influenced

All drinking water purveyors that rely on surface water supplies located downstream from any roadway are influenced by this source.

6.2.4.3 Roadway Maintenance Recommendations

In the past, Caltrans and the County Public Works Department have taken significant measures to improve roadway debris control and general maintenance. Measures taken include developing suitable practices to stabilize and dispose of landslide material and to control runoff from stockpiled material. The County, in consultation with water agencies, should identify areas suited to establish additional road maintenance service sites, and mechanisms to quickly move stockpiled material to long-term storage areas, such as has been implemented at the Cabrillo Quarry in Aptos.

As discussed in Section 4.7.1, the County previously maintained a Road Maintenance Manual that is used for road maintenance activities to minimize water quality impacts. In addition, the RCD and the NRCS have developed rural road assessment and education materials which evaluated rural private roads. They also developed a maintenance training program which has acquired a statewide reputation over the past 10 years. These programs and manuals help assure that appropriate measures are being implemented on both private and public roads and can be a resource for those individuals embarking on licensing of legal cannabis cultivation. The County has previously secured grants to evaluate improved roadside maintenance practices in riparian areas (herbicide reduction/elimination) and to prepare a new manual for road maintenance practices (erosion and sedimentation reduction). Herbicide use on road right of ways, discussed in Section 3.7.2, are likely the largest source of herbicides in the watersheds; therefore, continued herbicide reduction should be a priority to the County, Caltrans and PG&E. The inventory of potential sediment sources along county roads in the San Lorenzo River watershed identified priority projects for designed, permitting and implementation through the Integrated Watershed Restoration Program (IWRP) with funds from the Coastal Conservancy, State water bonds such as Proposition 1, and other sources.

Roads do, however, remain a major source of turbidity, and road systems periodically contribute large volumes of sediment when culverts are blocked or when concentrated runoff from roads cause incision: (a) into slopes between the road and the stream network, and (b) within the channels, by concentrating runoff and magnifying peak flows in streams.

It is recommended that:

- The County continue to use and augment the road maintenance measures and procedures developed by CalTrans and Public Works, including updating the County website with guidance documents and implement measures to control the downstream incision and bank erosion and stabilize and dispose of landslide material as well as measures to minimize pesticide and herbicide use.

- The County develop road density analysis using County GIS information for key water supply watersheds. The mapping information can be used to identify areas for inspection and maintenance activity. Rural roads, including those in the City and SLVWD properties, should be inspected prior to the rainy season and maintained as needed.

- Water purveyors support the RCD private rural road evaluation and maintenance training program to private residential and timber-harvest roads within the County (especially those in proximity to diversions and intakes).

6.2.4.4 Timber Harvests Roadway Recommendations

The recommendations stated above for roadway maintenance should also be applied to roads allowing access for timber harvests, especially after wildfire, by CalFire, owners, and other participants in THP review. Other recommendations are:

- For major portions of road networks, owners should require properly abandoned or rested (closed until next harvest) roads after logging activities are completed. Regulatory agencies should confirm this with monitoring. Methods include blocking access to the area and restoring road cuts to the original slopes, especially in areas where road densities exceed 3.0 miles per square mile (as recommended by NOAA Fisheries) within portions of a particular watershed within the THP ownership and adjacent to it.

- Purveyors should advocate for follow-up restoration of roads from NOAA fisheries road density analysis for key water-supply watersheds, using NOAA fisheries threshold of 3 miles per square mile as an indicator of ecosystem health.

- Purveyors and the County should work with CalFire to aggressively enforce existing requirements to minimize area damage and maintain roadways, with special attention to segments close to streams and emergency exemptions for salvage logging in high erosion hazard areas.

- Support effort to prohibit salvage logging in key municipal and public water district watersheds where it is inconsistent with fire resiliency and overall forest management needs.

- Monitor RWQCB implementation of 2012 updated conditional waiver of waste discharge requirements for timber harvests.

- The City and other water purveyors should lobby for inclusion in the official THP review team, including PG&E right of way maintenance activities, rather than be limited to an advisory role particularly for those harvest that have high potential water quality risk.

6.2.5 Mining/Quarry Activities

6.2.5.1 Conclusions

Quarries have been identified as a potential source of sediment during major storm events, reportedly caused by the failure of onsite settling/retention ponds to contain event stormwater runoff.

In the North Coast watersheds, Bonny Doon Quarry operations, specifically blasting, have historically contributed to periodic turbidity and nitrate spikes at Liddell Spring which pose challenges at the City's water treatment plant.

However, as discussed in Section 3.9, the Bonny Doon Quarry is now closed and undergoing reclamation. Therefore, this sediment source has decreased. In addition, nitrate data collected at Liddell Spring since 1967 suggests that background nitrate levels at the Spring had been steadily increasing from about 0.3 mg/l in the late 1960s to values above 1.0 mg/l in the 1990s. More recent data from 2017 to 2021 as shown on Figure 5-9 show that historic peak value of 2.3 mg/l in 2001, has not occurred recently and that most values are < 0.3 mg/l. The possible source of some of the historic elevated nitrate levels could be from quarry blasting (ammonium nitrate) at Bonny Doon Quarry – however, this was never confirmed and is no longer an issue with closure of the quarry. Post-quarry industrial activities and other land use changes should be evaluated for potential sources of contaminant including wastewater treatment for employees, chemical storage, and stormwater runoff.

6.2.5.2 Utilities influenced

The City has been periodically influenced by turbidity increases in the Liddell Spring source. In the San Lorenzo River watershed, the City is affected by sediment contributions from the one active sand quarry (Quail Hollow), one rock quarry (Felton) and from discontinued quarries (Olympia and Hanson) should stormwater containment facilities fail.

6.2.5.3 Quarries and Mines Recommendations

The City should advocate for water quality monitoring during closure and reclamation.

The City should also continue to review staff and EIR reports including closure and post-closure water quality monitoring reports.

Quarry operators and downstream water users should also:

- Review trends of water quality data collected. This review will help to identify effectiveness of implemented BMPs or any failure of onsite treatment practices, as well as promote meaningful input from purveyors into appropriate modifications of conditions during the 5-year permit-renewal process through the County.

- Recommend specific water quality objectives for springs and streams located downstream of quarries and request additional water quality data, if and where necessary.

- Inspect quarries routinely, including visits in the fall period to verify the capacity and condition of onsite settling/retention ponds and erosion control structures, and that these are prepared for heavy rainfalls.

- Monitor regulatory oversight of potential industrial land uses at Bonny Doon Quarry.

6.2.6 Geologic Hazards and Fires

6.2.6.1 Conclusions

Landslides are the most frequently occurring geologic event affecting the drinking water supply, causing elevated turbidities following major storm events. Earthquakes and erosion from fire areas can severely increase sediment and natural organic matter loading to surface waters, both initially and during the process of 'recovery' from these episodic events. Flame retardants associated with fighting wildfires and combustion products from homes and vehicles also pose a risk to water quality. Finally, erosion following major fires, floods, landslides and possibly droughts or earthquakes can disrupt use of some or many surface water intakes for periods ranging from several months to several years, or deliver a pulse of sediment to the channel which may take years to dissipate.

6.2.6.2 Utilities influenced

All utilities that use surface water can be influenced by geologic hazards and fires in these watersheds. Water treatment plant operators are usually aware of the potential turbidity spikes that may occur through review of online turbidity information.

6.2.6.3 Recommendations

Many of the recommendations from Section 6.2.4 for Roads are relevant for Geologic Hazards. Further recommendations regarding fires, some of which were discussed in Section 4.8, include:

- Continue to manage fuels and reduce wildfire hazards.

- For the watershed that drains to Loch Lomond, the City should continue to meet with fire management staff to communicate changes to security, field conditions, and other information necessary for fire management as well as incorporate recommendations of the 2021 Opportunities and Constraints Report, the Wildfire Resiliency Plan currently under preparation and continue the increased patrolling during fire season.

- Enhance collaboration with CalFire on improving Community Wildfire Protection Plan projects which includes Loch Lomond and SLVWD watershed lands as an asset at risk under CWPP.
- Maintain fuel breaks on watershed lands relative to use of herbicides in alignment with Integrated Pest Management Program policies. Most purveyors drawing upon surface or spring supplies should anticipate extended turbidity events following a large fire in their watersheds. Surface or spring supplies could also be impacted by flame retardants that should be monitored for in the wet season post fire. Planning should include monitoring water quality, implementation of water treatment processes for more turbid water, and for protecting diversion or distribution facilities from post-fire erosion and slope instability. While difficult, identifying alternative sources of supply, if needed, during the months or years following the fire for both turbidity and flame retardants should also be investigated.

6.2.7 Chemical Spills

6.2.7.1 Conclusions

Three groundwater chemical plumes in Felton have been reasonably contained by contemporary standards. The former Chevron and Exxon stations cases have been closed with investigation and follow up remediation at the Valeteria site anticipated as described in 3.10. The potential remains for chemical spills on highways, on major County roads such as Felton Empire Road or Smith Grade.

6.2.7.2 Utilities influenced

All utilities which obtain surface water from developed watershed areas are potentially influenced by spills on local roadways which should be managed by halting water diversion until clean-up has been completed and the pollutant has passed. In addition, long-term discharges such as from leaking underground tanks can be a source that eventually make their way to the creeks and rivers. Currently, the City is the only utility which has detected any solvent-type chemicals in the water. One chemical, PCE has been detected at levels 5 to 10 times below the regulated limit at the Felton Diversion, and not at any intake used to supply water directly to the treatment plant.

6.2.7.3 Recommendations

In an effort to minimize the impacts of chemicals, it is recommended that:

- Continue raw water testing of chemical contaminants, as appropriate,especially those that may be associated with post fire retardants and combustion products
- Collaboration with the Santa Cruz County Hazardous Materials Interagency Team (SCHMIT). Regarding notification of long-term spills and advocate for control of

hazardous materials transport be improved through periodic calls/meetings. SCHMIT responds to major hazardous materials incidents county-wide and is staffed by hazardous materials technicians from several area fire departments; and

- Continue efforts to communicate with dispatchers at NetCom and on-scene responders to discuss water agency spill notification procedures.

6.2.8 Pesticides and Herbicides

6.2.8.1 Conclusions

While the RWQCB established a TMDL for chlorpyrifos for the lower San Lorenzo River including the area of the San Lorenzo River Intake and the San Lorenzo River is now listed as impaired for chlordane as well as for PCBs as shown in Table 4-2, the occurrence of pesticides/herbicides has historically been low and not detected in the WY2021 as discussed in Section .5.4.5. However, the merits of the TMDL are unclear as data are limited to a few samples and chemical usage in the past has been limited.

6.2.8.2 Utilities influenced

All utilities that obtain surface water from watershed areas are potentially influenced by pesticides/herbicides, especially as illegally used for cannabis cultivation and for other agriculture such as vineyards, in the watershed.

6.2.8.3 Recommendations

In an effort to minimize the impacts of pesticide/herbicide use, it is recommended that:

- Continued implementation of an Integrated Pest Management Program to address appropriate herbicide application for fuel break maintenance.
- Coordinate with agricultural users (e.g., legal cannabis cultivation, vineyards, and tree farms) to identify sources.
- Advocate for organic-only agriculture in the watershed.
- Continue periodic pesticide/herbicide scans of raw water to identify in alignment with timing of application for vineyard/tree farm cultivation for potential frequency and severity of water quality impact.
- Monitor preparation of Caltrans’ Vegetation Control Plan required under 2022-XXX-DWQ (no number was available for this order adopted) the NPDES permit for stormwater management as well as PG&E and County pesticide/herbicide use.

6.3 Potential Contaminant Sources That Are Not Significant

Table 6-3 lists the potential contaminant sources which are not deemed to be significant contributors affecting public health at this time. The table lists the supporting information and exceptions when noted. Given the particular Santa Cruz County environment, most of these sources could become significant at times, conditions, or with events discussed above (Section 6.1). Conclusions for these potential contaminant sources are discussed in the following paragraphs.

Table 6-3: Potential Contaminant Sources Less Significant: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds			
Contaminant Source	***Supporting Information***	***Exceptions***	***General Conclusion***
Wildlife	SLVWD staff indicate that feral pigs no longer appear to be an erosion problem near intakes.		Pigs and other wild animal populations do not appear to have a significant potential for contamination of surface waters at this time.
Solid/Hazardous Waste Facilities	The Ben Lomond municipal landfill closed in 1987. No known hazardous waste facilities exist in the watershed.	Any remaining plume is not deemed a threat to water supply. County has needed to remove naturally-occurring cadmium which leaches from shales as a result of their exposure to the atmosphere as a result of landfill excavating activities.	Down-gradient monitoring indicates no contamination of surface waters.
Recreation	Recreational activities generally considered of most significance involve water contact recreation. However, an evaluation of the County fecal coliform bacteria data, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system. Bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).	The introduction of fecal matter from horses may be significant, especially at stream crossings. The potential for erosion from hiking, horseback riding, and mountain biking may also be significant.	There is an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. Erosion control measures have spread quickly throughout the survey area, both on public and private lands. Law enforcement has begun issuing tickets to bikers using illegal trails.
Agricultural Land Use	Less than one tenth of one percent of area of the watersheds is cultivated although some expansion in the Majors Creek watershed has occurred. Wineries may require National Pollutant Discharge Elimination System (NPDES) permits for process waters. Legal cannabis cultivation is limited to one grower in the watershed and is closely regulated.	Some small facilities or private-home vineyards need to improve their erosion control practices, particularly on steeper slopes.	Vineyards are generally not located near streams. Sediment contributions from these areas are usually attenuated before it reaches streams and intakes. Legal cannabis cultivation locations, especially near water ways, should be identified and monitored

6.3.1 Wildlife

The previous County's microbial source assessment study identified birds/wildlife as major contributor to elevated bacteria levels in the San Lorenzo River and tributary streams, especially during the summer as discussed in Section 6.2.1.1. Other wildlife was also found to be a significant source of bacteria, including stocked fish and geese that are found at Loch Lomond. Along with the SLVWD, all utilities with surface and/or spring water intakes in the upper watershed are potentially influenced by birds and other wild animals in the area. If wildlife access at diversions is occurring, fencing, and providing alternative water supply should be considered.

6.3.2 Grazing Animals and Livestock

Grazing is not widespread in the subject watersheds. Most of the existing grazing occurs away from local streams.

6.3.3 Solid or Hazardous Waste Facilities

The one closed landfill in the San Lorenzo River watershed (the Ben Lomond Landfill) does not appear to be contaminating the nearest stream, Newell Creek. Overall, illegal dumping is not a significant contaminant source in any of the watersheds with respect to drinking water quality.

6.3.4 NPDES Point Sources

Only small wastewater facilities exist in the San Lorenzo watershed. These facilities include the 1970s-vintage package treatment plant at the Boulder Creek Golf and Country Club, the Bear Creek Estates Wastewater Treatment Plan constructed in 1986 and upgraded in 2008, and the new facility at the San Lorenzo Valley schools in Felton. As noted earlier, SLVWD is considering upgrades at Bear Creek to improve operational reliability. These facilities are currently located with onsite wastewater disposal and operated in a manner to minimize downstream water quality impacts. Furthermore, the Country Club is investigating the feasibility of reclaiming treated wastewater to a quality suitable for onsite irrigation.

6.3.5 Recreational Uses

The long-term fecal coliform data indicates that swimming may not appreciably impact the microbiological water quality of the streams. In addition, the number of summer swimming holes has decreased as inflatable dams for recreational swimming have been limited in the watershed; a summer dam on Zayante Creek has been observed in recent years and other informal swimming holes may have come into use following winters where heavier rains may have continued the runoff period. County monitoring of swimming holes is limited and has not historically indicated significant water quality problems. The most potentially significant recreational activities are horseback riding, trail maintenance, and use of off-road vehicles of various types and sizes, all of which constitute locally significant sources of sediment. The use of bikes and vehicles in the watersheds and illicit recreational use in Henry Cowell State Park may increase erosion and sedimentation. To the extent that these trails and uses are routed away from stream channels, or are at least separated from them by setbacks or open space areas, sediment and microbial contributions to the adjoining streams will be reduced.

As discussed in Section 4.2.2., the City conducted a study in 2012 for expansion of recreational use at Loch Lomond, which concluded, with input from CalFire, that additional recreational use is not advisable because of the increase to fire risk and the inability to quickly respond. As discussed in Section 3.12.3, CDFW has increased fish stocking to meet recreational needs which may contribute to HAB events.

6.3.6 Agricultural Land Use

Although agricultural acreage continues to remain very small in both total acreage and individual operations, legalization of cannabis cultivation raised concerns in previous WSS updates with potential for significant effects on water supply remains and had been moved to the significant category. Following legalization, cannabis cultivation described earlier is limited to one grow in the watershed, which is closely monitored and therefore no longer a significant source of contamination. Non-cannabis agricultural has some relatively low risks. Vineyards potentially pose more a more serious challenge than Christmas tree plantations or organic vegetable farms, due to tillage disruption of steep slopes that result in erosion and use of chemicals for pest control. The chemical contributions from agriculture are discussed in Section 6.2.8.

6.4 Other Conclusions and Recommendations

6.4.1 Water-Quality Monitoring

6.4.1.1 Conclusions Regarding Water Quality Monitoring Programs

The drinking water purveyors participating in this study conduct the required monitoring for raw surface water quality; in addition, the City has recently conducted more extensive water quality monitoring especially following wildfire. Results are submitted to regulatory agencies, and in many cases will be available to the public through various purveyor and County web sites. Bacterial data, collected weekly, are routinely tabulated with some analysis now conducted by staff. The County website makes beach water quality data readily available to the public for assessing risk for water contact recreation, however long-term river data are less available in a form that allows for evaluation. Budget and staffing constraints continue to limit the ability to improve sharing of water quality data beyond what is currently available. The data collected by individual agencies are sufficient for water treatment plant operators to make real-time operating decisions regarding bypass of high turbidity source waters.

6.4.1.2 Recommendations Regarding Water Quality Monitoring Programs

Water purveyors should consider the following to their monitoring programs:

- Weekly raw water blend and bi-weekly source water total coliform and *E. coli* data collection should be continued.

- As described earlier under Section 6.2.6 Geologic Hazards and Fires and 6.2.8 for Pesticides and Herbicides and , the raw water-quality data programs should be augmented for pesticides and herbicides, as well as retardants and combustion by products post wildfire, because of the potential vulnerability of the water source to these type of contamination. Augmentation should intrinsically include electronic recordation and dissemination of data.

- Evaluate the data, such as for nitrate as described in Section 6.2.1.3, to identify any long-term adverse or improving trends and the underlying cause(s) of significant changes and assess the need for updates of the nitrate loading and nitrate management plan or other planning documents.

- Purveyors and the County should seek an assessment of water-quality trends following episodic events, such as large wildfires such as the 2020 CZU fire, earthquakes, and major storms such as occurred in 1982, 1998, 2012 and 2017, such that trends may be anticipated, contingency plans developed, and any needed interties or backup facilities identified. Western Santa Cruz County appears to have an unusual number and range of such events, and the experience from such events in and near the County could be readily distilled such that responses to these types of events can be readily planned and implemented.

- As discussed in Section 6.2.5 – Mining/Quarry Activities, current utility water quality databases should be augmented with data collected by quarry operators or other projects responsible for water-quality monitoring in surface or ground waters in either watershed. One potential quarry related monitoring activity is during reclamation grading of the closed Bonny Doon Quarry, which could require significant earth moving.

- Prepare for the next watershed sanitary survey update in 5 years by noting and recording concerns or problem areas, and implementing control measures applicable to specific watershed conditions.

6.4.2 Watershed Management Practices

6.4.2.1 **Conclusions Regarding Watershed Management Practices**

Established policies, ordinances, and regulations in the County's General Plan are available to improve surface water quality that are implemented by the County's Environmental Health and Planning Departments. As noted in the prior sanitary survey updates, the City has engaged in watershed management activities with a formal emphasis on source protection since 1997, and as discussed in Section 4.2.2.1, has a pool of staff that includes some full-time positions and support from other City staff such as ranger patrols and others that provide education and outreach. The City developed a comprehensive watershed lands management plan which includes no commercial logging (not precluding the cutting of trees for the purposes of restoration, widlife enhancement or ecoysystem management opportunities) on City watershed lands. SLVWD updated its watershed plan in 2010 and has had a no-commercial logging policy in place since 1985. The County updated its Watershed Management Plan for the San Lorenzo River Watershed in 2001.

County and local non-profit organizations efforts have led to numerous structural improvements and involvement with citizen groups to educate the general public, most notably during prior County-wide effort to develop watershed assessment and enhancement plans for selected watersheds, including the San Lorenzo Valley. Previously, the City led a coordinated effort called San Lorenzo River 2025 which targets action to improve riparian habitat that can leverage several resources including the County, RCD, and non-profits. The City also continues to spearhead the State of the San Lorenzo River Symposium ever year as well. This event should be continued in order to maintain scientific literacy and awareness of watershed stakeholders. Multiple staff commitments and limited bandwidth, however, tend to interfere with watershed management program progress. Therefore, to make the most of limited agency staff, it seems prudent to engage with County staff to update the 2001 watershed management plan and/or to coordinate program activities to take advantage of water purveyor and local non-profit organization staff. Local non-profits have been successful, for example, in engaging private horse owners in improving stable and manure management and could also be used to ramp up riparian protection incentive programs and road management programs.

6.4.2.2 Recommendations for Management Efforts for Water Utilities

Most of the ongoing watershed management efforts are coordinated by County staff as part of the wastewater management program, regional erosion-control efforts, and programs to promote salmonid recovery as well as incentive programs including mitigation banks. Therefore, the drinking water utilities should continue to be active in current watershed management programs, in part to meet the specific objectives for drinkable waters. Since County and/or NGO staff periodically change, an annual workshop to communicate City priorities and to find coordination and collaboration opportunities maybe prudent. State and federal funding may be available for some of the activities identified.

Some programs to consider, many of which are discussed in prior recommendations are:

<u>Public Education/Relations</u> —Formalized coordination with local NGOs on public education program may be effective at minimizing soil disruption, improving erosion control practices, and reducing urban runoff contamination. Purveyors can increase programs to mail educational pamphlets or develop informational websites.

<u>Increase Watershed Surveillance</u> — Staff should collaborate with other agencies regarding new development and redevelopment projects, code compliance and report activities within the watershed which can impact water quality, including the importance of preventing contaminants from entering the karst areas. For example, utilities can establish and publicize a watershed “hotline” telephone number to report illegal, unauthorized, or detrimental activities.

<u>Political Support</u> — Water utilities should enhance existing political support through activities such as collaboration on management plan activities, commenting on pending and proposed regulations, and inviting representatives to watershed focused events.

<u>Special Sandy Soil Provisions</u> – An integrated program should be developed and implemented to mesh use of BMPs and other measures designed to minimize the erosion, sedimentation, nutrient, and pathogen issues of Zayante and other sandy soils, plus protect the ground water, wetlands, and valuable stream habitats that they support. Such a program would mean more

recharge of aquifers with lower level of contaminants, less sand in streams, more water in wetlands and channels, and less maintenance of public facilities, in addition to cleaner water.

Road Restoration based on Road Density Analysis – Lobby Board of Supervisors and County Management to develop and fund road restoration program based on road density analysis for key water-supply watersheds developed as an indicator of ecosystem health. Identify grant funding to support these and other activities that benefit water quality and the Coho Recovery Plan.

San Lorenzo Valley Watershed Management Plan In 2001 County Environmental Health completed an update to the 1979 Watershed Management Plan. Water utilities should review and consider updating the plan in addition to emphasizing to their staff and customers the benefits likely to accrue to drinking water quality from successfully achieving the programs goals. They should also continue their participation in the program and support implementation through the County's Integrated Regional Water Management Plan.

6.4.2.3 Recommendations for Watershed Managers

Other issues the County and water utilities should consider when developing watershed management programs include:

Continue to investigate and implement feasible management practices. Descriptions of alternative practices are available from numerous sources, especially from such agencies as the American Water Works Association (AWWA) and Water Environment Federation (WEF). Both of these agencies have recently sponsored research projects and conferences to assist communities improve watershed management and protection.

Publicize the programs and materials: Materials are available from the RCD, other County agencies, and local NGOs which describe specific practices to control erosion from hillsides and roadways, stabilize slopes, construct silt fences construct spring boxes, and to site, construct and maintain septic or advanced onsite waste-disposal systems:

Investigate methods to integrate watershed management projects with other benefits. Some projects, such as riparian restoration and mitigation bank incentives, can enhance watershed management and may be able to obtain Federal and State funding if other benefits (e.g., fishery improvements and groundwater storage) are integrated. The existing 2001 watershed management program, which could merit review and potential update may be a good vehicle for identifying specific activities and may be a good candidate for funding. Several watershed management projects are funded using this approach especially through the Department of Water Resources IRWM program. Through the IRWM program, the City and County staff are able to meet with other agencies and utilities to discuss watershed management funding needs for specific programs. This includes establishing guidelines to propose projects to councils, boards, etc., and to request support from non-conventional sources for pilot programs, etc.

Collaboration with utilities and local large land owners: Water utilities should work collaboratively with each other and other large land holders to find aggregated large-scale management projects to improve fuel reduction, erosion, and road maintenance.

Development of a holistic approach to manage areas with sandy soils – As described earlier, these measures which (a) limit erosion, (b) reduce sedimentation of streams and drainage improvements, (c) maintain needed recharge to the sandy aquifers critical to the region's drought-year water supply, (d) sustain sufficient recharge to protect water quality and control nitrate accumulation in the aquifers, and (e) allow springs and wetlands supported by these aquifers to maintain their functions and values.

Engage in County Ordinance Update – The County septic ordinances were updated in 2022; since other ordinances in Chapter 16 are to be reviewed in the coming years, the watershed management staff should provide input during the review process for those ordinances that can be strengthened to improve water quality.

6.4.3 Emergency Plans

All water purveyors now have vulnerability assessments, risk, and resiliency assessments, and have or are updating emergency response plans, including links to 911 and emergency services agencies. Continued maintenance and updating of these plans as well as routinely conducting emergency drills by the purveyors is needed. Improved maps are available to emergency crews through the County's GIS services and via web-based mapping and aerial photography available through commercial websites at all times. As discussed in Section 6.2.7, continued efforts to improve notification of water utilities of chemical spills and other water quality emergencies by dispatchers and on-scene planning is an important element of emergency planning.

6.5 Summary of Activities

Implementation of the broad range of recommended actions (as described in Section 6.4) is outside of City's & SLVWD's direct control; therefore, collaboration with other agencies and NGOs is likely the most feasible means as reallocation of, or possibly additions to, existing staff is unlikely to occur. In addition, the City and SLVWD should continue to seek opportunities to identify and apply for funding for projects/programs that could be implemented by law enforcement and watershed staff as well as by NGOs. Therefore, the drinking water utilities and County should discuss the watershed issues with other entities and develop an implementation plan, including the need for additional staffing and exploration of outside funding, for the selected management practices.

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Appendix A: Primary and Secondary Maximum Contaminant Limits

MCLs, DLRs, PHGs, for Regulated Drinking Water Contaminants

(Units are in milligrams per liter (mg/L), unless otherwise noted.)

Last Update: January 3, 2023

The following tables includes California's maximum contaminant levels (MCLs), detection limits for purposes of reporting (DLRs), public health goals (PHGs) from the Office of Environmental Health Hazard Assessment (OEHHA). For comparison, Federal MCLs and Maximum Contaminant Level Goals (MCLGs) (USEPA) are also displayed.

Inorganic Chemicals Table, Chemicals with MCLs in 22 CCR §64431

State Regulated Inorganic Chemical Contaminant	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Aluminum	1	0.05	0.6	2001	--	--
Antimony	0.006	0.006	0.001	2016	0.006	0.006
Arsenic	0.010	0.002	0.000004	2004	0.010	zero
Asbestos (MFL = million fibers per liter; for fibers >10 microns long)	7 MFL	0.2 MFL	7 MFL	2003	7 MFL	7 MFL
Barium	1	0.1	2	2003	2	2
Beryllium	0.004	0.001	0.001	2003	0.004	0.004
Cadmium	0.005	0.001	0.00004	2006	0.005	0.005
Chromium, Total - OEHHA withdrew the 0.0025-mg/L PHG	0.05	0.01	withdrawn Nov. 2001	1999	0.1	0.1

State Regulated Inorganic Chemical Contaminant	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Chromium, Hexavalent - 0.01-mg/L MCL & 0.001-mg/L DLR repealed September 2017	--	--	0.00002	2011	--	--
Cyanide	0.15	0.1	0.15	1997	0.2	0.2
Fluoride	2	0.1	1	1997	4.0	4.0
Mercury (inorganic)	0.002	0.001	0.0012	1999 (rev2005)*	0.002	0.002
Nickel	0.1	0.01	0.012	2001	--	--
Nitrate (as nitrogen, N)	10 as N	0.4	45 as NO3 (=10 as N)	2018	10	10
Nitrite (as N)	1 as N	0.4	1 as N	2018	1	1
Nitrate + Nitrite (as N)	10 as N	--	10 as N	2018	--	--
Perchlorate	0.006	0.002	0.001	2015	--	--
Selenium	0.05	0.005	0.03	2010	0.05	0.05
Thallium	0.002	0.001	0.0001	1999 (rev2004)	0.002	0.0005

Copper and Lead Table, 22 CCR §64672.3

Values referred to as MCLs for lead and copper are not actually MCLs; instead, they are called “Action Levels” under the lead and copper rule.

State Regulated Copper and Lead Contaminant	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Copper	1.3	0.05	0.3	2008	1.3	1.3
Lead	0.015	0.005	0.0002	2009	0.015	zero

Radiological Table, Radionuclides with MCLs in 22 CCR §64441 and §64443

[units are picocuries per liter (pCi/L), unless otherwise state; n/a = not applicable]

State Regulated Radionuclides Contaminant	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Gross alpha particle activity - OEHHA concluded in 2003 that a PHG was not practical	15	3	none	n/a	15	zero
Gross beta particle activity - OEHHA concluded in 2003 that a PHG was not practical	4 mrem/yr	4	none	n/a	4 mrem/yr	zero
Radium-226	--	1	0.05	2006		
Radium-228	--	1	0.019	2006		
Radium-226 + Radium-228	5	--	--	--	5	zero

State Regulated Radionuclides Contaminant	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Strontium-90	8	2	0.35	2006	--	--
Tritium	"20,000"	"1,000"	400	2006	--	--
Uranium	20	1	0.43	2001	30 µg/L	zero

Organic Chemicals Table, Chemicals with MCLs in 22 CCR §64444

Volatile Organic Chemicals (VOCs)

State Regulated Volatile Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Benzene	0.001	0.0005	0.00015	2001	0.005	zero
Carbon tetrachloride	0.0005	0.0005	0.0001	2000	0.005	zero
1,2-Dichlorobenzene	0.6	0.0005	0.6	1997 (rev2009)	0.6	0.6
1,4-Dichlorobenzene (p-DCB)	0.005	0.0005	0.006	1997	0.075	0.075
1,1-Dichloroethane (1,1-DCA)	0.005	0.0005	0.003	2003	--	--
1,2-Dichloroethane (1,2-DCA)	0.0005	0.0005	0.0004	1999 (rev2005)	0.005	zero
1,1-Dichloroethylene (1,1-DCE)	0.006	0.0005	0.01	1999	0.007	0.007

State Regulated Volatile Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
cis-1,2-Dichloroethylene	0.006	0.0005	0.013	2018	0.07	0.07
trans-1,2-Dichloroethylene	0.01	0.0005	0.05	2018	0.1	0.1
Dichloromethane (Methylene chloride)	0.005	0.0005	0.004	2000	0.005	zero
1,2-Dichloropropane	0.005	0.0005	0.0005	1999	0.005	zero
1,3-Dichloropropene	0.0005	0.0005	0.0002	1999 (rev2006)	--	--
Ethylbenzene	0.3	0.0005	0.3	1997	0.7	0.7
Methyl tertiary butyl ether (MTBE)	0.013	0.003	0.013	1999	--	--
Monochlorobenzene	0.07	0.0005	0.07	2014	0.1	0.1
Styrene	0.1	0.0005	0.0005	2010	0.1	0.1
1,1,2,2-Tetrachloroethane	0.001	0.0005	0.0001	2003	0.1	0.1
Tetrachloroethylene (PCE)	0.005	0.0005	0.00006	2001	0.005	zero
Toluene	0.15	0.0005	0.15	1999	1	1
1,2,4-Trichlorobenzene	0.005	0.0005	0.005	1999	0.07	0.07

State Regulated Volatile Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
1,1,1-Trichloroethane (1,1,1-TCA)	0.200	0.0005	1	2006	0.2	0.2
1,1,2-Trichloroethane (1,1,2-TCA)	0.005	0.0005	0.0003	2006	0.005	0.003
Trichloroethylene (TCE)	0.005	0.0005	0.0017	2009	0.005	zero
Trichlorofluoromethane (Freon 11)	0.15	0.005	1.3	2014	--	--
"1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)"	1.2	0.01	4	1997 (rev2011)	--	--
Vinyl chloride	0.0005	0.0005	0.00005	2000	0.002	zero
Xylenes	1.750	0.0005	1.8	1997	10	10

Non-Volatile Synthetic Organic Chemicals (SOCs)

State Regulated Non-Volatile Synthetic Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Alachlor	0.002	0.001	0.004	1997	0.002	zero
Atrazine	0.001	0.0005	0.00015	1999	0.003	0.003
Bentazon	0.018	0.002	0.2	1999 (rev2009)	--	--

State Regulated Non-Volatile Synthetic Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Benzo(a)pyrene	0.0002	0.0001	0.000007	2010	0.0002	zero
Carbofuran	0.018	0.005	0.0007	2016	0.04	0.04
Chlordane	0.0001	0.0001	0.00003	1997 (rev2006)	0.002	zero
Dalapon	0.2	0.01	0.79	1997 (rev2009)	0.2	0.2
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	0.00001	0.000003	2020	0.0002	zero
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07	0.01	0.02	2009	0.07	0.07
Di(2-ethylhexyl)adipate	0.4	0.005	0.2	2003	0.4	0.4
Di(2-ethylhexyl)phthalate (DEHP)	0.004	0.003	0.012	1997	0.006	zero
Dinoseb	0.007	0.002	0.014	1997 (rev2010)	0.007	0.007
Diquat	0.02	0.004	0.006	2016	0.02	0.02
Endothal	0.1	0.045	0.094	2014	0.1	0.1

State Regulated Non-Volatile Synthetic Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Endrin	0.002	0.0001	0.0003	2016	0.002	0.002
Ethylene dibromide (EDB)	0.00005	0.00002	0.00001	2003	0.00005	zero
Glyphosate	0.7	0.025	0.9	2007	0.7	0.7
Heptachlor	0.00001	0.00001	0.000008	1999	0.0004	zero
Heptachlor epoxide	0.00001	0.00001	0.000006	1999	0.0002	zero
Hexachlorobenzene	0.001	0.0005	0.00003	2003	0.001	zero
Hexachlorocyclopentadiene	0.05	0.001	0.002	2014	0.05	0.05
Lindane	0.0002	0.0002	0.000032	1999 (rev2005)	0.0002	0.0002
Methoxychlor	0.03	0.01	0.00009	2010	0.04	0.04
Molinate	0.02	0.002	0.001	2008	--	--
Oxamyl	0.05	0.02	0.026	2009	0.2	0.2
Pentachlorophenol	0.001	0.0002	0.0003	2009	0.001	zero
Picloram	0.5	0.001	0.166	2016	0.5	0.5

State Regulated Non-Volatile Synthetic Organic Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Polychlorinated biphenyls (PCBs)	0.0005	0.0005	0.00009	2007	0.0005	zero
Simazine	0.004	0.001	0.004	2001	0.004	0.004
Thiobencarb	0.07	0.001	0.042	2016	--	--
Toxaphene	0.003	0.001	0.00003	2003	0.003	zero
1,2,3-Trichloropropane	0.000005	0.000005	0.0000007	2009	--	--
2,3,7,8-TCDD (dioxin)	3x10-8	5x10-9	5x10-11	2010	3x10-8	zero
2,4,5-TP (Silvex)	0.05	0.001	0.003	2014	0.05	0.05

Disinfection Byproducts Table, Chemicals with MCLs in 22 CCR §64533

State Regulated Disinfection Byproducts Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Total Trihalomethanes	0.080	--	--	--	0.080	--
Bromodichloromethane	--	0.0010	0.00006	2020	--	zero
Bromoform	--	0.0010	0.0005	2020	--	zero

State Regulated Disinfection Byproducts Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
Chloroform	--	0.0010	0.0004	2020	--	0.07
Dibromochloromethane	--	0.0010	0.0001	2020	--	0.06
Haloacetic Acids (five) (HAA5)	0.060	--	--	--	0.060	--
Monochloroacetic Acid	--	0.0020	0.053	2022	--	0.07
Dichloroacetic Acid	--	0.0010	0.0002	2022	--	zero
Trichloroacetic Acid	--	0.0010	0.0001	2022	--	0.02
Monobromoacetic Acid	--	0.0010	0.025	2022	--	--
Dibromoacetic Acid	--	0.0010	0.00003	2022	--	--
Bromate	0.010	0.0050**	0.0001	2009	0.01	zero
Chlorite	1.0	0.020	0.05	2009	1	0.8

Chemicals with PHGs established in response to DDW requests. These are not currently regulated drinking water contaminants.

State Regulated Disinfection Byproducts Contaminants	State MCL	State DLR	State PHG	State Date of PHG	Federal MCL	Federal MCLG
N-Nitrosodimethylamine (NDMA)	--	--	0.000003	2006	--	--

*OEHHA's review of this chemical during the year indicated (rev20XX) resulted in no change in the PHG.

**The DLR for Bromate is 0.0010 mg/L for analysis performed using EPA Method 317.0 Revision 2.0, 321.8, or 326.0.

Appendix B: Water Year 2021 Source Water Quality Monitoring Report

Santa Cruz Water Department

Source Water Monitoring Study Report

Water Year 2021 (October 1, 2020 – September 30, 2021)

Prepared by the Santa Cruz Water Department's Water Quality Laboratory

Table of Contents

List of Acronyms

Acronym/Abbreviation	Definition
AL	Action Level
ASR	Aquifer Storage and Recovery
CEC	Contaminants of Emerging Concern
CCR	Consumer Confidence Report
CFS	Cubic Feet per Second
CZU	Cal Fire designation for its San Mateo-Santa Cruz Unit
DBP	Disinfection Byproduct
DBPR	Disinfection Byproduct Rule
DOC	Dissolved Organic Carbon
EPA	United States Environmental Protection Agency
GHWTP	Graham Hill Water Treatment Plant
GWUDI	Groundwater Under the Direct Influence of Surface Water
HAL	Health Advisory Level
LCR	Lead and Copper Rule
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MCL	Maximum Contaminant Level
MST	Microbial Source Tracking
NL	Notification Level
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
PVC	Polyvinyl Chloride
RTCR	Revised Total Coliform Rule
SCWD	City of Santa Cruz Water Department
SDWA	Safe Drinking Water Act
SLR	San Lorenzo River
SMCL	Secondary Maximum Contaminant Level
SOC	Synthetic Organic Compound
SOP	Standard Operating Procedure
SWRCB-DDW	State Water Resources Control Board Division of Drinking Water
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WQL	Santa Cruz Water Department’s Water Quality Laboratory
WSAC	City’s Water Supply Advisory Committee
WSAS	Water Supply Augmentation Strategy
WSS	Watershed Sanitary Survey
WY	Water Year

List of Data Units

Unit	Definition
CU	Color Unit
GC/mL	Genome Copies per milliliter
MFL	Million Fibers per Liter
mg/L	Milligrams per Liter
mL	Milliliter
MPN/100 mL	Most Probable Number per 100 milliliters
ND	Not Detected
NTU	Nephelometric Turbidity Unit
pCi/L	Picocuries per Liter
PFU/mL or PFU/100 mL	Plaque Forming Unit
ppb	Parts per Billion or µg/L
ppm	Parts per Million or mg/L
ppq	Parts Per Quadrillion
ppt	Parts Per Trillion
µg/L	Micrograms per Liter

List of Tables

List of Figures

Executive Summary

The purpose of this report is to provide results from the Santa Cruz Water Department's (SCWD) Source Water Monitoring Program for Water Year (WY) 2021 (October 1, 2020 through September 30, 2021). During the study period, the SCWD's Water Quality Laboratory (WQL) staff conducted weekly, monthly, quarterly and storm event sampling to characterize source waters for conventional, fire-related and emerging contaminants. This report focuses on the water quality of source water, before treatment and delivery to the City of Santa Cruz customers. The WQL implements a robust compliance sampling program that collects over 1,350 treated water samples from the Graham Hill Water Treatment Plant (GHWTP) and the distribution system each year. As detailed in the 2020 Consumer Confidence Report (CCR), the SCWD's treated water meets all applicable State and Federal drinking water standards. The San Lorenzo River and North Coast Watersheds Sanitary Survey Report Update -February 2018 (Kennedy/Jenks Consultants), referred to as Watershed Sanitary Survey (WSS) throughout this document, complements this report and describes how hydrology, watershed processes, and land use can affect water quality.

The SCWD increased source water monitoring in 2016 in an effort to develop a comprehensive characterization of water quality to inform future decision making for improvements to the GHWTP. The Source Water Monitoring Program was revised for WY 2021 in response to the CZU Lightning Complex Wildfire that damaged portions of the SCWD's upper watersheds. The SCWD facilities did not sustain damage from the wildfire, however approximately 20% of the San Lorenzo River (SLR) watershed was within the CZU fire perimeter, as well as the upper reaches of the North Coast watersheds (Laguna Creek, Majors Creek, and Liddell Creek) were affected by the wildfire. The Source Water Monitoring Program was expanded in WY 2021 to incorporate additional parameters related to fire impacts on water quality, additional sampling locations in the upper source watersheds, and soil sampling in the affected watersheds. Sampling frequency was also increased to include routine wet season, dry season and storm event sampling. Additional sample locations in upper Majors Creek, upper Laguna Creek, and two locations in the upper SLR watershed, including Junction Park in Boulder Creek and Highlands Park in Ben Lomond, were established to monitor in conjunction with SCWD's routine source water locations. Additionally, five soil and water quality sampling locations were established in the affected watersheds at Clear Creek-Private Property, Clear Creek-City Property, Felton Empire Rd-Tributary to Fall Creek, Laguna Creek at Ice Cream Grade, and Pine Ridge-Tributary to Laguna Creek.

Drinking water quality is regulated by the State Water Resources Control Board Division of Drinking Water (SWRCB-DDW). Several types of regulatory levels exist for drinking water quality, including action level (AL), health advisory level (HAL), primary maximum contaminant level (MCL), secondary maximum contaminant level (SMCL), and notification level (NL). While these regulatory levels do not apply to source water, their application to source water results can provide context.

Over 90% of the water served to SCWD's customers is produced at the GHWTP, which operates under a BIN 2 classification as prescribed by the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), with specific requirements for pathogen removal. The GHWTP raw blend influent consists of multiple surface water and groundwater sources including Loch Lomond Reservoir, the San Lorenzo River, three north coast sources (Liddell Spring, Laguna Creek and Majors Creek), and three groundwater wells under the direct influence of surface water at Tait St. (Tait Wells) of varying proportions. These source waters have variable water quality largely influenced by winter storms. In general, the SLR provides the greatest quantity of water treated throughout the year, while Loch Lomond Reservoir is the largest volume of stored water available for use. Loch Lomond Reservoir water is utilized conservatively to preserve supple for us during the dry season or drought conditions, when other sources are not available. The North Coast sources consistently have the best water quality compared to the other sources, but are used the least, as available flows for diversion are frequently unavailable. Water Treatment Operators utilize source availability and water quality data to make operational decisions to choose which raw sources to treat and the quantity of each source to ensure that the finished water quality leaving the GHWTP is of high quality.

During WY 2021, the WQL collected weekly, biweekly, monthly, and quarterly water quality samples from the sources and upper watershed locations. In addition, nine storm events were sampled between the months of October 2020 and May 2021, with the most significant rainfall occurring on January 27, 2021. As expected, elevated color, turbidity, dissolved organic carbon (DOC), total organic carbon (TOC), total coliform/*E. coli*, and metals (primarily aluminum, arsenic, iron, lead, and manganese) were observed in the SCWD's source water and upper watershed locations during the storm. Routine follow-up monitoring confirmed that within a few days, once the precipitation and streamflow rate or discharge decreased, water quality results returned to normal baseline levels.

Unregulated contaminants of emerging concern (CECs) that include pharmaceuticals and personal care products such as caffeine, DEET, and sucralose as well as per- and polyfluoroalkyl substances (PFAS) were detected in small amounts in the SLR throughout the WY. Fire related parameters associated with urban and rural run-off such as asbestos were not detected; however, three dioxin and furan chemicals were detected at Laguna Creek, SLR Tait St. Diversion, and SLR Highlands Park during the January 27, 2021 storm. Radiological compounds including radium 226, radium 228, gross alpha, and uranium were detected during the January 27, 2021 storm in the SLR; all results were below the primary maximum contaminant levels (MCLs). The treated water leaving the GHWTP continuously met all State and Federal drinking water standards during the WY. The 2021 CCR, which will provide more information on the SCWD's treated finished water during WY 2021, will be available by July 1, 2022.

The 2020 CCR can be found at the following location:
https://www.cityofsantacruz.com/home/showpublisheddocument/84858/637594518948170000

Limited to no historical data exists for the newly established sampling locations and specific water quality parameters added to the Source Water Monitoring Program to characterize impacts of the CZU Wildfire. As such, it is difficult to determine the extent of fire-related impacts.

Section 1 of this report includes the introduction and background on the initial 2016 source water monitoring study, in addition to the updates to the program for WY 2021. It also provides a description of the GHWTP source waters and SCWD watersheds, details on the CZU Lighting Complex Fire, and the WY 2021 sampling plan. Section 2 presents the results of the WY 2021 source water quality monitoring, as well as a discussion of historical data. Data summaries and trends in treatment, microbial, and regulated and unregulated chemistry parameters are also provided. Conclusions and next steps are summarized in Section 3 and references are provided in Section 4.

This report was prepared by the WQL.

Section 1: Introduction

1.1 Background on Source Water Monitoring Program

The Santa Cruz Water Department (SCWD) began an intensive year-round Source Water Monitoring Program in October 2016 to characterize source water quality in an effort to inform future decision making for improvements to the Graham Hill Water Treatment Plant (GHWTP). The SCWD draws on several sources to supply the GHWTP including the San Lorenzo River (SLR), Loch Lomond Reservoir, three North Coast sources-Laguna Creek, Liddell Spring, and Majors Creek and three groundwater wells (Tait Wells) that are under the direct influence of surface water. The GHWTP is a conventional surface water treatment plant that uses coagulation, flocculation, sedimentation, filtration, and disinfection for water treatment. A particular focus of the 2016 study was to better understand the range of high turbidity winter flow rates from the SLR to determine if they could be used to augment water supply.

This work was initiated from efforts in 2014 to 2015 when the SCWD's Water Supply Advisory Committee (WSAC) developed strategies for improving both the quantity and reliability of the Santa Cruz water supply. The outcome of the WSAC's effort was the Water Supply Augmentation Strategy (WSAS), which is currently being implemented by the SCWD (WSAC 2015). The WSAS identified multiple paths forward, in order of priority, (1) conservation, (2) aquifer storage and recovery (ASR), (3) in-lieu water transfers to neighboring agencies, and (4) potable reuse or desalination. Two of the proposed strategies, ASR and in-lieu transfers, involve increased treatment of higher-turbidity winter water flow rates from the SLR and North Coast sources. In the ASR strategy, additional potable supply (i.e., in excess of the daily demands) would be produced in the winter months and injected and stored in the mid-county or Santa Margarita groundwater basins for future use. Similarly, the in-lieu option would utilize the additional potable supply during the winter to provide drinking water to neighboring agencies (e.g. Soquel Creek Water District). The recommendation to study the water quality of winter flow rates were adopted from the SCWD's WSAC to better understand the chemical components and treatability of winter water flows to augment the water supply.

Currently, SLR water is not consistently used throughout much of the winter because storm events lead to elevated turbidity, color, bacteria, and total organic carbon (TOC) levels that, in turn, lead to treatment challenges. The implementation of the ASR and in-lieu transfer strategies, however, hinges on some of this water being used as the source for the increased potable supply. As a result, extensive sampling of winter water of the SLR was needed to understand the implications of treating water affected by winter storms at the GHWTP and to determine the required level of treatment based on source water conditions. The GHWTP, which was commissioned in 1960, is an aging treatment plant facing several challenges. Over the years, various upgrades have been completed to ensure the plant can continue to meet customer demand and regulatory requirements. The Graham Hill Water Treatment Plant Source Water Quality Monitoring Study Report - February 25, 2019 (Trussell Technologies) included the findings from the initial source water quality monitoring study for Water Year (WY) 2017 (October 1, 2016 – September 30, 2017) and WY 2018 (October 1, 2017 – September 30, 2018). The report also provided a preliminary evaluation on strategies to mitigate the current treatment issues at the GHWTP while treating winter water SLR water.

1.2 Water Year 2021 Source Water Monitoring Program Update

The Source Water Monitoring Program was revised for Water Year (WY) 2021 in response to the CZU Lightning Complex Wildfire that began on August 16, 2020 and damaged upper portions of the Santa Cruz Water Department's (SCWD's) source water watersheds. Revisions included the incorporation of key parameters related to fire impacts on water quality, additional sampling locations in the upper source watersheds, soil sampling in the affected watersheds, and a standard sampling frequency including routine wet and dry season as well as event-based winter storm sampling. Additional sample locations in upper Majors Creek, upper Laguna Creek, and two locations in the upper San Lorenzo River (SLR) watershed, including Junction Park in Boulder Creek and Highlands Park in Ben Lomond, were established to monitor in conjunction with SCWD's routine source water locations. A detailed description of the WY 2021 sampling plan is provided in Section 1.5, Sampling Plan.

Additionally, five soil and water quality sampling locations were established in the affected watersheds at Clear Creek-Private Property, Clear Creek-City Property, Felton Empire Rd-Tributary to Fall Creek, Laguna Creek at Ice Cream Grade, and Pine Ridge-Tributary to Laguna Creek. A report with these results will be available at a later date.

1.3 Graham Hill Water Treatment Plant Source Waters

Over 90% of the water served to Santa Cruz Water Department's (SCWD's) customers is produced at the Graham Hill Water Treatment Plant (GHWTP). As previously mentioned, the GHWTP is a conventional surface water treatment plant that uses coagulation, flocculation, sedimentation, filtration, and disinfection for water treatment. The raw blend influent consists of multiple surface water and groundwater sources including Loch Lomond Reservoir, the San Lorenzo River (SLR), Liddell Spring, Laguna Creek, Majors Creek and three groundwater wells under the direct influence of surface water at Tait St. (Tait Wells) (Figures 1 and 2). In addition, a small proportion of the raw blend influent consists of reclaimed waters recycled from the treatment process. A detailed description of each water source is provided below.

More detailed information about each water source and its watershed is provided in the San Lorenzo River and North Coast Watersheds Sanitary Survey Update - February 2018 (Kennedy/Jenks Consultants), which can be found here:
https://www.cityofsantacruz.com/home/showpublisheddocument/85117/637605784635270000

San Lorenzo River

The San Lorenzo River (SLR) water is diverted at two locations: Tait St. Diversion (Intake to GHWTP) and Felton Diversion. The Tait St. Diversion, located in the City of Santa Cruz (west) of the GHWTP (Figure 1), pumps water from both the river and the Tait Wells located next to the river. These waters are combined in an intake sump to then enter the Coast Pipeline (discussed below) and conveyed to the GHWTP. SLR water is also diverted about five miles upstream of the Tait St. Diversion in Felton at the Felton Diversion. This water can be pumped to the Loch Lomond Reservoir for additional reservoir storage and ultimately back to the GHWTP by way of the Newell Creek pipeline. Under the current water rights diversion permit for the Felton Diversion, they cannot be directly diverted to the GHWTP.

Loch Lomond Reservoir

Loch Lomond Reservoir is located on Newell Creek, about ten miles northeast of the City of Santa Cruz. The reservoir's maximum storage capacity is about 8,600 acre-feet. Water is conveyed from Loch Lomond to the GHWTP through the Newell Creek Pipeline. Loch Lomond primarily receives local watershed runoff but can also receive a small amount of water diverted from the SLR at the Felton Diversion during wet years, as allowed under the current water rights diversion permit.

North Coast

The North Coast water supply consists of two coastal streams and one spring located approximately six to eight miles northwest of the City of Santa Cruz. Water from Liddell Spring, Laguna Creek, and Majors Creek is transported through the Coast Pipeline to the Tait St. Diversion (Figure 1), where it is then conveyed to the GHWTP. These three source waters exhibit significant differences in source water quality and are discussed individually throughout the following document.

The Majors Creek pipeline is currently out of service, although it is expected to be back in service in early 2022. SCWD commitments to bypass flows to support the anadromous Laguna Diversion Dam Project. Laguna Creek was not in use during Water Year (WY) 2021 and therefore did not contribute to the raw blend influent. Liddell Spring was the only North Coast source to contribute to the raw blend influent during WY 2021.

Tait Wells

The Tait Wells are three groundwater wells located near the SLR at the Tait St. Diversion. The water drawn from these wells is classified as Groundwater Under Direct Influence of Surface Water (GWUDI), as they are hydraulically connected to the SLR. Because the wells are considered to be under the influence of surface water, SCWD is restricted to conditions in the surface water right when taking water from the wells. Water produced by the Tait Wells is delivered to the SLR intake sump at the Coast Pump Station and then pumped to the common transmission pipeline that also conveys the SLR and North Coast water to the GHWTP.

Reclaim

GHWTP filter backwash water and sedimentation basin solids are blended in a reclaim tank before being clarified and recycled back to the head works of the GHWTP. In the clarification process, concentrated solids are wasted to the sanitary sewer. Clarified water flows through an air stripper designed to remove disinfection byproducts in the recycled water stream before it returns to the beginning of the treatment process. The GHWTP Wastewater Discharge permit limits the concentration and amount of solids that can be discharged.

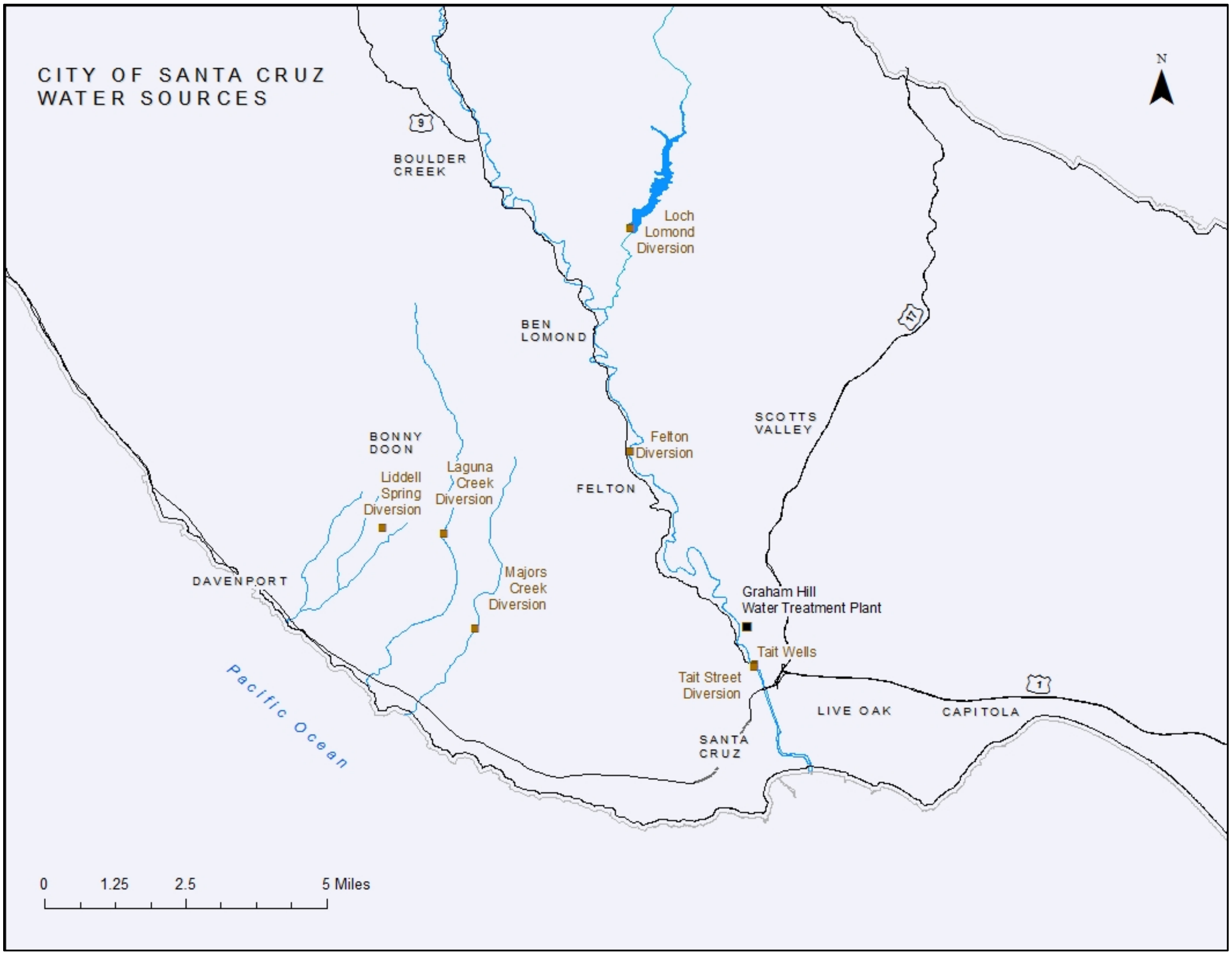


Figure 1. Map of Source Waters to the Graham Hill Water Treatment Plant

CITY OF SANTA CRUZ
DRINKING WATER SOURCE WATERSHEDS

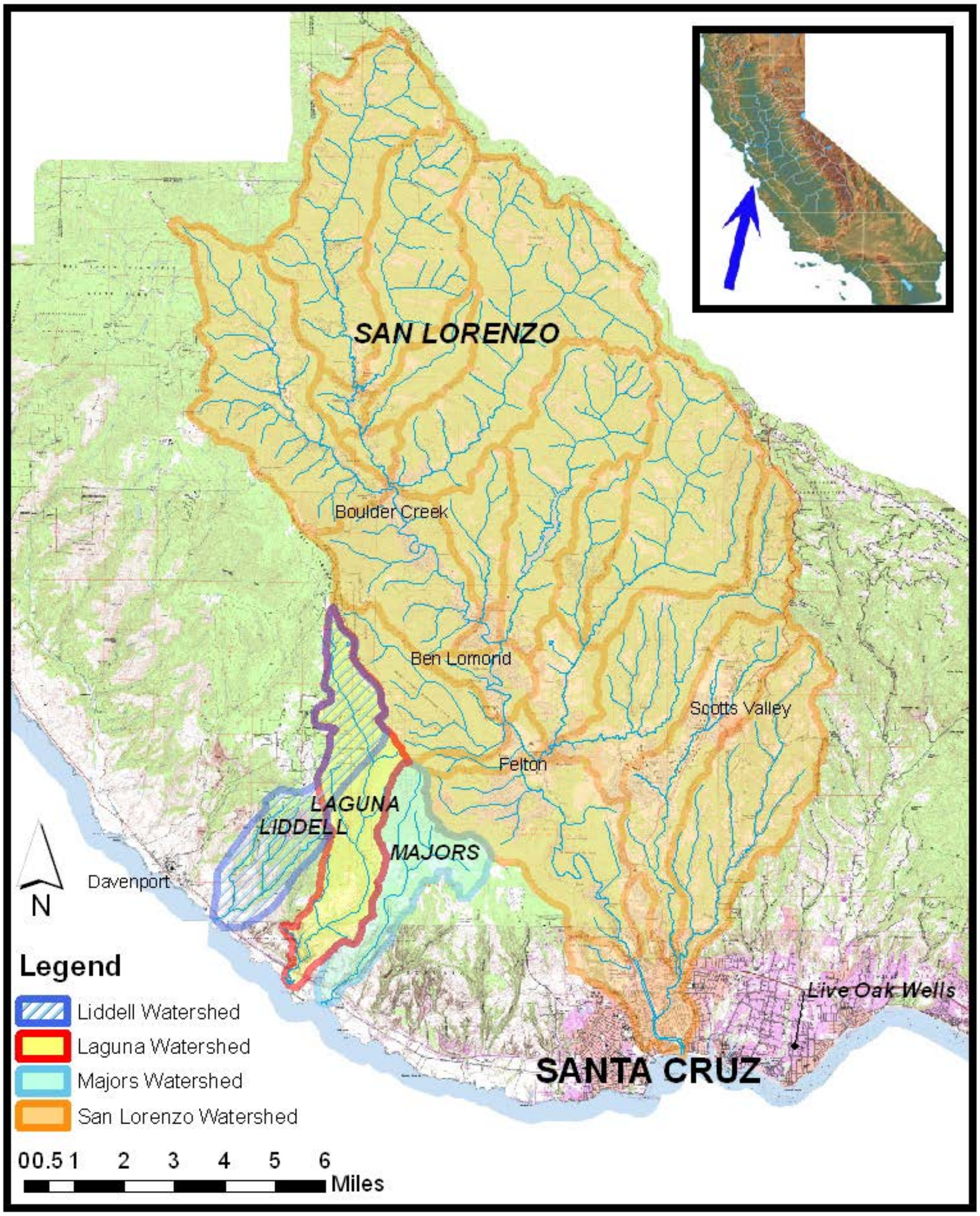


Figure 2. Map of Santa Cruz Water Department's Drinking Water Source Watersheds

During WY 2021 (October 1, 2020-September 30, 2021), surface water and GWUDI contributed to 96% and 4%, respectively, of the total source water influent for treatment at the GHWTP. The SLR was the largest contribution (57%) of source water influent during the WY 2021 water quality monitoring period (Figure 3).

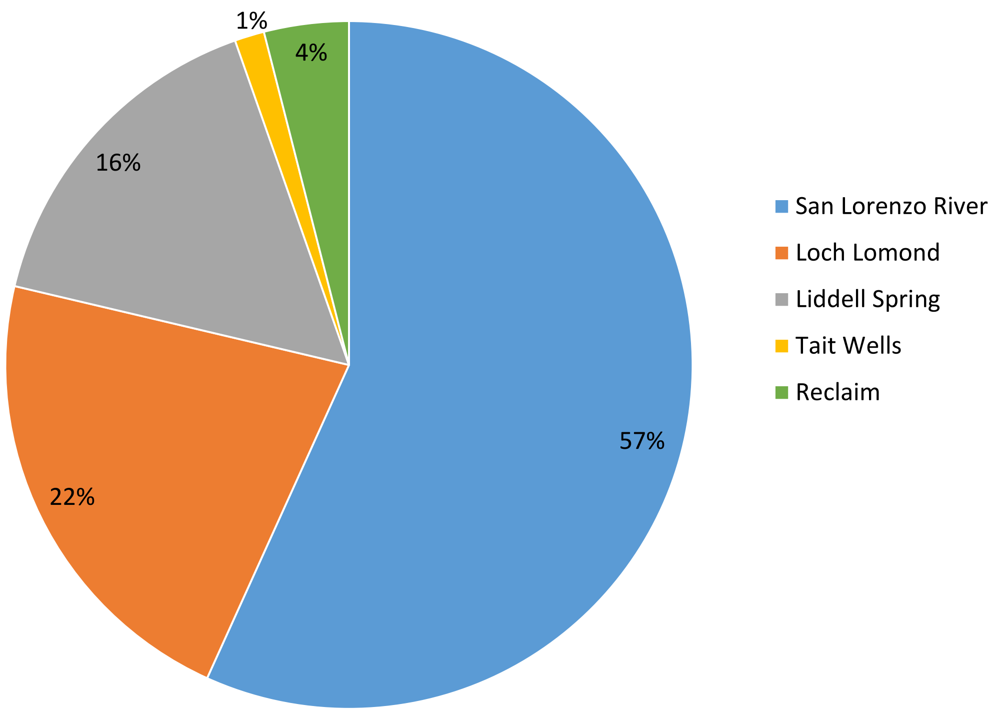


Figure 3. Contributions of various source waters to the raw blend at the Graham Hill Water Treatment Plant during Water Year WY 2021 (October 2020 – September 2021)

1.4 CZU Lightning Complex Fire

The Santa Cruz Water Department (SCWD) facilities did not sustain direct damage from the CZU Lighting Complex Fire. However, approximately 20% of the San Lorenzo River (SLR) watershed was included in the CZU fire perimeter, as well as the upper reaches of the North Coast watersheds (Laguna Creek, Majors Creek, and Liddell Creek). Because the SLR typically supplies approximately half of the SCWD's drinking water, the impacts to its watershed may have the greatest impact on source water quality and treatment operations. The Loch Lomond Reservoir and surrounding watershed were not within the affected fire zones. A brief description of potential post wildfire source water quality impacts is provided in this section. Figure 4 provides a detailed image of the CZU Lightning Complex Fire Perimeter in relation to the SCWD source and upper watershed locations.

The SCWD's Water Quality Laboratory (WQL) performed a literature review on source water quality impacts following a wildfire prior to developing the post CZU Wildfire Sampling Plan for Water Year (WY) 2021. It was found that source water quality impacts are expected to directly correlate with precipitation events and may be the greatest following the first flush storm event after a fire (Writer & Murphy, 2021). Water quality impacts typically/are expected to vary with each storm depending on a number of factors including, rainfall amounts, intensity and antecedent conditions, principally soil saturation. Generally, storms with more rainfall result in higher turbidity but lower concentrations of constituents such as nutrients, metals or organic carbon because the latter are diluted. Maximum concentrations will likely decline with subsequent storms, but may remain elevated above baseline levels for a number of years. Sediment, turbidity and total organic carbon (TOC) loadings are typically the most prominent post fire effect on water quality. Turbidity and total suspended solids (TSS) levels can vary widely, but may approach high values during first flush and heavy precipitation events after an extended period of dryness.

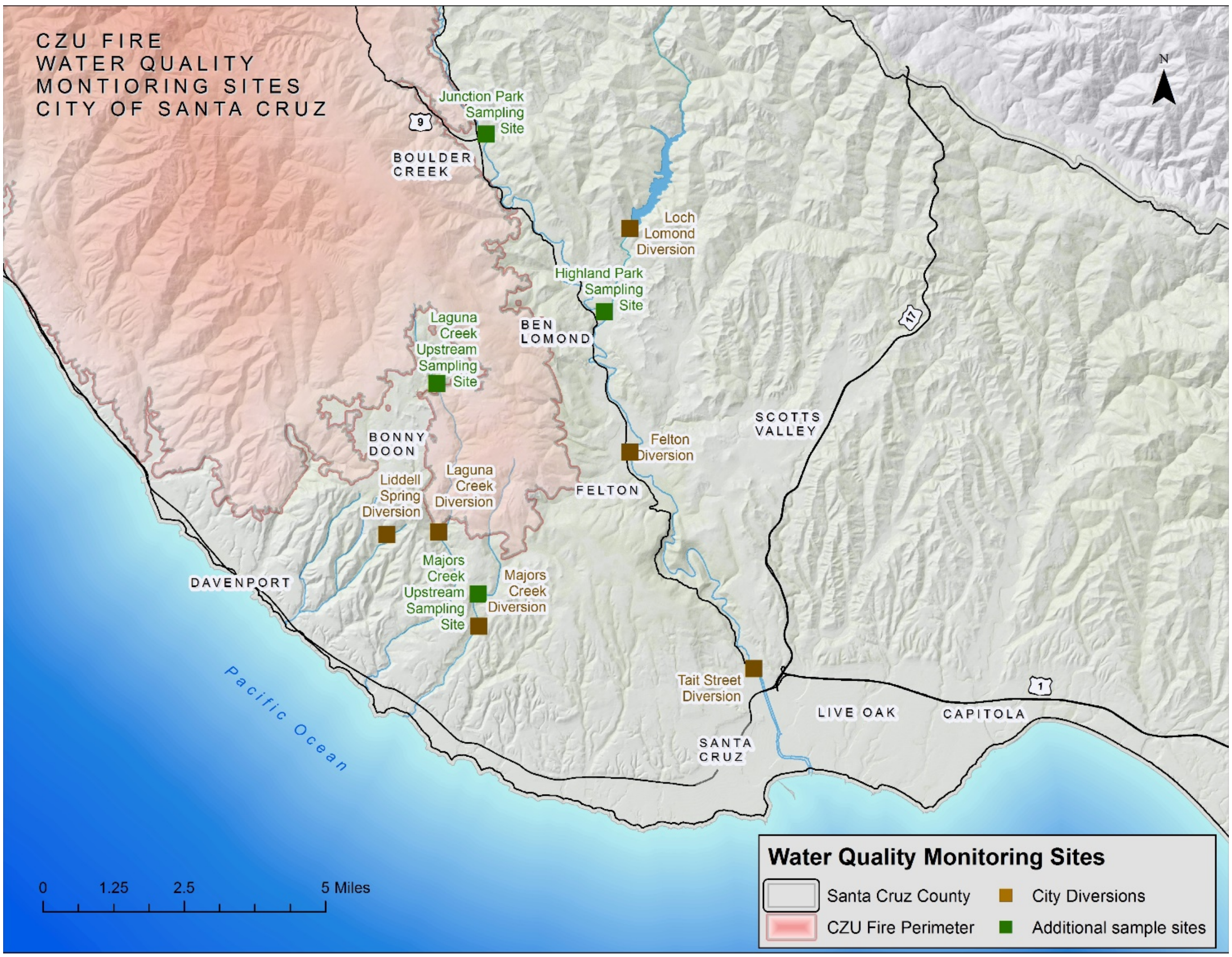


Figure 4. Map of Santa Cruz Water Department's Source and Upper Watershed Sampling Locations in relation to the CZU Lightning Complex Fire Perimeter

1.5 Sampling Plan

The Santa Cruz Water Department's Water Quality Laboratory (WQL) collected weekly, biweekly, monthly, and quarterly water quality samples from eleven locations, including five surface water sources, four upper watershed locations, and the Graham Hill Water Treatment Plant (GHWTP) finished water and raw blend according to the wet season, storm event, and dry season sections of the Water Year (WY) 2021 Source Water Monitoring Plan. Water quality parameters collected in accordance with the Source Water Monitoring Plan for WY 2021 are summarized in Table 1. The wet season, storm event, and dry season sections of the Source Water Monitoring Plan for WY 2021 are summarized in Tables 2-4.

Table 1. Water Quality Parameters for Monitoring Watershed Conditions Post CZU Lightning Fire

Category	Water Quality Parameter	Individual Parameters
Primary Drinking Water Standards	Volatile Organic Compounds	Full Title 22 VOC Screen (including parameters such as Benzene, PCE, Toluene, and MTBE)
	Synthetic Organic Compounds	1,2,3-TCP, 2,4-D, Alachlor, Atrazine, Bentazon, Carbofuran, Diquat, Endothall, Ethylene Dibromide (EDB), Lindane, Oxamyl, Simazine
	Radiological	Gross Alpha, Radium 226, Radium 228, Uranium
Primary/ Secondary Water Standards	Inorganics (Total/Dissolved)	Aluminum, Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Chromium VI, Cobalt, Copper, Lead, Lithium, Mercury, Molybdenum, Nickel, Perchlorate, Selenium, Silver, Thallium, Vanadium and Zinc
	Anions	Bromide, Chloride, Fluoride, Nitrate, Nitrite, Phosphate (Ortho/Total) and Sulfate
Secondary Drinking Water Standards	General Physical	Alkalinity, Color, Conductivity, Hardness, Odor, pH and Turbidity
	Metals	Cations (Calcium, Magnesium, Potassium and Sodium), and Total/Dissolved Iron and Manganese
	MBAS	Foaming Agents
Treatment	TOC/DOC	Total Organic Carbon/ Dissolved Organic Carbon
	UV254/SUVA	UV absorbance at 254 nm/ Specific Ultraviolet Absorbance
	TSS	Total Suspended Solids
	TDS	Total Dissolved Solids
	MIB/Geosmin	Methylisoborneol/Geosmin
Indicator	Microbial Profile	Bacteroides (Human Specific and Universal), Ms-2 Coliphage, Somatic Coliphage
	Total Coliform/ *E.coli*	
	Enterococci	
Environmental	Ammonia Nitrogen	
Unregulated Contaminants of Emerging Concern	PFAS/PFOS	Per- and Polyfluoroalkyl Substances
	CEC	Contaminants of Emerging Concern (including parameters such as pharmaceuticals and personal care products)
	Dioxins/Furans	Polychlorinated, aromatic hydrocarbons released from municipal waste and residential wood combustion (including parameters such as 2,3,7,8-TCDD)

1.5.1 Wet Season (October 2020 – May 2021)

The source water monitoring sampling plan for WY 2021 indicates the location, sampling frequency and water quality parameters collected during the wet season (Table 2). The wet season data correlates with the WY and captures first flush runoff as well as, winter and spring storm events. Notably, the sampling plan sought to target intra-storm variability, and as such, samples were collected during the rising and falling limbs of the storm hydrograph, as well as baseline rate of flows following the storm events. Sampling frequency was increased from monthly to weekly or biweekly for select parameters including color, turbidity, and dissolved/total organic carbon (DOC/TOC) given these parameter's effect on treatability. In addition, the collection of fire-related parameters was also increased from quarterly to monthly in order to characterize the impact of urban and rural run-off to source waters in fire-impacted watersheds.

Table 2. Water Year WY 2021 Wet Season Sampling Plan

WY 2021 Source Water Monitoring Program Wet Season Sampling Frequency											
Water Quality Parameter	**Laguna Creek**	**Liddell Spring**	**Loch Lomond**	**SLR Felton Diversion**	**SLR Tait St. Diversion**	**Raw Blend**	**GHWTP**	**SLR Highlands**	**Upper Laguna Creek**	**SLR Junction**	**Upper Majors**
Volatile Organic Compounds				M	M		M	M		Q	Q
Synthetic Organic Compounds				M	M		M				
Radiological				M	M		M				
Inorganics	M	M	M	M	M		M	M	M	Q	Q
Anions	M	M	M	M	M	M	M	M	M	Q	Q
General Physical	BW	BW	BW	W	W	W	W	M	M	Q	Q
Metals	M	M	M	M	M		M	M	M	Q	Q
MBAS				M	M			M	M	Q	Q
TOC/DOC	BW	BW	BW	W	W	W	W	M	M	Q	Q
UV254/ SUVA	BW	BW	BW	W	W	W	W	M	M	Q	Q
TSS	BW	BW	BW	W	W			M	M	Q	Q
TDS	M	M	M	M	M			M	M	Q	Q
MIB/Geosmin			Q								
Microbial Profile				M	M						
Total Coliform/ *E. coli*	BW	BW	BW	W	W	W	W	M	M	Q	Q
Enterococci	BW	BW	BW	W	W	W	W	M	M	Q	Q
Ammonia Nitrogen	M	M	M	M	M			M	M	Q	Q
PFAS/PFOS				M	M		M				
CEC				M	M		M				
Bromide	M	M	M	M	M	M		M	M	Q	Q
Glyphosphate				M	M			M		Q	
W= Weekly BW=Biweekly M=Monthly Q=Quarterly											

Storm Event

Storm event monitoring occurred during the initial increase of discharge and rising limb of the hydrograph (pre-peak), during peak discharge, during the receding limb of the hydrograph (post-peak), and once the discharge leveled off and established a new baseline at select locations based on storm intensity and source contribution. Primarily, storm event monitoring was performed at the San Lorenzo River (SLR) Felton Diversion and Tait St. Diversion in order to better characterize the impact of winter storms on water quality. These sites were selected given the nature of the fire's impact on the watershed, and because the SLR is the largest source water contribution to the GHWTP. It is important to note that the WQL has not previously monitored during storm events, and as such, caution should be used when comparing the most recent results to historic data. The Source Water Monitoring Plan for WY 2021 storm event sampling indicates the location and water quality parameters that were collected during a storm event (Table 3).

Table 3. Water Year WY 2021 Storm Event Sampling Plan

WY 2021 Source Water Monitoring Program Storm Event Sampling Frequency								
Water Quality Parameter	**Laguna Creek**	**Liddell Spring**	**SLR Felton Diversion**	**SLR Tait St. Diversion**	**SLR Highlands**	**Upper Laguna Creek**	**SLR Junction**	**Upper Majors**
Volatile Organic Compounds	X		X	X	X	X	X	X
Synthetic Organic Compounds	X		X	X	X	X	X	
Radiological	X		X	X	X	X	X	
Inorganics	X		X	X	X	X	X	X
Anions			X	X	X		X	
General Physical	X	X	X	X	X	X	X	X
Metals	X		X	X	X	X	X	X
MBAS	X		X	X	X	X	X	X
TOC/DOC	X	X	X	X	X	X	X	X
UV254/ SUVA	X	X	X	X	X	X	X	X
TSS	X	X	X	X	X	X	X	X
Asbestos	X		X	X	X	X	X	X
Microbial Profile			X	X				
Total Coliform/ *E. coli*	X	X	X	X	X	X	X	X
Enterococci	X	X	X	X	X	X	X	X
PFAS/PFOS	X		X	X	X	X	X	
CEC	X		X	X	X	X	X	
Bromide	X		X	X	X	X	X	X
Dioxin/Furan	X		X	X	X	X	X	X
X indicates that samples were collected								

1.5.2 Dry Season (June 2021 – September 2021)

The source water monitoring sampling plan for WY 2021 indicates the location, sampling frequency and water quality parameters collected during the dry season (Table 4). The dry season data captures low rate of flow baseline data for the post CZU Lighting Fire water quality parameters (Table 1). Historic sampling and analysis demonstrates that water quality is strongly influenced by storm water runoff. As such, dry season sampling was reduced from weekly or biweekly to monthly and quarterly to determine background contaminant concentrations.

Table 4. Water Year WY 2021 Dry Season Sampling Plan

WY 2021 Source Water Monitoring Program Dry Season Sampling Frequency											
Water Quality Parameter	**Laguna Creek**	**Liddell Spring**	**Loch Lomond**	**SLR Felton Diversion**	**SLR Tait St. Diversion**	**Raw Blend**	**GHWTP Finished Water**	**SLR Highlands**	**Upper Laguna Creek**	**SLR Junction**	**Upper Majors**
Volatile Organic Compounds				Q	Q		Q	Q		Q	Q
Inorganics	Q	Q	Q	M	M		M	Q	Q	Q	Q
Anions	Q	Q	Q	M	M	M	M	Q	Q	Q	Q
General Physical	BW	BW	W	W	W	W	W	Q	Q	Q	Q
Metals	Q	Q	Q	M	M		M	Q	Q	Q	Q
MBAS				Q	Q			Q	Q	Q	Q
TOC/DOC	M	M	M	M	M	M	M	Q	Q	Q	Q
UV254/ SUVA	M	M	M	M	M	M	M	Q	Q	Q	Q
TSS	BW	BW	BW	W	W			M	M	Q	Q
TDS	Q	Q	Q	M	M		Q	Q	Q	Q	Q
MIB/Geosmin			Q								
Microbial Profile				M	M						
Total Coliform/ *E. coli*	BW	BW	W	W	W	W	W	Q	Q	Q	Q
Enterococci	BW	BW	W	W	W	W	W	M	M	Q	Q
Ammonia Nitrogen	Q	Q	Q	M	M			Q	Q	Q	Q
PFAS/PFOS				M	M		M				
CEC				M	M		M				
Bromide	Q	Q	Q	M	M	M		Q	Q	Q	Q
Glyphosphate				M	M			Q		Q	
W= Weekly BW=Biweekly M=Monthly Q=Quarterly											

Additional information on the SCWD's Post CZU Source Water Quality Sampling Plan for WY 2021 and potential water quality impacts can be found at the following location: https://www.cityofsantacruz.com/government/city-departments/water/water-quality/czu-fire-water-quality.

1.6 Source Selection

The raw source water blend (Raw Blend) at the Graham Hill Water Treatment Plant (GHWTP) consists of multiple raw sources including surface water and groundwater wells under the direct influence of surface water (GWUDI). These sources are vulnerable to changing water quality due to environmental conditions such as drought, wildfire, precipitation and storm events that contribute water runoff. All of these conditions have the potential to affect the water quality of surface sources, therefore affecting their treatability.

Water Treatment Operators utilize source availability and water quality data when choosing how much of each of the raw sources to treat to ensure that the finished water quality leaving the GHWTP meets all State and Federal drinking water standards. In general, the San Lorenzo River (SLR) provides the greatest quantity of water treated throughout the year, while Loch Lomond Reservoir is the largest volume of stored water available for use. Loch Lomond Reservoir water is utilized conservatively to preserve supply for drought periods and is used only when other sources are unavailable due to water quality concerns or insufficient streamflow. Diversifying source selection based on source availability and water quality is a fundamental treatment operations practice with established criteria for source selection.

1.7 San Lorenzo River Turn In/Out Procedure

Water Treatment Operators follow a standard operating procedure (SOP) that utilizes water treatment parameters including color, turbidity, and total organic carbon (TOC) to trigger the turning in and out of the San Lorenzo River (SLR) during storm events. Generally, water from the North Coast is the first water to be used, followed by the SLR and Tait Wells, and finally the Loch Lomond Reservoir. The Santa Cruz Water Department (SCWD) has an established SOP that guides the use of the SLR during storm events. Turbidity is closely monitored in the SLR and the source is turned out when turbidity reaches 10 NTU at the sample location at the Graham Hill Water Treatment Plant (GHWTP) or 25 NTU at the SLR intake (Tait St. Diversion). The source is turned back in when turbidity decreases below 10 NTU and when other water quality parameters, notably TOC, is better than what is available from Loch Lomond.

In response to the CZU Lighting Complex Wildfire and the potential for post wildfire water quality impacts on the SLR, the SOP was revised for Water Year (WY) 2021 to include a more conservative trigger for turning the source out prior to a storm event and incorporate the use of additional wildfire water quality data to review before turning the source back in use. When the SLR is turned back in following a weather related turn out, Water Treatment Operators adjust the SLR intake flow rate to contribute only 25% of the total raw water blend. If the GHWTP finished water quality is acceptable after 12 hours, including TOC <2.5 mg/L, the SLR intake flow rate contribution is increased. A detailed summary of the post CZU SLR Turn In/Out SOP is provided below:

Criteria for turning out the SLR due to weather related event:

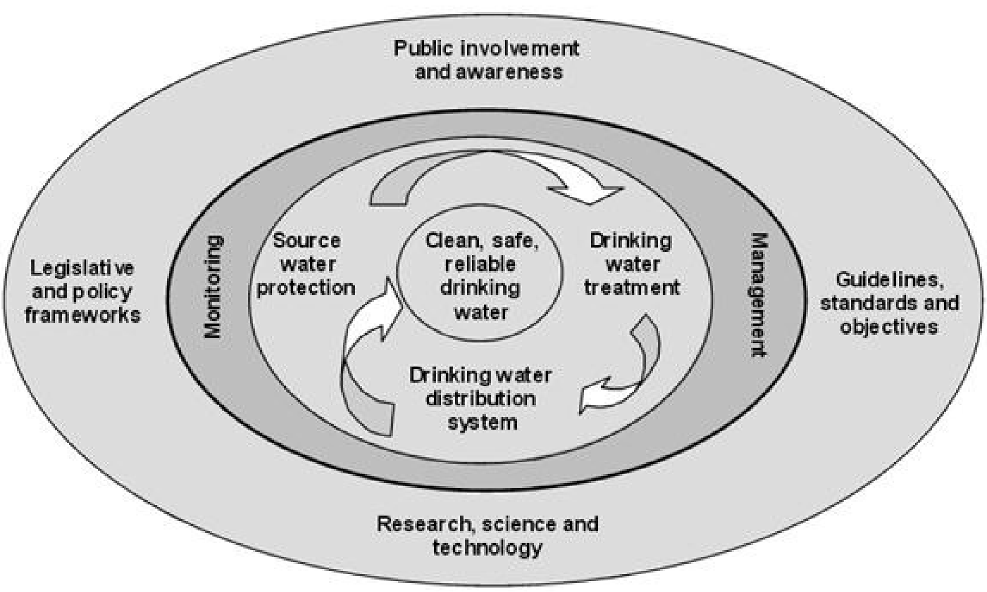
- Any rise of the SLR cubic feet per second (CFS) at the United States Geological Survey (USGS) Big Trees gage (Felton Diversion) after a rain event has started. (First flush rain event runoff is expected at the SLR intake (Tait St. Diversion) within hours.)
- SLR turbidity >25 NTU at the SLR intake (Tait St. Diversion)

Criteria for reestablishing use of the SLR after a weather related turn out:

- First flush event has peaked and the SLR CFS is declining;
- Acceptable water quality for all of the following parameters based on a grab sample collected from the SLR near the intake (Tait St. Diversion):
    - Color <50 CU;
    - pH, odor, and temperature all in normal range;
    - TOC <4.0 mg/L (or less than alternative sources); and
    - Turbidity <25 NTU

1.8 Water Quality Management Multi-Barrier Approach

Like many other water utilities, the Santa Cruz Water Department (SCWD) uses a multi-barrier approach to protecting water quality. The multi-barrier approach is an integrated system of procedures, processes and tools that collectively prevent or reduce contamination of drinking water from source to tap in order to reduce risks to public health. The first barrier is source water protection, the second is effective water treatment, which also includes multiple barriers, and the third is careful management of the treated water distribution system to keep water quality from degrading as it moves from treatment to tap (Figure 5). This multi-barrier approach allows the SCWD to manage the risk of contamination and waterborne disease to ensure that the water meets all state and federal drinking water standards. A diagram of how SCWD manages each of the three elements is provided below.



From Source to Tap – May 2002

Figure 5. Multi-Barrier Approach

Source Water Protection

Source water assessment and active watershed management are the key elements of an effective source water protection program. The Water Resources section of the SCWD patrols the watersheds from which it draws water, and completes a thorough sanitary survey of each watershed every three years. These efforts keep the SCWD aware of changes in activities or occurrences in the watersheds that may be sources of contamination from natural conditions, such as soil erosion that increases sediment loading in source water, or human-caused sources such as agricultural run-off that may introduce fertilizers, herbicides or pesticide residues into the water. High quality drinking water begins with actively protecting and managing water sources.

The water quality results presented in this report are complemented by the discussion of watershed processes found in the Watershed Sanitary Survey (WSS), notably on pages 2-3 to 2-17. Nonpoint source runoff, which is runoff that is generated during storm events, picks up pollutants as it moves over the land surface, and is the main driver for water quality concerns in the SCWD's source water watersheds. As described in the WSS, rainfall, watershed processes and land use are all important factors to understand when attempting to understand water quality. The reader of this report is encouraged to also review the WSS in order to have a context for the results presented herein.

The most recent SCWD WSS can be found at the following location:
https://www.cityofsantacruz.com/home/showpublisheddocument/85117/637605784635270000

Water Treatment

Water treatment is key to both the multi-barrier approach and to protecting public health. State and Federal regulations require water utilities who rely on surface water sources such as rivers, streams, and lakes to provide significant levels of treatment, typical of a facility like the Graham Hill Water Treatment Plant (GHWTP). As previously discussed in Section 1.3 Graham Hill Water Treatment Plant Source Waters, the GHWTP is a conventional surface water treatment plant that uses coagulation, flocculation, sedimentation, filtration, and disinfection for water treatment. Work is currently underway to upgrade the GHWTP. As part of the upgrades, the treatment process will be modified to use high rate clarification via the use of plate settlers, ozone, and combination of granular activated carbon and biologically activated filtration. Together these improvements will allow the process to treat higher levels of turbidity while also improving our ability to address existing and emerging contaminants of concern.

Distribution System

The distribution system is the final physical barrier in the multi-barrier approach. After treated drinking water leaves the GHWTP, its quality is maintained throughout the distribution system. Diligence is required by SCWD's Distribution and Production sections to ensure sufficient disinfectant, chlorine residual, is present at all points throughout the distribution system in order to adequately protect public health. Distribution system barriers prevent new contaminants from entering the water distribution system by maintaining positive pipeline pressure and regulating cross-connections. Local flushing of dead ends is also used to reduce residence times of treated water in parts of the distribution system. On average, approximately 1, 300 samples are taken annually from the distribution system to demonstrate that water quality meets all applicable standards. Additionally, the SCWD employs standard practices to reduce water age and address water quality concerns at various locations by regularly flushing water mains.

Section 2: Source Water Quality Summary

2.1 Stream Discharge Reference and Storm Event Monitoring

For the Santa Cruz Water Department (SCWD), source water quality is most impacted by nonpoint source runoff generated during storm events. Water quality parameters including color, turbidity, total organic carbon (TOC), nitrate, metals, total coliform, and *E. coli* have shown to be affected by severe weather conditions and trend closely with stream discharge or rate of flow data and water year (WY) classification. Overall, annual weather conditions, represented through stream discharge, WY classification and storm events, can be correlated with water quality parameters to provide weather related water quality trends. The SCWD's Water Quality Laboratory (WQL) monitors real-time stream discharge to determine storm related sampling events so that water quality data can be correlated with current and historical discharge and WY classification.

The SCWD uses the United States Geological Survey (USGS) Stream Gages at San Lorenzo River (SLR) in Santa Cruz, located below the SCWD's Tait St. Diversion intake, and at Big Trees located below the Felton Diversion, to monitor real time stream discharge. Real time stream discharge data is used to determine when to collect storm event sampling (pre-peak, peak, receding and baseline). Storm events are indicated on the USGS stream gage with a peak and rise in river discharge. Nine storm events were sampled during WY 2021, with the most significant rainfall occurring on January 27, 2021 (Figure 6). Figure 7 provides a visual summary of the SLR discharge between October 2020 and September 2021.

In addition, the USGS stream gage at the SLR in Santa Cruz is used to compare WY 2021 water quality parameters results to historical stream discharge data results. To aid in the visualization of trends in water quality parameters, many of the figures shown in this section have been overlaid on a plot of the SLR in Santa Cruz stream discharge data. Historical stream discharge data from the stream gage at SLR in Santa Cruz shows the critically dry and dry conditions in 2012, 2014, 2015, 2018, and 2020 as well as the more extreme wet conditions in 2017 and 2019 (Figure 8). The WY classification at the SLR Tait St. Diversion intake is determined by calculating the total annual runoff in the SLR, which also provides historical information on WY trends (Figure 9). Additionally, cumulative runoff in each WY is used to determine required bypass rate of flows at each stream diversion, which has an impact on which sources are available at any given time.

The following source water quality summary provides data on water quality parameters throughout the wet season, dry season and storm events of WY 2021 at five surface water sources, four upper watershed locations and the Graham Hill Water Treatment Plant (GHWTP) finished water and raw blend. In addition, this water quality summary report provides context as to how WY 2021 water quality parameter data compares to historical water quality data based on WY for SCWD's SLR Tait St. Diversion intake. Most historical data trends begin in 2015. The following source water quality summary adds to the SCWD's continued monitoring of source water over a variety of stream flow rates, WYs and storm event conditions to determine correlations between water quality parameters and weather related water quality trends.

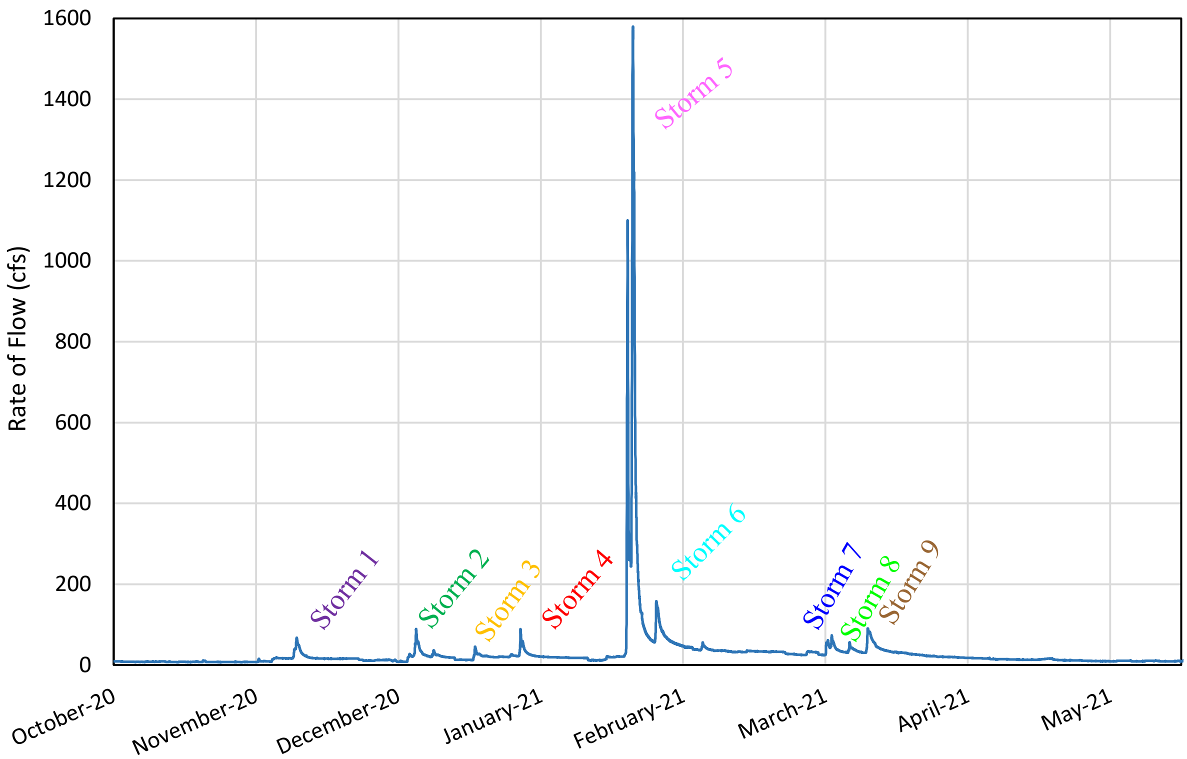


Figure 6. Assigned storms during the WY 2021 Wet Season (October 2020 – May 2021). River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

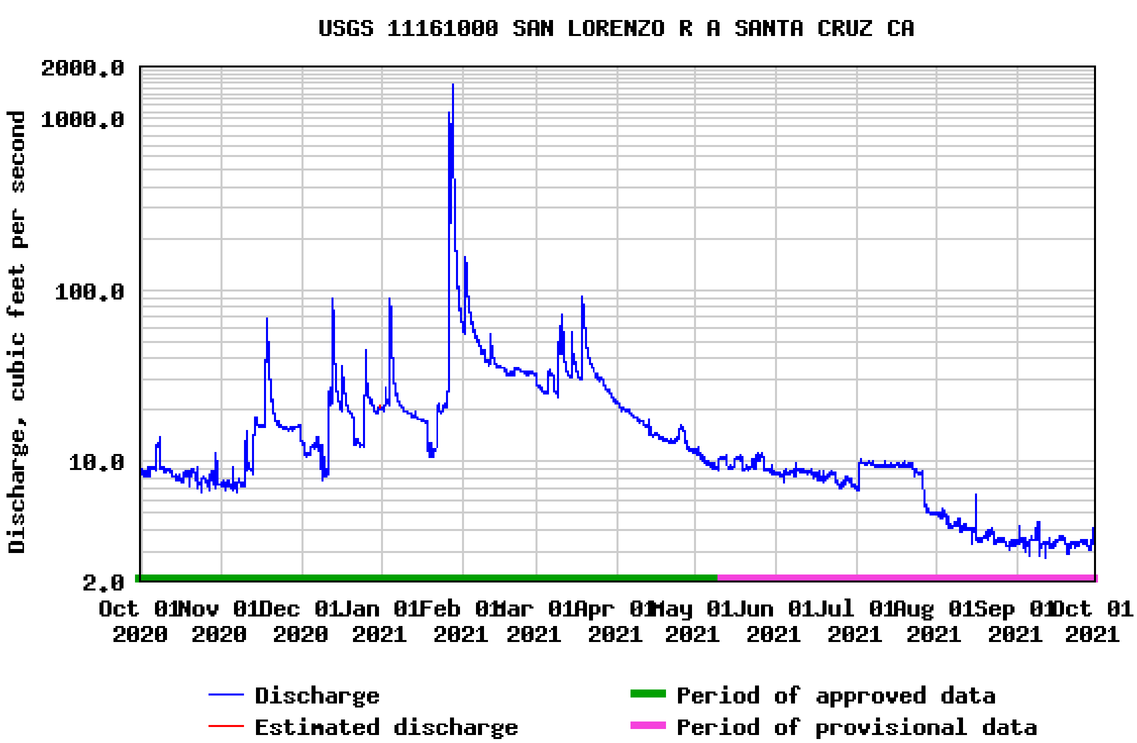


Figure 7. San Lorenzo River Discharge during WY 2021

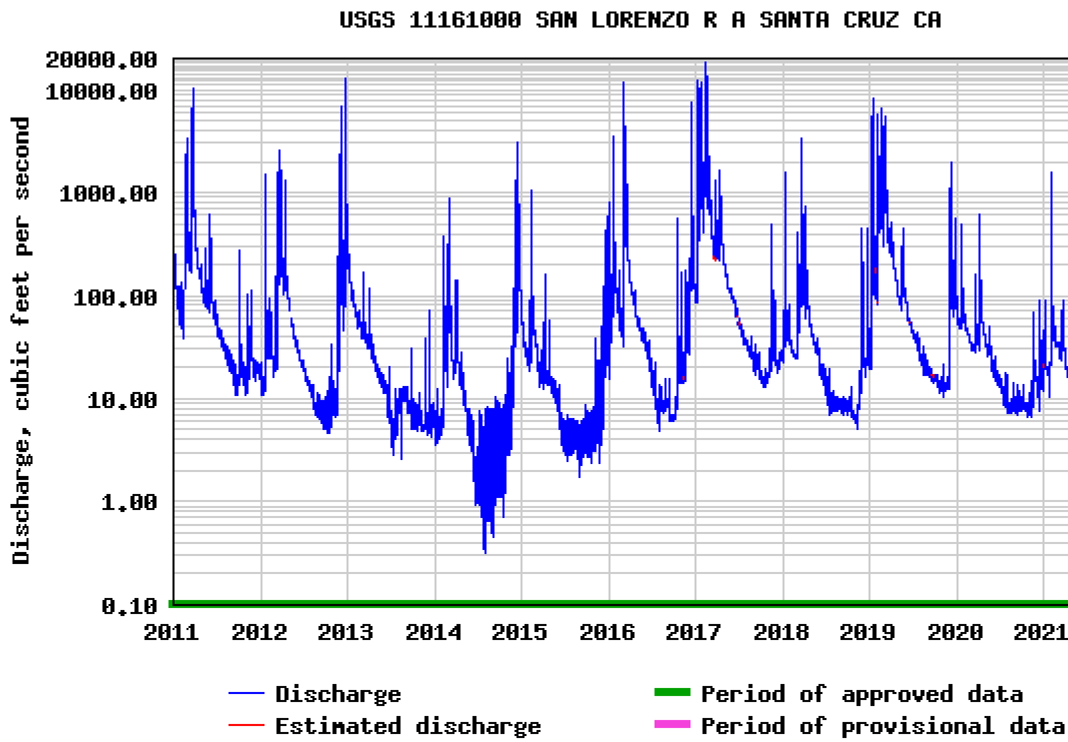


Figure 8. Historical San Lorenzo River Discharge between January 2011 and December 2021

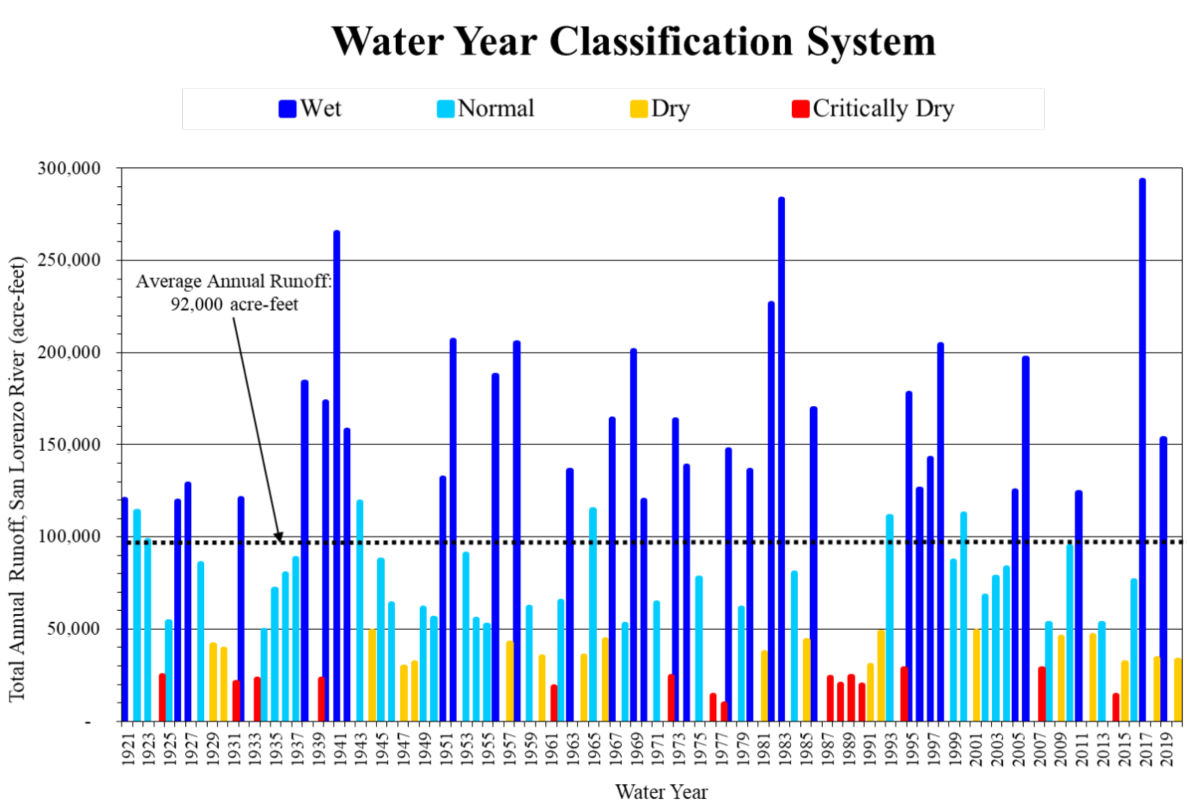


Figure 9. Santa Cruz Water Department's Water Year Classification

2.2 Drinking Water Regulations

The United States Environmental Protection Agency (EPA) and/or state agencies regulate the water quality of drinking water systems. EPA delegates primary enforcement responsibility for drinking water program implementation and enforcement to the State. In California, the State Water Resources Control Board Division of Drinking Water (SWRCB-DDW), formerly Department of Public Health, is the primacy agency for drinking water regulations. To maintain primacy, the authority to enforce drinking water regulations, under the Safe Drinking Water Act (SDWA), the SWRCB-DDW must adopt drinking water regulations that are at least as stringent as the federal regulations and meet other relevant criteria. The paragraphs below provide a brief description of four regulatory terms used throughout this report including, action level (AL), health advisory level (HAL), primary maximum contaminant level (MCL), secondary maximum contaminant level (SMCL), and notification level (NL).

Primary drinking water standards are legally enforceable standards and treatment techniques that apply to public water systems. They protect public health by limiting the levels of contaminants in drinking water. The MCL of a primary standard is the highest level of a contaminant that is allowed in public drinking water supplies. Primary MCLs are typically reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) unless otherwise noted.

The list of primary drinking water standards and their associated MCLs can be found here: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/mcls_epa_vs_dwp.pdf.

Secondary drinking water standards are recommendations rather than legally enforceable standards and are intended to supplement the primary standards by providing guidance for public water systems. Secondary drinking water standards include a list of contaminants that may affect drinking water cosmetic or aesthetic qualities. The Secondary Maximum Contaminant Level (SMCL), when exceeded, may adversely affect the aesthetic quality (e.g. color, taste, odor or appearance) of drinking water or may interfere with water treatment methods.

The list of secondary drinking water standards and their associated SMCLs can be found here: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ddw_secondary_standards.pdf.

Notification Levels (NLs) are non-regulatory health-based advisory levels established by SWRCB-DDW for chemicals in drinking water that are unregulated and/or lack primary/secondary MCLs. Monitoring conducted by public water systems for unregulated chemicals with notification levels is not required. However, public water systems are required to participate in EPA studies to monitor unregulated contaminants under the Unregulated Contaminants Monitoring Rule (UCMR). A list of California's current drinking water notification levels can be found here: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notification_levels_response_levels_overview.pdf.

Action Levels (ALs) are a specified concentration of a contaminant in treated water that, if exceeded, triggers further action (e.g. further treatment and monitoring) that a water system must follow. For example, lead and copper are regulated by ALs and the lead and copper rule (LCR), which allows up to 10% of the study's samples to exceed the AL to remain in compliance.

Health advisories provide information on contaminants that can cause human health effects and are known or anticipated to occur in drinking water. EPA's health advisories are non-enforceable and non-regulatory and provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. EPA's health advisory level (HAL) for Perfluorooctanoic Acid (PFOA) and Perfluorooctane sulfonic acid (PFOS) offers a margin of protection for all Americans throughout their life from adverse health effects resulting from exposure to PFOA and PFOS in drinking water.

Table 5 provides context for drinking water measurement units and can be used throughout this document as a reference when interpreting water quality results.

Table 5. Drinking Water Measurement Units

Units	Units	Equivalence
mg/L = milligrams per liter	ppm = parts per million	1 second in 11.5 days
µg/L = micrograms per liter	ppb = parts per billion	1 second in nearly 32 years
ng/L = nanograms per liter	ppt = parts per trillion	1 second in nearly 32,000 years
pg/L = picograms per liter	ppq = parts per quadrillion	1 second in nearly 32,000,000 years

2.3 Treatment Parameters

2.3.1 Color

Color is a water quality parameter used to define the aesthetic quality of water resulting from the presence of certain dissolved species and natural organic matter including humic and fulvic acids. Additionally, color can be an indication of the presence of other constituents including suspended particles such as algae, clay, iron, and manganese. The secondary maximum contaminant level (SMCL) for color in finished water is 15 color units (CU).

As shown in Table 6 and in Figure 10, color increased during storm events and was therefore consistently higher during the wet season at all of the source water locations, except for Liddell Spring. The North Coast sources including Liddell Spring and Laguna Creek consistently have the lowest color compared to the other sources, with Liddell Spring consistently having a color of 1 CU throughout the WY. Loch Lomond color varies slightly between the dry and wet season, primarily due to algae growth and storm water runoff. The San Lorenzo River (SLR), both Felton Diversion and Tait. St. Diversion locations are the most variable and susceptible to increase in color during winter storms, and have the highest values overall. It is also notable that water quality generally improves between the SLR Felton Diversion and the SLR Tait St. Diversion locations. Between these sample locations water flows through the Henry Cowell Redwoods State Park and a relatively un-developed portion of the watershed. The natural landscape serve to clean water as it travels. This is keeping in line with the multi-barrier approach that seeks first to manage watershed lands to maintain water quality.

The Raw Blend average color was below 10 CU even though the blend consisted mostly of contributions from the overall high color waters of the SLR. This is due to the contribution from Liddell Spring; a source with a consistent color of 1 CU, which provides a buffer against the color fluctuations of the San Lorenzo, and Loch Lomond sources (Figure 11). The average color data for Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion was significantly higher than the median values, as those sources are more impacted by storm runoff events compared to Loch Lomond. The Graham Hill Water Treatment Plant (GHWTP) finished water color average of less than 1 CU was consistently below the SMCL throughout the WY.

A comparison of the SLR stream rate of flow in Santa Cruz and color grab sample data is shown in Figure 12. As can be seen, the SLR stream rate of flow and color data trend well, with the color increasing with storm events and river flow rate.

As shown in Figure 13, the color of the SLR Tait St. Diversion had a color result of 800 CU on January 27, 2021 during the largest storm recorded in WY 2021. A color result of 800 CU is the highest result recorded by the WQL since January 2015. However, event based storm sampling was not consistently conducted; therefore higher color results may have previously occurred but were not captured by the WQL's sampling.

As shown in Table 7, color increased during storm events and were therefore consistently higher during the wet season at all upper watershed sampling locations. Upper Laguna Creek had the lowest color results compared to the other locations, as Upper Majors Creek, SLR Junction Park, and SLR Highlands Park are more susceptible to an increase in color during winter storms.

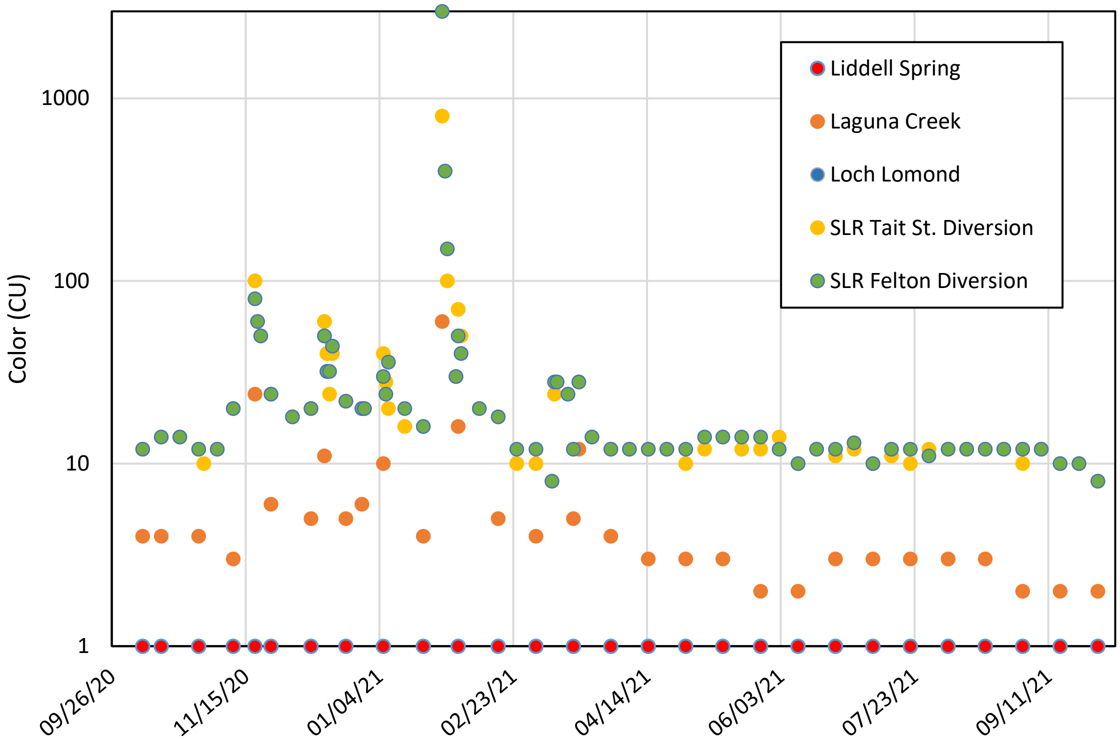


Figure 10. Color of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

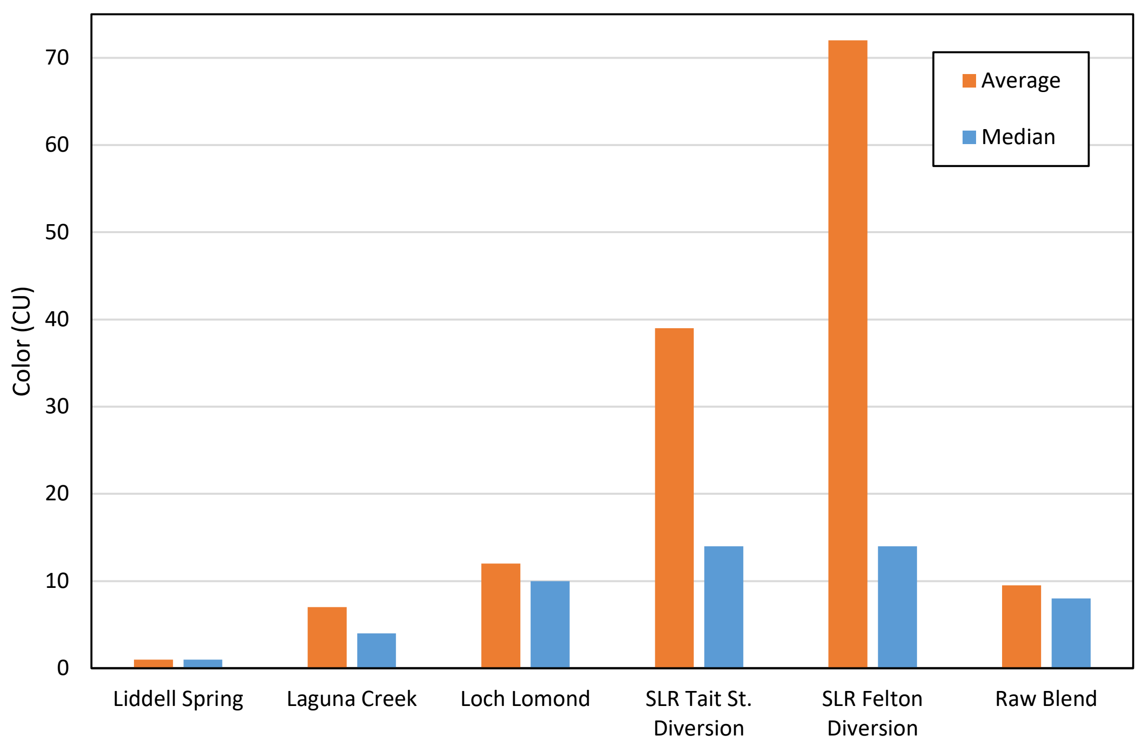


Figure 11. Average and median source water color data for WY 2021

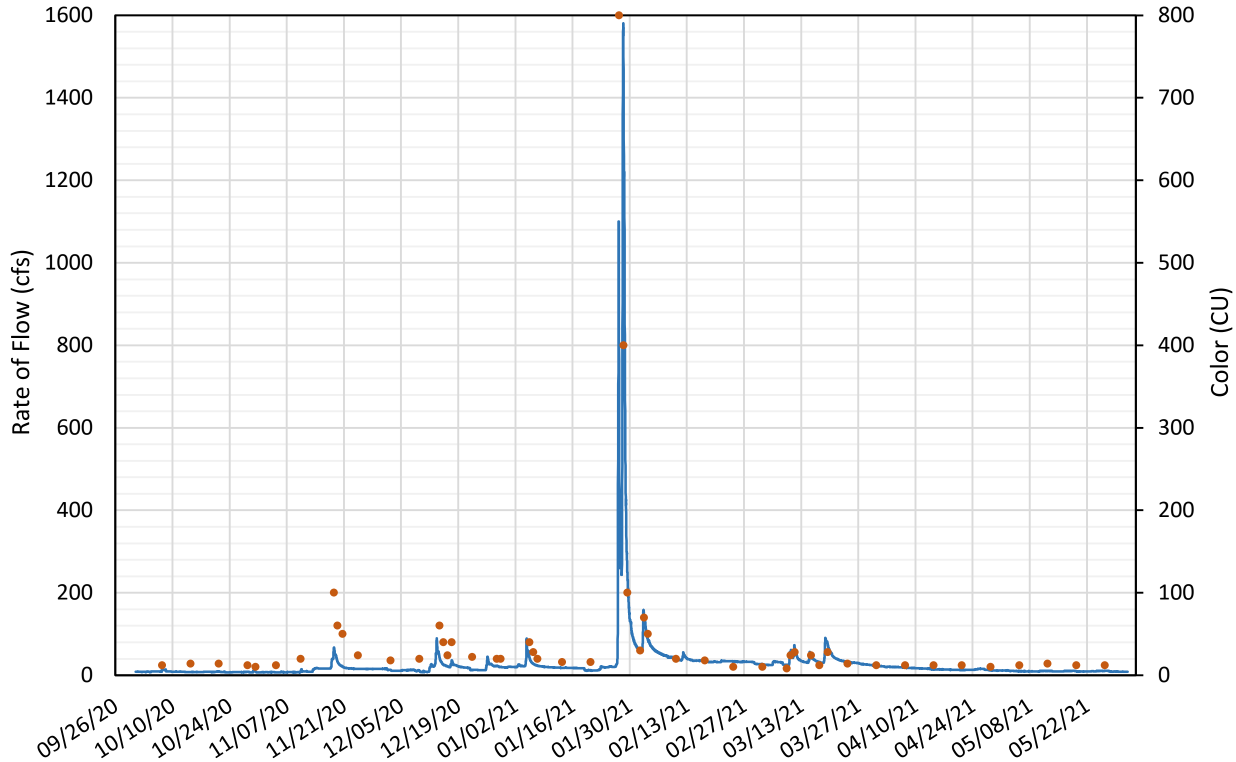


Figure 12. Summary of the San Lorenzo River rate of flow and color data during the Wet Season (October 2020 – May 2021). Color data are from grab samples taken by the Santa Cruz Water Department's Water Quality Laboratory. River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

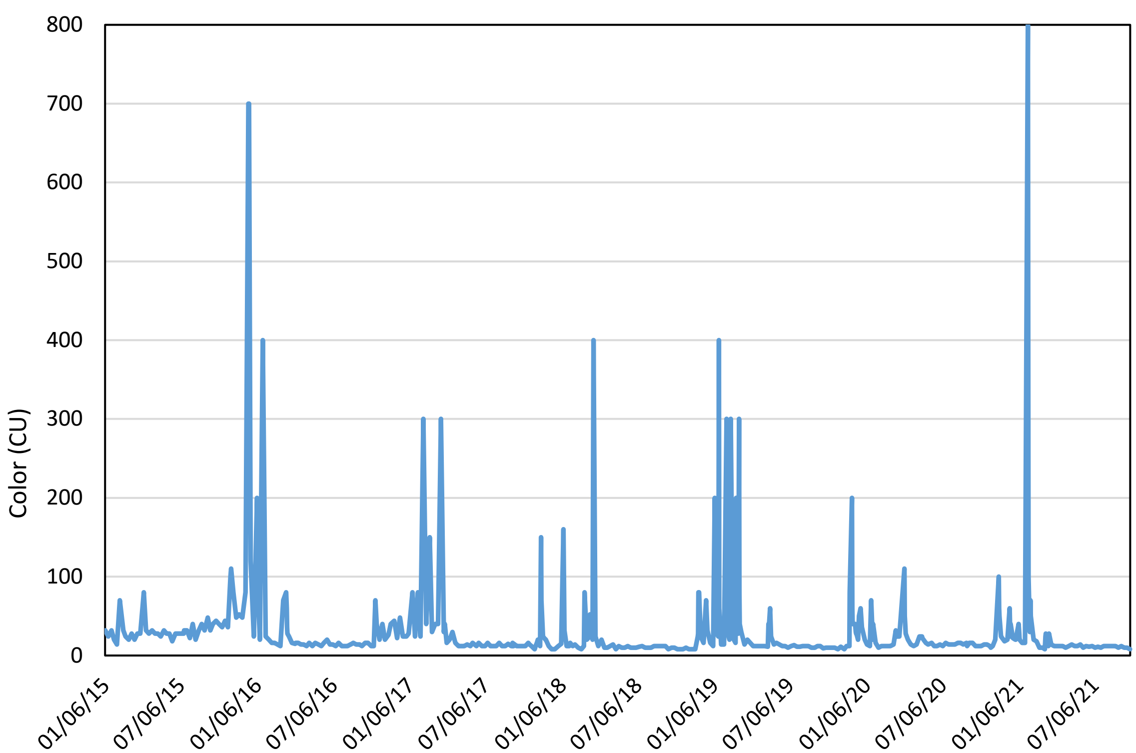


Figure 13. Summary of color data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.3.2 Turbidity

Turbidity is an optical assessment of water clarity; it measures the scattering of light by suspended particles – a phenomenon that causes water to appear cloudy (Crittenden et al. 2012). Turbidity is thus a measurement of the suspended and colloidal particles in water such as clay, silt, algae, plankton, and other microscopic organisms and has implications for solids handling and disinfection at the Graham Hill Water Treatment Plant (GHWTP). Turbidity can be thought of as a proxy for overall water quality, as higher turbidity reflects soil erosion and watershed runoff that can include nonpoint source pollution. In addition, higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. The GHWTP has historically removed San Lorenzo River (SLR) water as a source when the turbidity rises above 25 NTU in order to ensure this goal is met and to avoid issues with solids production, per operations standard operating procedures. The secondary MCL (SMCL) for turbidity in finished water is 5 nephelometric turbidity units (NTU).

As shown in Table 6 and in Figure 14, turbidity followed a similar trend to color and increased during the wet season during storm events as a result of soil erosion and runoff. Generally, turbidity was consistently higher during the wet season at all of the source water locations with Liddell Spring affected the least. The North Coast sources including Liddell Spring and Laguna Creek consistently had the lowest turbidity compared to the other sources. This reflects the fact that Liddell Spring is, as the name implies, a spring that flows below ground and thus not subject to influence of storm water runoff. Laguna Creek results may be due to the fact that the watershed is less-intensively developed than is the SLR watershed. Loch Lomond turbidity varied slightly between the dry and wet season, primarily due to algae and storm water runoff. The SLR locations, both Felton Diversion and Tait. St. Diversion, are the most variable and susceptible to an increase in turbidity during winter storms, having the highest values overall. The SLR locations exceeded 25 NTU six times between November 2020 and February 2021, with a high result of 1600 NTU at Felton Diversion on 01/27/21. On average, the turbidity at Felton Diversion was greater than at the Tait St. Diversion (Figure 15), which again demonstrates the improvement generally seen as water flows through the undeveloped portions of the watershed, including Henry Cowell State Park. The San Lorenzo River Tait St Diversion was not used during periods of high turbidity per operations standard operating procedures. The maximum recorded turbidity for Raw Blend was 12 NTU; however, the average Raw Blend turbidity did not exceed 5 NTU during WY 2021 (Figure 15). This is due to the blending of Liddell Spring, which generally has lower turbidity and provides a buffer against the fluctuations of the SLR and Loch Lomond to reduce the overall turbidity of the Raw Blend. The average turbidity data for Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion was significantly higher than the median values, as those sources are more impacted by storm runoff events compared to Loch Lomond. The GHWTP finished water turbidity was consistently below the secondary MCL (SMCL) throughout the WY with a result of 0.05 NTU.

A comparison of the SLR stream rate of flow in Santa Cruz and turbidity grab sample data is shown in Figure 16. As can be seen, the SLR stream rate of flow and turbidity data trend well, with the color increasing with storm events and river flow rate.

As shown in Figure 17, the turbidity of the SLR Tait St. Diversion reached a result of 400 NTU during the largest storm recorded in WY 2021. The storm events captured during WY 2019 (October 1, 2018-September 30, 2019) produced higher turbidity results than during the WY 2021 monitoring period.

As shown in Table 7, turbidity increased during storm events and was therefore consistently higher during the wet season at all upper watershed sampling locations. Upper Laguna Creek had the lowest turbidity compared to the other locations, as Upper Majors Creek, SLR Junction Park, and SLR Highlands Park are more susceptible to an increase in turbidity during storm events.

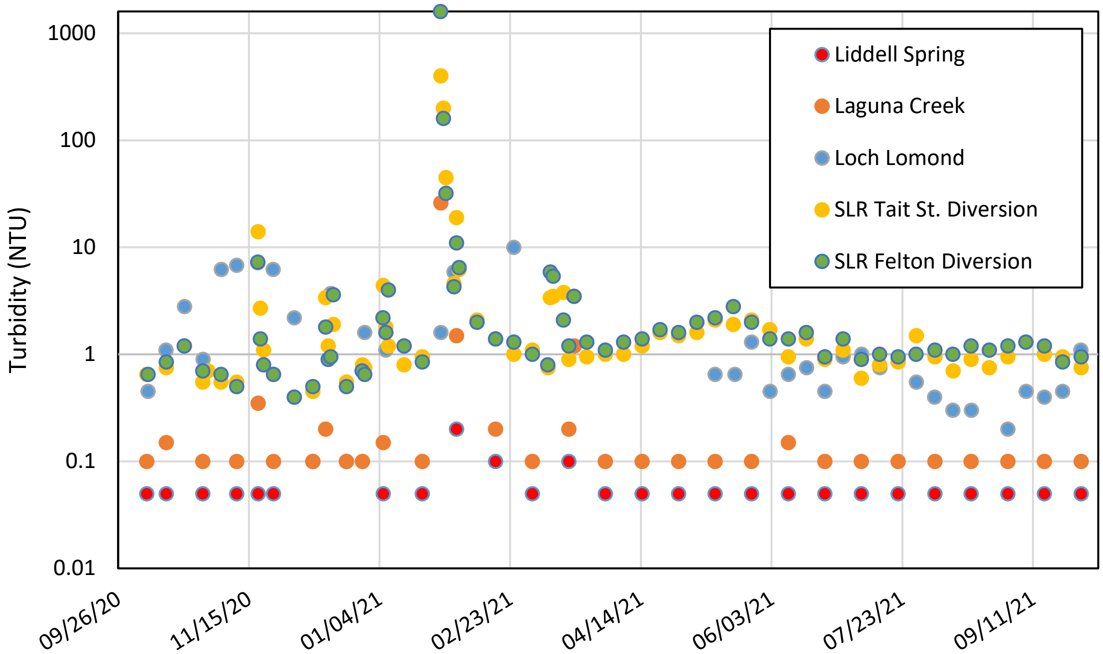


Figure 14. Turbidity of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

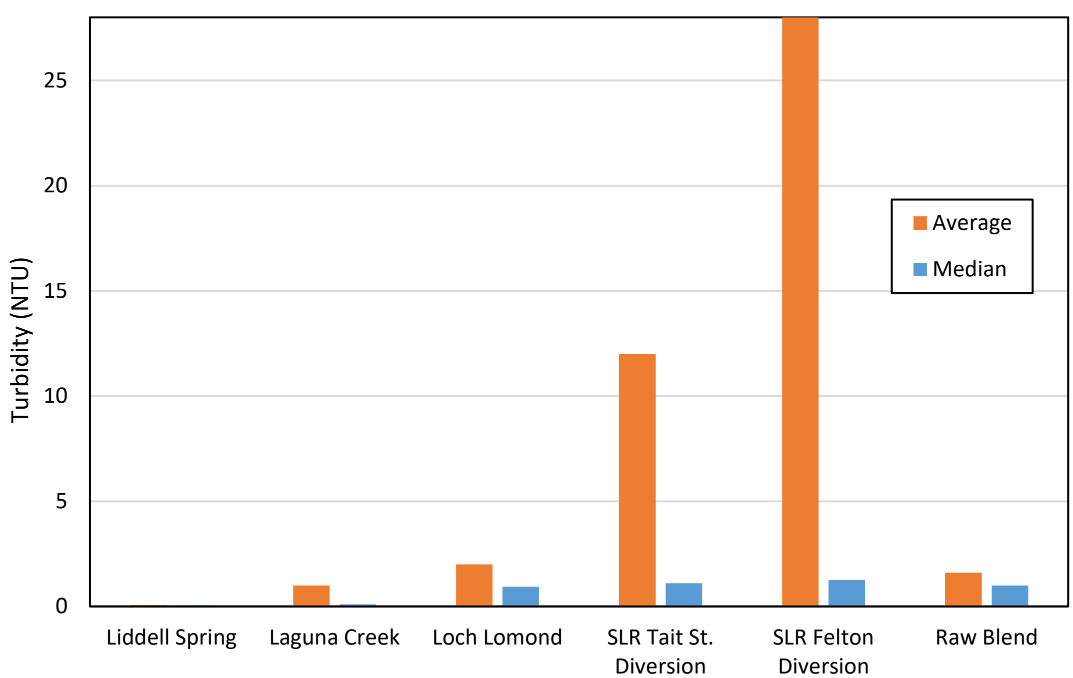


Figure 15. Average and median source water turbidity data for WY 2021

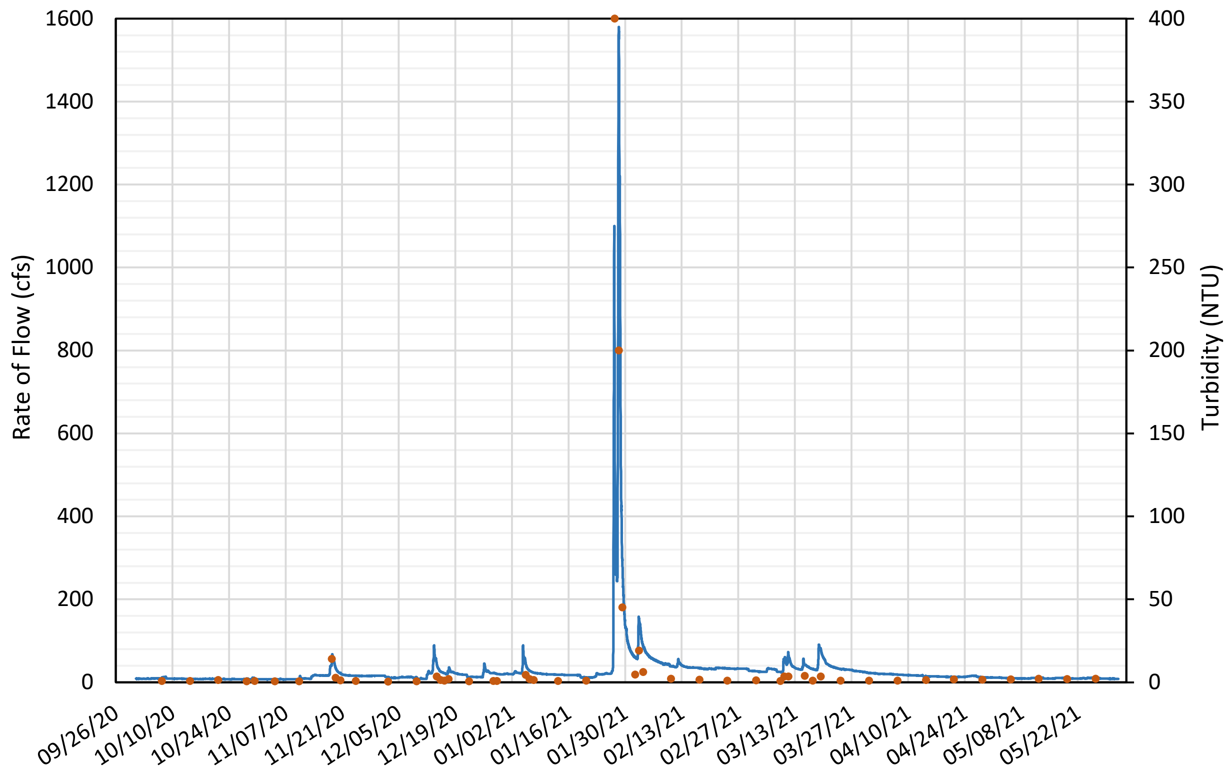


Figure 16. Summary of the San Lorenzo River rate of flow and turbidity data during the Wet Season (October 2020 – May 2021). Turbidity data are from grab samples taken by the Santa Cruz Water Department's Water Quality Laboratory. River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

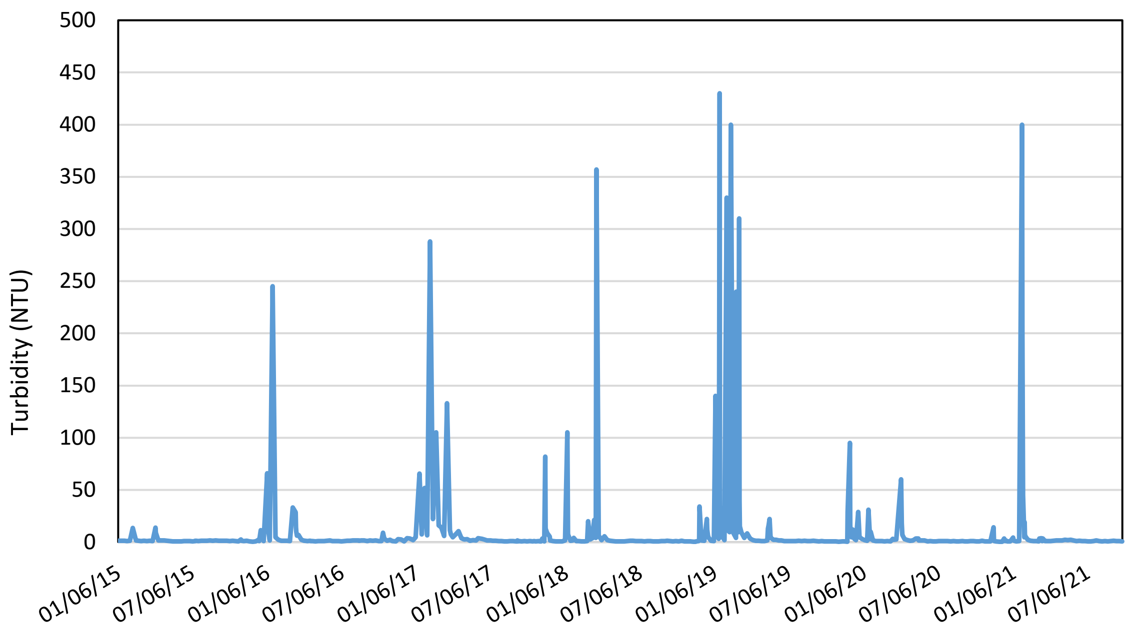


Figure 17. Summary of turbidity data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.3.3 Total Organic Carbon / Dissolved Organic Carbon

Total Organic Carbon (TOC) is a measurement of the total amount of carbon (dissolved and particulate carbon) in water. The difference between dissolved and total fractions is a somewhat arbitrary difference, with the former being the amount of carbon that is able to pass through a 0.45 µm filter. For drinking water, dissolved organic carbon (DOC) is an important water quality parameter measured for several purposes including aesthetic problems, disinfection efficacy at the treatment plant, and an increase in the potential for bacterial growth in the distribution system. In the Santa Cruz Water Department's (SCWD) source water and upper watershed locations studied, essentially all (97- 100%) of the TOC is present in dissolved form (DOC), so DOC and TOC can be used interchangeably.

TOC is an important water quality treatment parameter because it has implications for a number of issues, including coagulation treatment requirements and disinfection byproduct (DBP) formation. DBPs are formed when chlorine is added to water and interacts with carbon to form a number of by-products that may be harmful to human health. The SCWD actively manages sources, treatment and the distribution system to limit formation of DPBs, and collects routine samples to ensure that they are below applicable maximum contaminant levels (MCLs). Water Treatment Operators remove the San Lorenzo River (SLR) water as a source when the TOC rises above 4 mg/L in order to avoid treatment issues per standard operating procedures. There is not a primary and/or secondary MCL for TOC in finished water.

TOC concentrations in most of the source waters displayed seasonal trends, with TOC increasing in the wet season including fluctuations at the North Coast sources (Table 6 and Figure 18). While some water quality constituents such as pH, conductivity, alkalinity, and hardness experience a decrease in concentration in the winter because of dilution by rainwater, TOC is similar to color and turbidity and increases as storms wash organic material into the water. The TOC concentrations of the North Coast sources generally remained low during the wet season, even during storm events, consistent with the trends previously discussed. Results fluctuated, with Liddell Spring ranging from a minimum of non-detect to a maximum of 0.98 mg/L and Laguna Creek ranging from 0.56 mg/L to 6.3 mg/L. Loch Lomond generally had the highest TOC, ranging between 3.4 and 4.2 mg/L, and did not exhibit a high degree of variability as a result of storm events. Loch Lomond had the highest average TOC for WY 2021 (Figure 19). The SLR showed the greatest variation in TOC concentration during storms exceeding 4 mg/L numerous times between November 2020 and March 2021, with a high result of 19 mg/L at Felton Diversion on January 27, 2021. The average TOC of the Raw Blend was below 2.5 mg/L for WY 2021. This is due to the blending of Liddell Spring, which generally has lower TOC and provides a buffer against the fluctuations of the SLR and the consistent high average of Loch Lomond to reduce the overall TOC of the Raw Blend. The average TOC data for Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion was significantly higher than the median values, as those sources are more impacted by storm runoff events compared to Loch Lomond. Loch Lomond TOC results are consistent throughout the year; therefore, the average and median values are similar.

As shown in Figure 20, the TOC of the SLR Tait St. Diversion reached a result of 12 mg/L during the largest storm recorded in WY 2021, which occurred on January 27, 2021. A TOC result of 17 mg/L is the highest result recorded by the WQL since January 2015. However, event based storm sampling was not consistently conducted; therefore higher TOC results may have previously occurred but not captured by the WQL's sampling.

As shown in Table 7, TOC concentrations increased during storm events and were therefore consistently higher during the wet season at all upper watershed sampling locations. Upper Laguna Creek had the lowest TOC compared to the other locations.

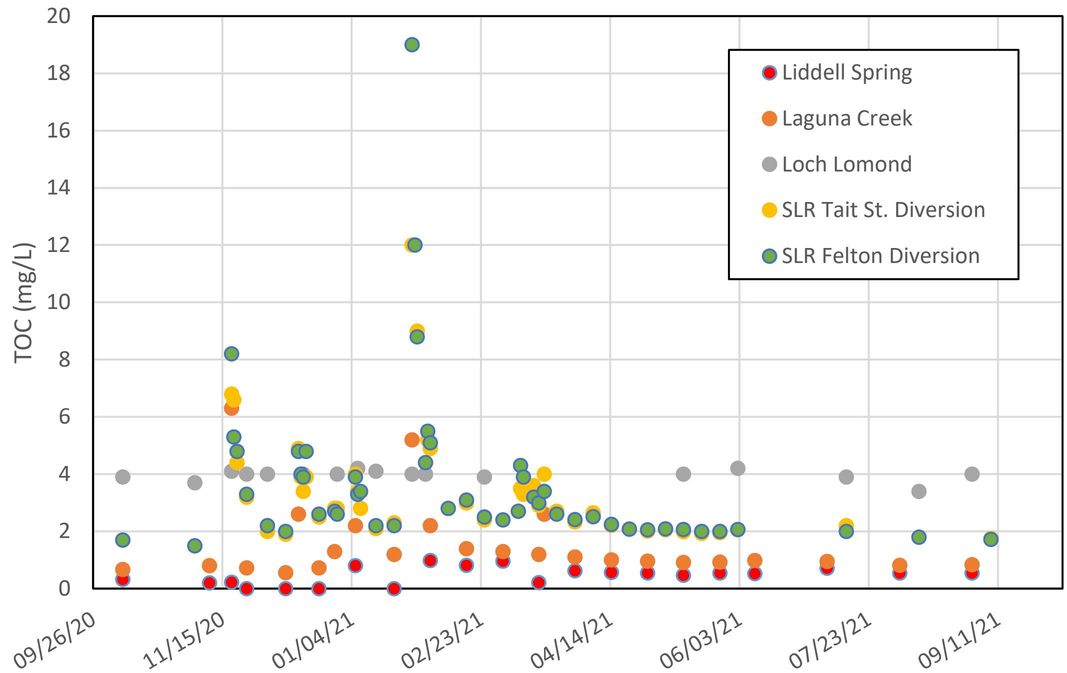


Figure 18. Total organic carbon (TOC) of source waters between October 2020 and September 2021

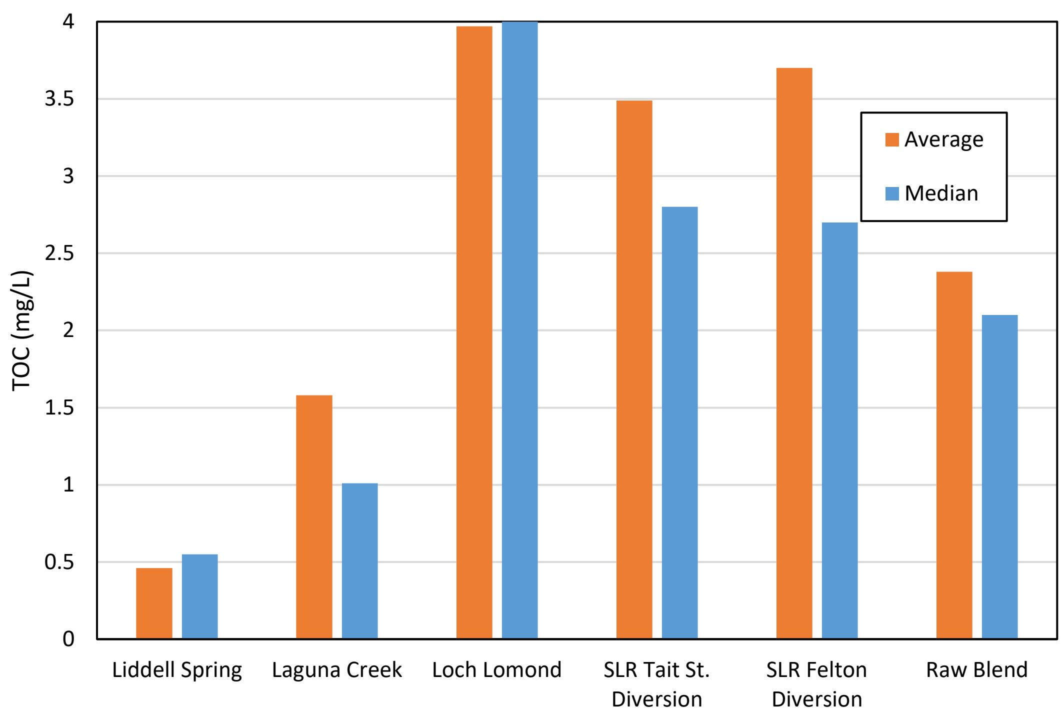


Figure 19. Average and median source water total organic carbon (TOC) data for WY 2021

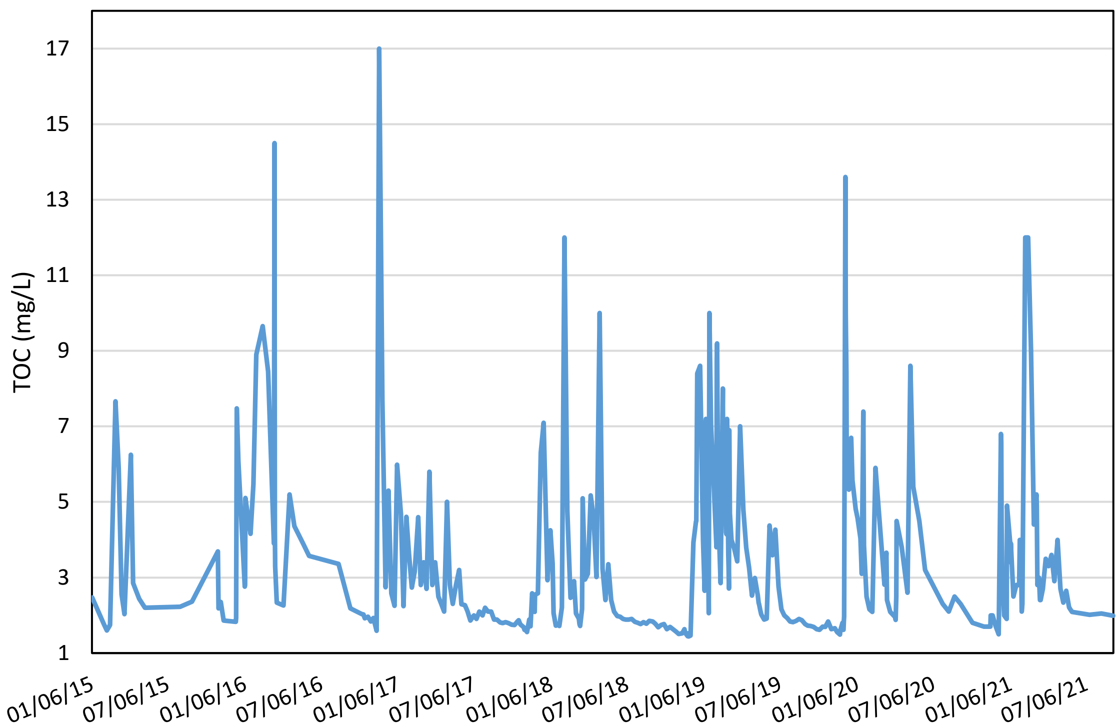


Figure 20. Summary of total organic carbon (TOC) data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.3.4 Dissolved Organic Carbon

The Graham Hill Water Treatment Plant (GHWTP) has historically switched off (turned out) the San Lorenzo River (SLR) as a source water when the total/dissolved organic carbon (TOC/DOC) rises above 4 mg/L in order to avoid treatment issues per standard operating procedures. There is not a primary and/or secondary maximum contaminant level (MCL) for DOC in finished water.

Given the overlap between TOC and DOC, it is unsurprising that DOC displayed similar seasonal trends as TOC (Table 6 and Figure 21). The concentrations of the North Coast sources generally remained low during the wet season, even during storm events, however, results fluctuated with Liddell Spring ranging from a minimum of 0.20 mg/L to a maximum of 0.56 mg/L and Laguna Creek ranging from 0.56 mg/L to 6.2 mg/L. Loch Lomond generally had the highest DOC for WY 2021, ranging between 3.6 and 4.4 mg/L, and did not exhibit a high degree of variability as a result of storm events. Loch Lomond had the highest average DOC for WY 2021 (Figure 22). The SLR showed the greatest variation in DOC concentration during storms exceeding 4 mg/L numerous times between November 2020 and March 2021, with a high result of 11 mg/L at Felton Diversion on January 27, 2021. The average DOC concentration of the Raw Blend was below 2.5 mg/L for WY 2021 (Figure 22). This is due to the blending of Liddell Spring, which generally has lower TOC and provides a buffer against the fluctuations of the SLR and the consistent high average of Loch Lomond to reduce the overall DOC of the Raw Blend. The average DOC data for Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion was significantly higher than the median values, as those sources are more impacted by storm runoff events compared to Loch Lomond. Loch Lomond DOC results are consistent throughout the year; therefore, the average and median values are similar.

As shown in Figure 23, the DOC of the SLR Tait St. Diversion reached a result of 11 mg/L during the largest storm recorded in WY 2021 on January 27, 2021. A DOC result of 12 mg/L in WY 2017 and WY 2020 are the highest results recorded by the WQL since 2015. However, event based storm sampling was not consistently conducted prior to the current sampling program, and as such, higher DOC results may have previously occurred but were not captured by the WQL's sampling.

As shown in Table 7, DOC upper watershed sampling locations that were sampled during storm events had higher DOC concentrations. Following trends in other constituents, Laguna Creek had the lowest levels of DOC when compared to other sources.

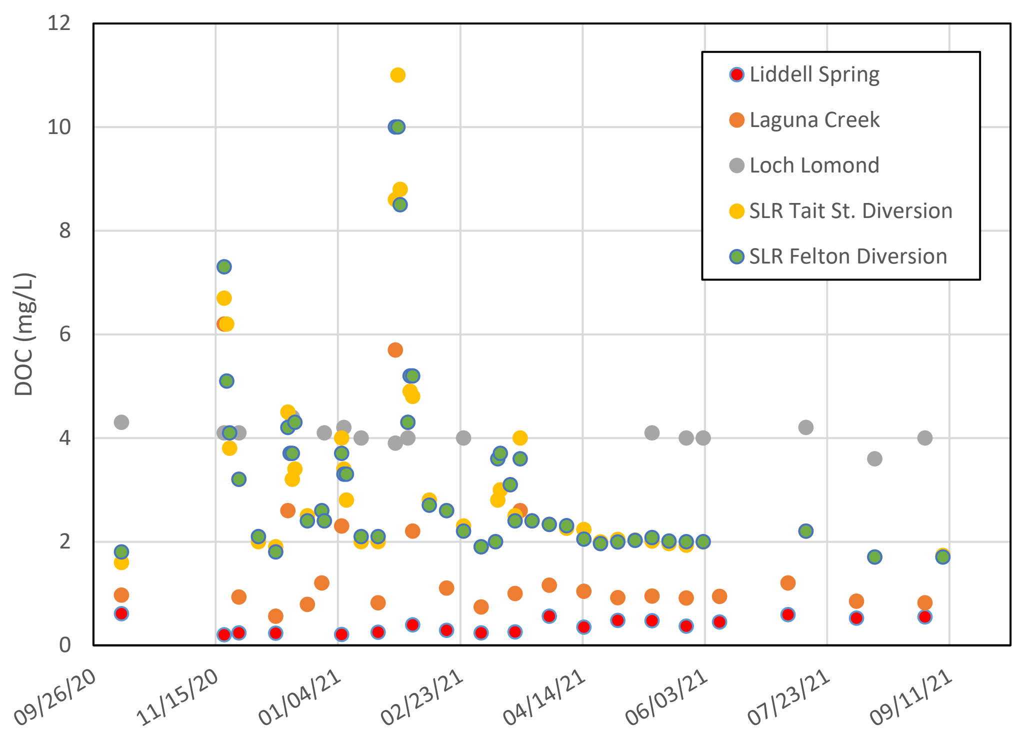


Figure 21. Dissolved organic carbon (DOC) of source waters between October 2020 and September 2021

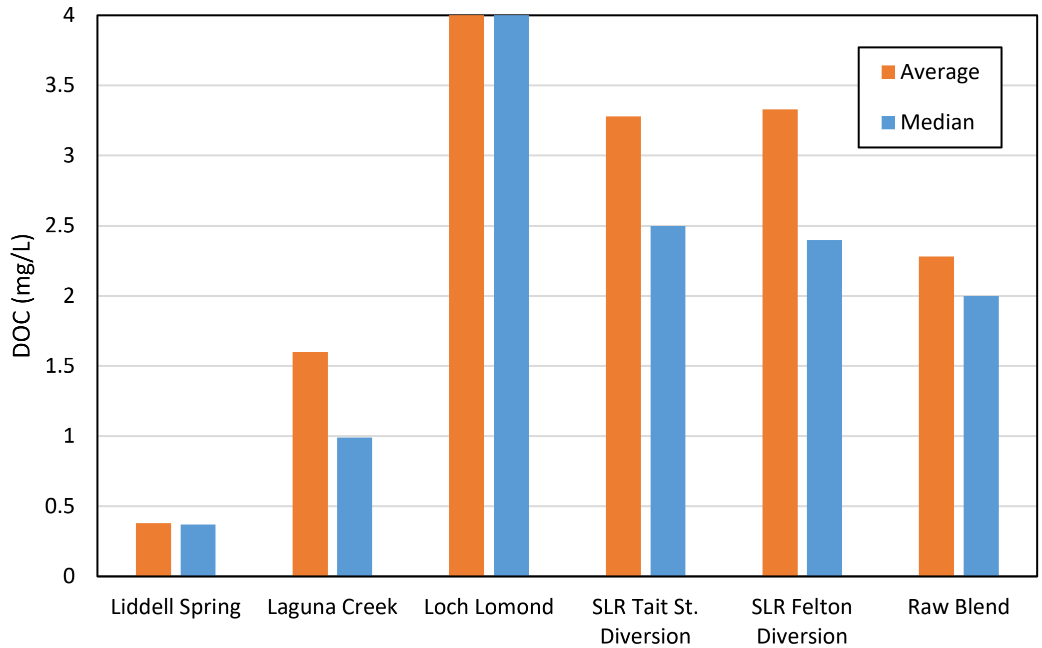


Figure 22. Average and median source water dissolved organic carbon (DOC) data for WY 2021

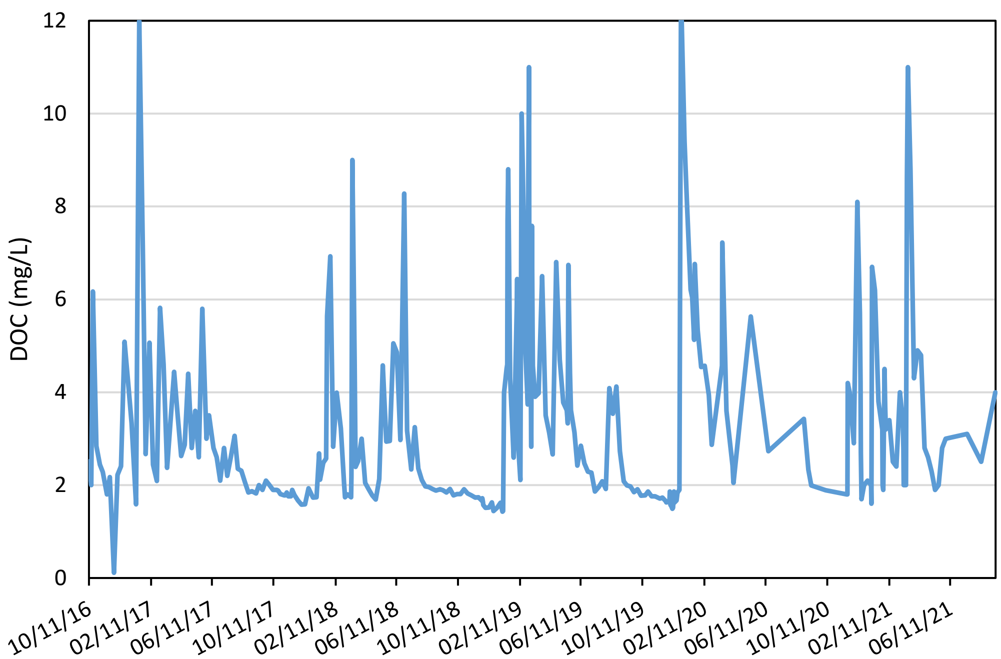


Figure 23. Summary of dissolved organic carbon (DOC) data from the San Lorenzo River Tait St. Diversion between October 2016 and September 2021

2.3.5 Total Suspended Solids

Total suspended solids (TSS) is a direct measurement of the quantity of suspended particles (solids) in a water sample. It is quantified as the dry weight of solids captured through a specified filter size. TSS results inform water treatment and solids handling requirements at the Graham Hill Water Treatment Plant (GHWTP). TSS data was only collected at source water and upper watershed locations and not at the GHWTP finished water or Raw Blend. There is neither a primary or secondary contaminant level (MCL) for TSS in finished water.

The TSS results exhibit the same trends as color, turbidity, and total/dissolved organic carbon (TOC/DOC) increasing dramatically during the wet season (Table 6 and Figure 24). The TSS concentrations of the North Coast sources generally remained low during the wet season, even during storm events. However, results at Laguna Creek fluctuated with results ranging from non-detect (ND) to 22 mg/L. Again, because Liddell Spring is not directly affected by surface runoff, TSS was consistently not detected throughout the WY. Loch Lomond's values varied seasonally due to algae growth in the summer and storm runoff in the winter, ranging from non-detect to a maximum 1.6 mg/L in the dry season and 9.1 mg/L in the wet season. TSS was highest in the San Lorenzo River with a result of 1,630 mg/L at Felton Diversion on January 27, 2021. The San Lorenzo River (SLR) at Felton Diversion had the highest TSS average of 45 mg/L for WY 2021 (Figure 25). The average TSS data for Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion was significantly higher than the median values, as those sources are more impacted by storm runoff events compared to Loch Lomond. Loch Lomond TSS results are consistent throughout the year; therefore, the average and median values are similar.

As shown in Figure 26, TSS of the SLR at Tait St. Diversion had a maximum value of 706 mg/L during the largest storm recorded in WY 2021, which is the highest value recorded by WQL since 2015. Again, because event based storm sampling was not consistently conducted prior to this effort, it is unclear how this result compares to historical values.

As shown in Table 7, upper watershed sampling locations that were sampled during storm events had higher TSS concentrations. Following trends in other constituents, Laguna and Majors Creeks had the lowest levels of TSS when compared to other sources.

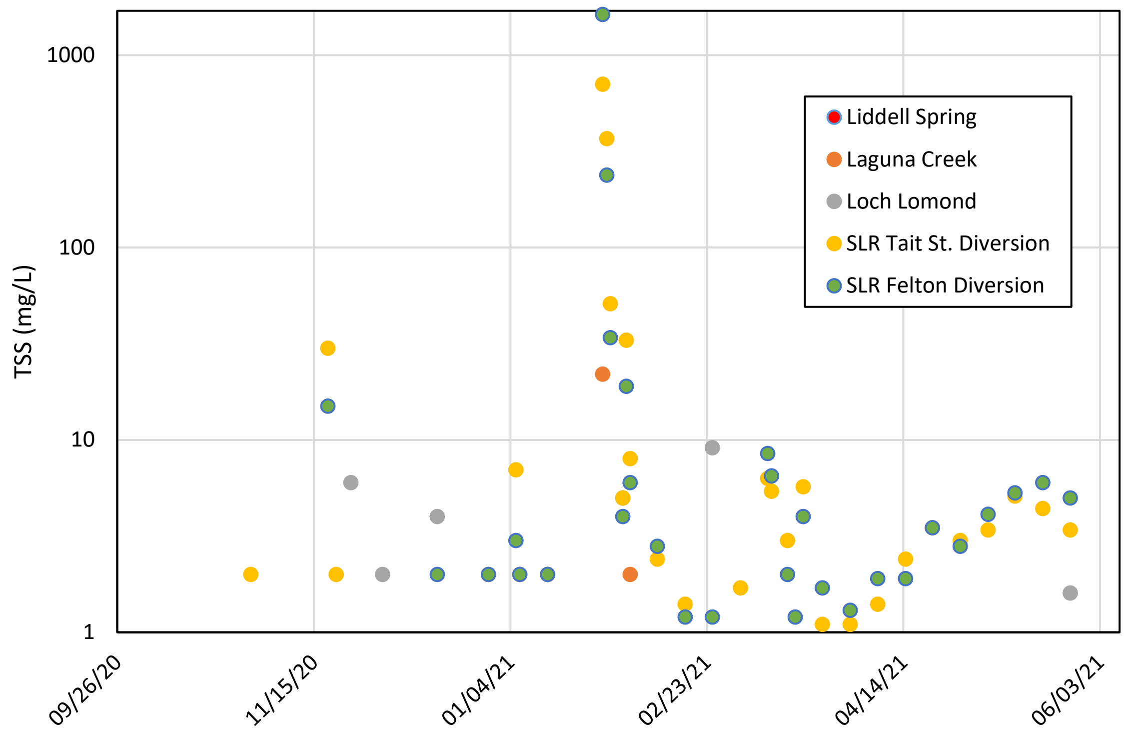


Figure 24. Total suspended solids (TSS) of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

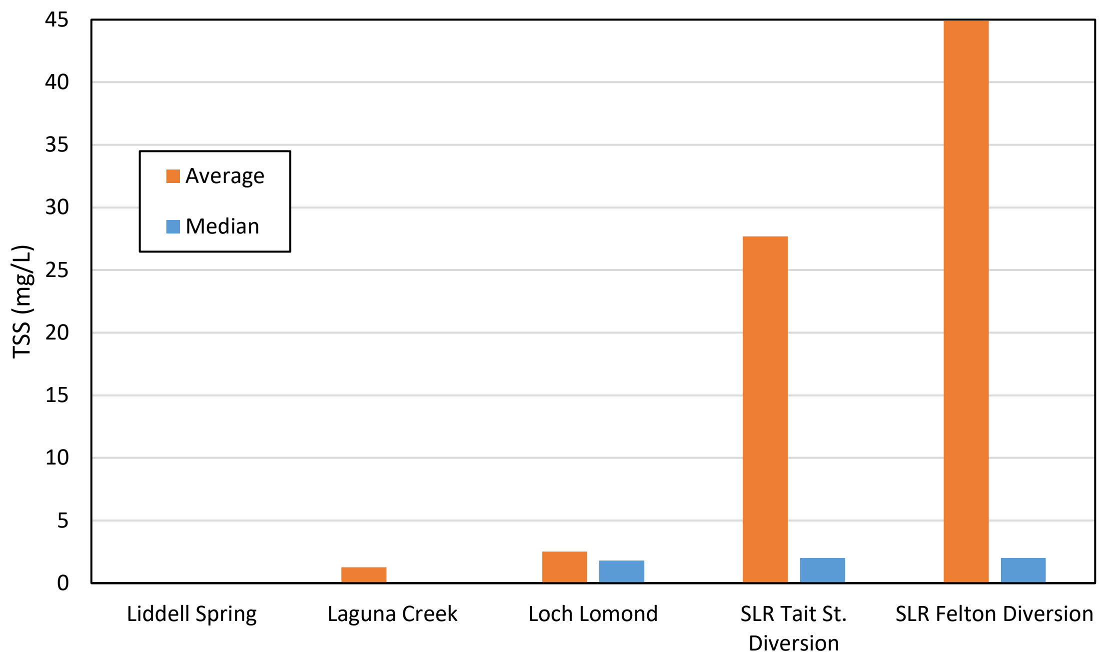


Figure 25. Average and median source water total suspended solids (TSS) data for WY 2021

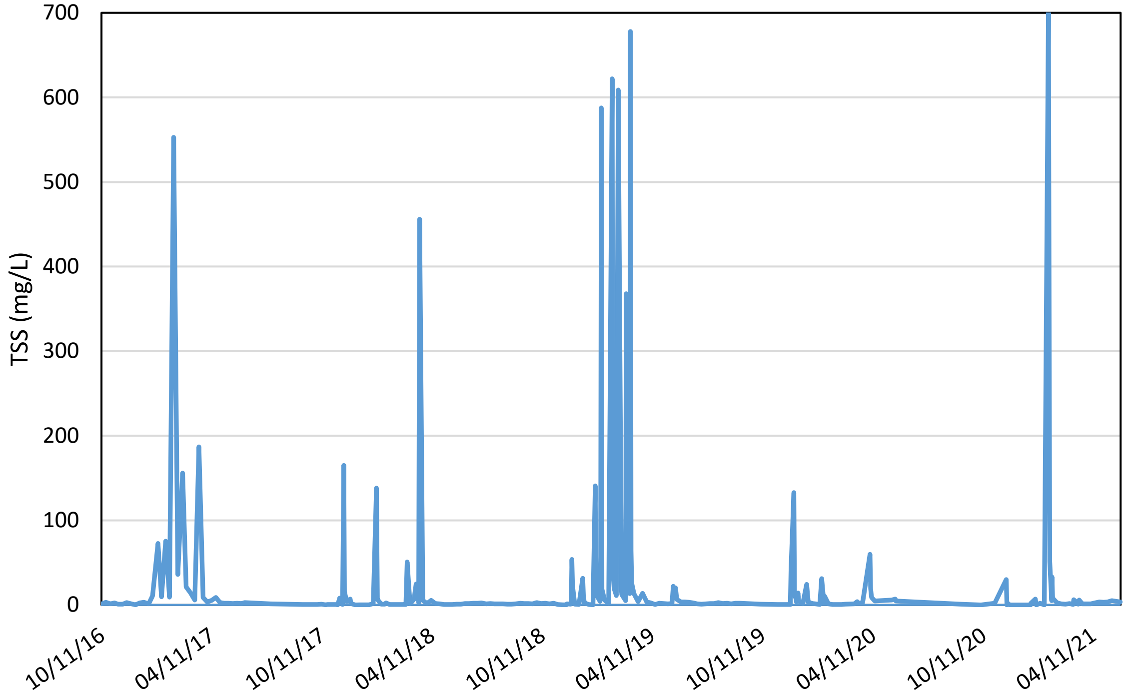


Figure 26. Summary of total suspended solids (TSS) data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

Table 6. Summary of Water Treatment Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021. Values presented are average (minimum – maximum)

			GHWTP Finished Water		Raw Blend		Liddell Spring		Laguna Creek		Loch Lomond		SLR Tait St. Diversion		SLR Felton Diversion	
Parameter	**Primary MCL**	**Secondary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Color (CU)		15	1 (1 - 1)	1 (1 - 1)	8 (6 - 24)	11 (5 - 24)	1 (1 - 1)	1 (1 - 1)	3 (2 - 4)	12 (4 - 60)	11 (6 - 28)	17 (12 - 24)	12 (8 - 20)	63 (8 - 800)	12 (8 - 20)	124 (8 – 3,000)
Turbidity (NTU)		5	0.05 (0.05 - 0.05)	0.05 (0.05 - 0.05)	1.1 (0.55 - 1.8)	2.2 (0.40 - 12)	0.06 (0.05 - 0.10)	0.08 (0.05 - 0.20)	0.10 (0.10 - 0.15)	2.03 (0.10 - 26)	1.2 (0.2 - 6.8)	4.1 (1.1 - 10)	1.1 (0.55 - 2.1)	20.4 (0.4 - 400)	1.2 (0.5 - 2.8)	25 (0.4 – 1,600)
Total Organic Carbon (mg/L)			1.5 (1.1 - 2.6)	2.0 (1.0 - 2.8)	2.1 (1.5 - 4.0)	2.7 (1.3 - 4.0)	0.50 (0.20 - 0.71)	0.42 (ND - 0.98)	0.89 (0.67 - 1.0)	2.0 (0.56 - 6.3)	3.9 (3.4 - 4.2)	4.0 (3.9 - 4.2)	2.0 (1.5- 2.6)	4.1 (1.9 - 12)	2.0 (1.5 - 2.5)	4.4 (2.0 - 19)
Dissolved Organic Carbon (mg/L)			1.5 (1.2 - 2.3)	1.8 (1.1-2.7)	2.0 (1.6 - 3.3)	2.4 (1. 3 - 4.0)	0.49 (0.35 - 0.61)	0.29 (0.20 - 0.56)	0.96 (0.82 - 0.96)	2.0 (0.56 - 6.2)	4.0 (3.6 - 4.3)	4.1 (3.9 - 4.4)	2.0 (1.6 - 2.3)	3.8 (1.9 - 11)	2.0 (1.7 - 2.3)	3.8 (1.8 - 10)
Total Suspended Solids (mg/L)							ND	ND	0.14 (ND - 0.3)	1.6 (ND - 22)	0.67 (ND - 1.6)	3.1 (ND - 9.1)	2.9 (ND - 5.1)	34.6 (ND - 706)	3.4 (ND - 6)	55.2 (ND – 1,630)
ND=Analyte Not Detected																

Table 7. Summary of Water Treatment Parameters Measured in Upper Watershed Locations between October 2020 and September 2021. Values presented are average (minimum – maximum).

			Upper Laguna Creek		Upper Majors Creek		SLR Junction Park		SLR Highlands Park	
Parameter	**Primary MCL**	**Secondary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Color (CU)		15	3 (2 - 6)	14 (4 - 40)	4 (3 - 6)	47 (24 - 70)	12 (8 - 20)	80 (40 - 120)	14 (12 - 20)	80 (12 - 400)
Turbidity (NTU)		5	0.2 (0.10 - 0.35)	1.6 (0.1 - 8.8)	0.38 (0.35 - 0.45)	8.2 (1.4 - 15)	0.52 (0.45 - 0.60)	9 (4.9 - 13)	1.5 (0.75 - 2.8)	36.1 (0.75 - 200)
Total Organic Carbon (mg/L)			2.1 (0.61 - 5.5)	2.6 (0.63 - 5.5)	0.89 (0.70 - 1.0)	5.2 (4.1 - 6.4)	1.8 (1.6 - 2.1)	10.3 (4.7 - 16)	2.2 (1.9 - 2.4)	5.1 (2.4 - 11)
Dissolved Organic Carbon (mg/L)			0.85 (0.78 - 0.90)	2.5 (0.69 - 5.2)	1.0 (0.91 - 1.0)	5.1 (3.9 - 6.3)	1.8 (1.6 - 2.2)	9.8 (4.5 - 15)	2.0 (1.9 - 2.3)	4.5 (2.2 - 8.7)
Total Suspended Solids (mg/L)			0.06 (ND - 0.1)	1 (ND - 7)	0.3 (ND - 0.6)	5 (2 - 8)	0.3 (ND - 0.6)	14.5 (4.0 - 25)	3.5 (2.0 - 6.1)	49.3 (ND - 374)
ND=Analyte Not Detected										

2.4 Microbial Parameters

Microbial indicators are ubiquitous in the natural environment, but their presence in elevated numbers can suggest the presence of pathogenic organisms. The Graham Hill Water Treatment Plant (GHWTP) management of pathogenic organisms is guided by the Federal Long Term 2 Enhance Surface Water Treatment Rule (LT2ESWTR) and the Stage 2 Disinfection Byproduct Rule (DBPR). Under LT2ESWTR, the Santa Cruz Water Department (SCWD) is classified under BIN 2, which requires treatment techniques that achieve 3-log removal of Cryptosporidium, 4-log removal of Giardia and 5-log virus removal. The GHWTP meets these requirements through a combination of treatment process and filter performance.

2.4.1 Total Coliform

Total coliforms are a group of bacteria that are naturally present in the environment and found in plant and soil material as well as in the digestive tracts of animals and humans. Total coliforms are described as indicator bacteria because while their presence in water does not cause illness, their presence indicates that those organisms that do cause illness are also present. Coliforms come from the same source as pathogenic organisms and provide a reasonable indication of whether other pathogenic bacteria are present. Total coliform is monitored in the Santa Cruz Water Department's (SCWD) water distribution system to comply with the revised Total Coliform Rule (RTCR) and is also used to evaluate the source water microbial load. There are no primary and/or secondary maximum contaminant levels (MCL) for Total coliforms in surface source water.

Sampling demonstrates elevated levels of total coliform counts in some source waters, particularly during storm events, however coliform entering the treatment process is reduced by selectively turning out sources during storm events. Any remaining coliform is effectively treated at GHWTP and water quality is maintained through chlorine residual in the distribution system.

As shown in Table 8 and in Figure 27, total coliform counts are highly variable by source and increase during the wet season due to storm events. In general, total coliforms results are consistently higher during the wet season at all source water locations, except for Liddell Spring. The North Coast sources, including Liddell Spring and Laguna Creek, have consistently low total coliform results compared to the San Lorenzo River (SLR). Results at Laguna Creek fluctuated ranging from 74-7,270 MPN/100 mL during the wet season compared to a maximum value of 92,080 MPN/100 mL for the SLR at Felton Diversion. The SLR, at both Felton Diversion and Tait. St. Diversion locations are the most variable and susceptible to increases in microbial load during winter storms, having the highest total coliform values overall. The Felton Diversion had the highest total coliform geometric mean for WY 2021 (Figure 27). The maximum recorded total coliform result for Raw Blend was 4,611 MPN during the dry season; and the geometric mean Raw Blend total coliform result did not exceed 500 MPN/100 mL during WY 2021. This is due to the blending of Liddell Spring, which generally has lower total coliform load and provides a buffer against the fluctuations of the SLR and Loch Lomond to reduce the overall total coliform load of the Raw Blend. The GHWTP finished water was consistently absent for Total coliforms throughout WY 2021.

As shown in Figure 28, the concentration of total coliform at SLR Tait St. Diversion reached a maximum result of 54,750 MPN/100 mL on the first storm event of WY 2021 (November 18, 2020). A total coliform result of 104,620 MPN/100 mL was the highest result recorded by WQL since 2015 during WY 2019.

As shown in Table 9, total coliform concentrations increased during storm events and are therefore consistently higher during the wet season at all upper watershed sampling locations. The upper SLR watershed locations at Junction and Highlands Park are more susceptible to an increase in total coliform during winter storms. SLR Junction Park is the furthest upstream sample location on the SLR and obtained a maximum result of 173,289 MPN/100 mL on the first storm event of the year (November 18, 2020).

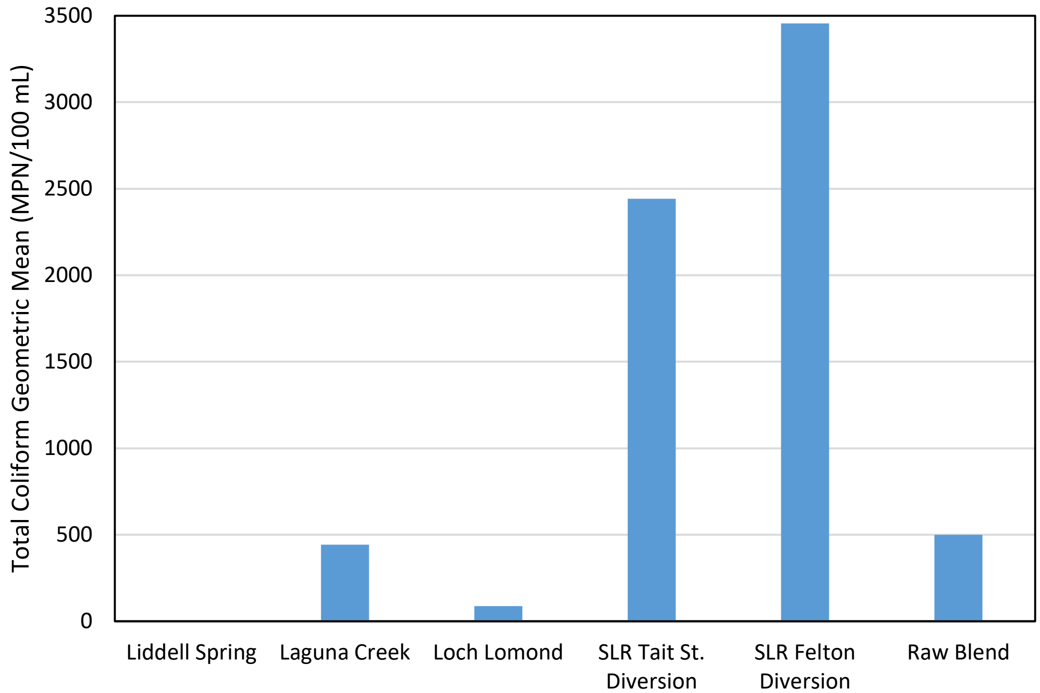


Figure 27. Summary of total coliform geometric mean of source waters between October 2020 and September 2021

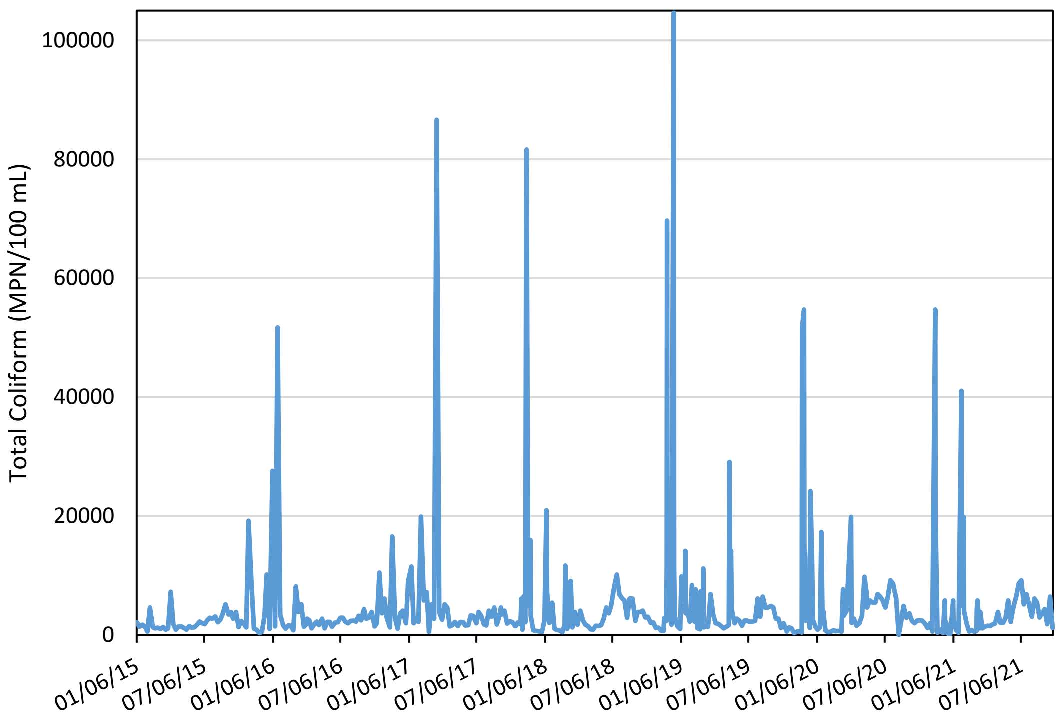


Figure 28. Summary of total coliform data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.4.2 *E. coli*

The concentration of *E. coli* provides an indication of the extent of human and animal fecal contamination of a watershed, as it is more specific than total coliform. For drinking water supplies, the common guidance is that fecal coliform levels above 200 MPN/100 mL signifies a source with potentially large contamination from human sources (NRC 2004). However, the distribution system is frequently sampled for the presence of *E.coli,* and should it be detected, extensive customer and agency notifications are required, along with flushing and disinfection of the affected area of the distribution network.

Even though there are no formal *E. coli* regulations for source water, the fecal coliform Total Maximum Daily Load (TMDL) can be used as a point of comparison. According to the United States Environmental Protection Agency (EPA), TMDL is the calculation of the maximum amount of a pollutant allowed to enter a water body so that the water body will meet and continue to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant. The San Lorenzo River (SLR) Watershed has a TMDL for fecal coliform (*E. coli*) of 200 MPN/100 mL (30-day log-mean limit), with 90% of samples below 400 MPN/100 mL (TMDL Report for the San Lorenzo River, Soquel Creek, and Aptos Creek Watersheds September 2021). The SLR Watershed is densely populated with septic systems, and failing septic systems are considered a threat to water quality. For a more thorough discussion of this concern, please refer to the Watershed Sanitary Survey (WSS).

Similar to total coliform, *E. coli* concentrations were highly variable by source and increased during the wet season due to storm events. *E. coli* results were consistently higher at all source water locations, except for Liddell Spring (Table 8 and Figure 27). The North Coast sources, including Liddell Spring and Laguna Creek, have consistently lower *E. coli* results compared to the San Lorenzo River (SLR); however results at Laguna Creek fluctuated ranging from <1-164 MPN/100 mL during the wet season. Loch Lomond fluctuated slightly in the wet season with results ranging from <1-3.1 MPN/100 mL The SLR, at both Felton Diversion and Tait St. Diversion locations, are the most variable and susceptible to increase in microbial load during the wet season, having the highest *E. coli* values overall. Felton Diversion had the highest *E. coli* result of 5,794 MPN/100 mL on 01/27/21. The Felton Diversion location had the highest *E. coli* geometric mean for WY 2021 (Figure 27). The maximum recorded *E. coli* result for Raw Blend was 260 MPN/100 mL; however, the geometric mean Raw Blend *E. coli* result did not exceed 23.9 MPN/100 mL during WY 2021. This is due to the blending of Liddell Spring and Loch Lomond, which generally have lower *E. coli* loads, and provides a buffer against the fluctuations of the SLR to reduce the overall *E. coli* load of the Raw Blend. The GHWTP finished water was consistently absent for *E. coli* throughout WY 2021.

As shown in Figure 30, the concentration of *E. coli* at SLR Tait St. Diversion for WY 2021 reached a result of 2,430 MPN/100 mL on the first storm event of WY 2021. The highest *E. coli* result recorded was 7,060 MPN/100 mL in WY 2016.

As shown in Table 9, *E. coli* concentrations increased during storm events and were therefore consistently higher during the wet season at all upper watershed sampling locations. The upper SLR watershed locations at Junction and Highlands Park are more susceptible to an increase in *E. coli* during the wet season. SLR Highland Park obtained a result of 6,488 MPN/100 mL on the first storm event of the year (11/18/20).

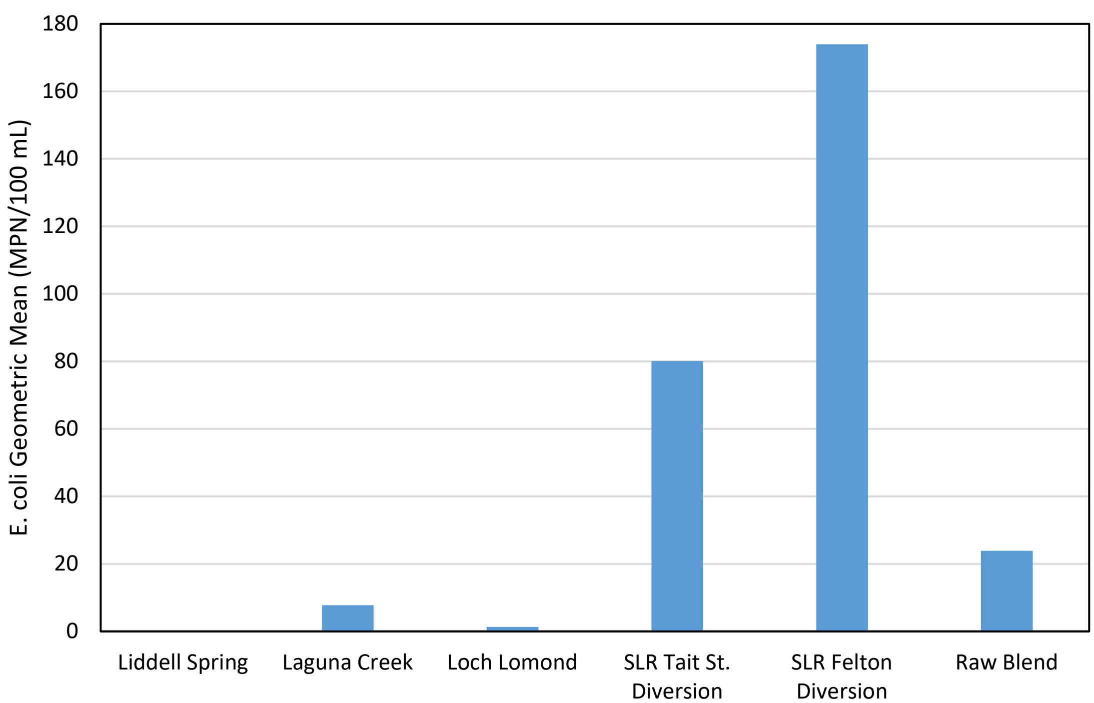


Figure 29. Summary of *E. coli* geometric mean of source waters between October 2020 and September 2021

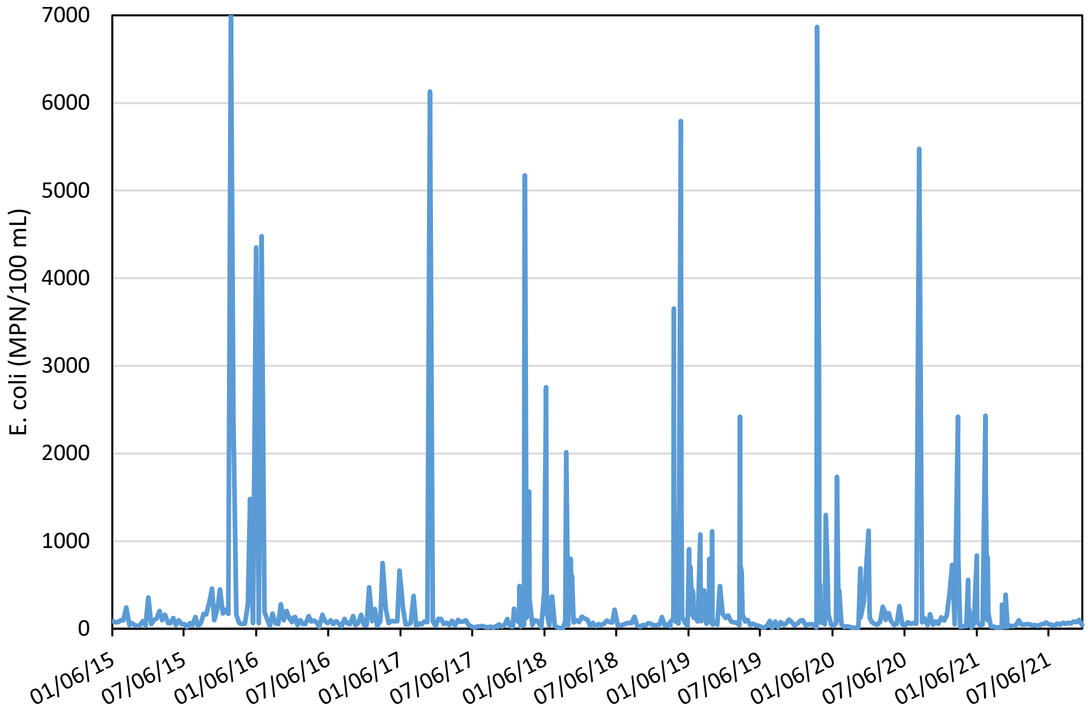


Figure 30. Summary of *E. coli* data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.4.3 Enterococci

Enterococci are bacteria that live in the intestinal tracts of warm-blooded animals, including humans, and indicate possible contamination by fecal waste. Typical sources of Enterococci include wastewater treatment plant effluent, failing or improperly sited septic systems, storm water runoff, homeless encampments, and domestic animal and wildlife waste. Enterococci are indicators of the presence of fecal material in water and, therefore, of the possible presence of disease-causing bacteria such as viruses, bacteria, and protozoa. There are no formal Enterococci limits for source water.

Similar to total coliform and *E. coli*, Enterococci concentrations are highly variable by source and increased during the wet season due to storm events. Enterococci results were consistently higher during the wet season at all of the source water locations, except for Liddell Spring and Loch Lomond (Table 8 and Figure 31). The North Coast sources, including Liddell Spring and Laguna Creek, have consistently low Enterococci results compared to the San Lorenzo River (SLR); however, results at Laguna Creek fluctuated ranging from <1-266 MPN/100 mL during the wet season. Loch Lomond fluctuated slightly in the wet season with results ranging from <1-1 MPN/100 mL. Both SLR locations, Felton Diversion and Tait. St. Diversion, are the most variable and susceptible to increase in microbial load during the wet season, having the highest Enterococci values overall. Felton Diversion had the highest Enterococci result of 12,340 MPN/100 mL on January 27, 2021. The Felton Diversion location had the highest Enterococci geometric mean for WY 2021 (Figure 28). The maximum recorded Enterococci result for Raw Blend was 158 MPN/100 mL; however, the geometric mean Raw Blend Enterococci result did not exceed 17.5 MPN/100 mL during WY 2021. This is due to the blending of Liddell Spring and Loch

Lomond, which generally have lower Enterococci loads, and provide a buffer against the fluctuations of the San Lorenzo River to reduce the overall Enterococci load of the Raw Blend.

Consistent monitoring of Enterococci by the Santa Cruz Water Department's (SCWD) Water Quality Laboratory (WQL) began in 2017. As shown in Figure 32, the concentrations at SLR Tait St. Diversion reached a result of 7,540 MPN/100 mL during the largest storm recorded (January 27, 2021) for WY 2021. The highest Enterococci result recorded was 9,600 MPN/100 mL in WY 2018.

As shown in Table 9, Enterococci concentrations increased during storm events and were therefore consistently higher during the wet season at all upper watershed sampling locations. The upper SLR watershed locations at Junction and Highlands Park are more susceptible to an increase in Enterococci during winter storms. SLR Highland Park obtained a high result of 15,531 MPN/100 mL during the largest storm recorded for WY 2021 on January 27, 2021.

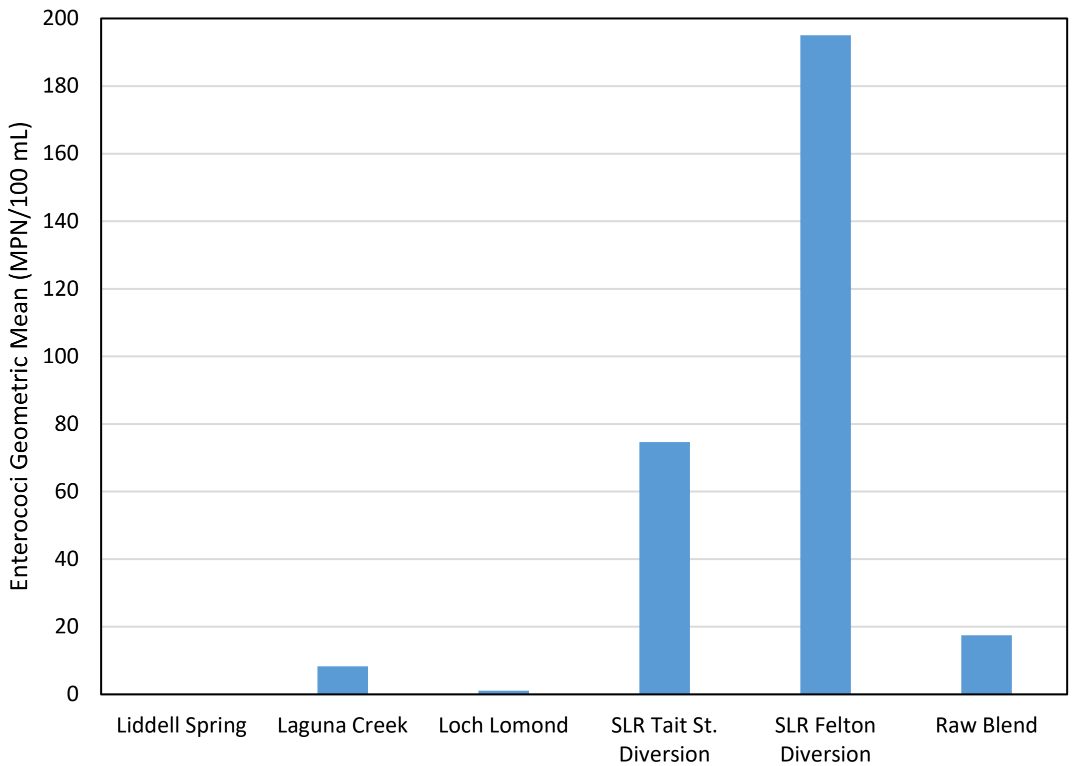


Figure 31. Summary of Enterococci geometric mean of source waters between October 2020 and September 2021

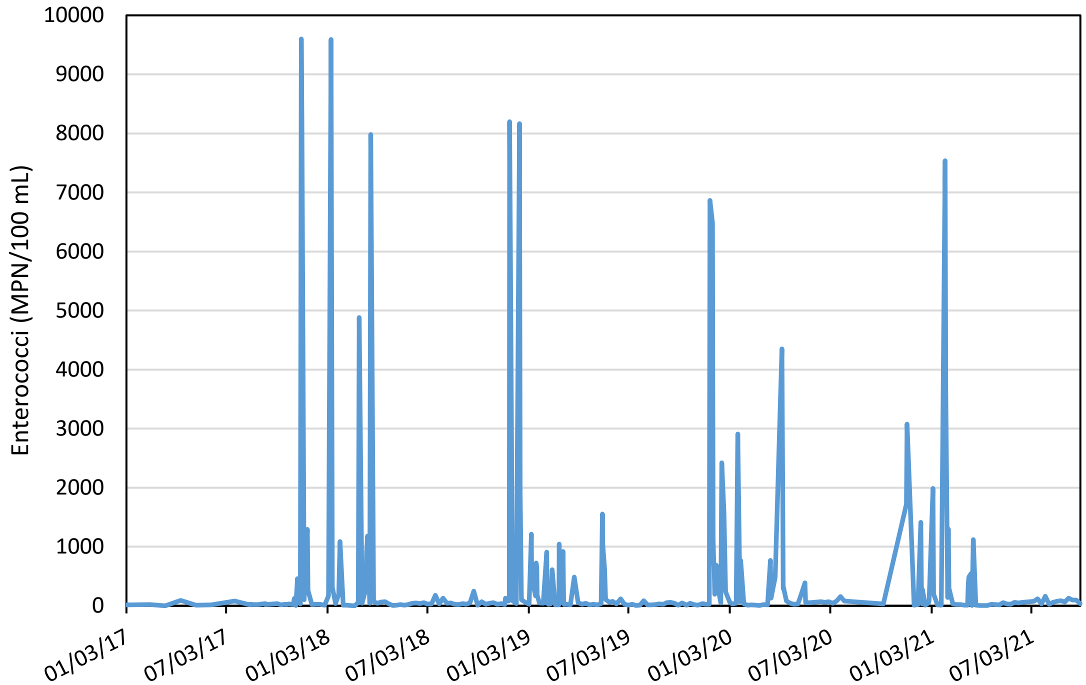


Figure 32. Summary of Enterococci data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.4.4 Microbial Source Tracking

Microbial Source Tracking (MST) is the process of identifying the particular source (e.g. human, cattle, and bird) of fecal contamination in water. In December 2016, the Santa Cruz Water Department's (SCWD) Water Quality Laboratory (WQL) began MST monitoring in the San Lorenzo River (SLR) in order to gain a better understanding of the source of the fecal contamination in the SLR. The four MST analyses performed include Universal Bacteroides, Human Bacteroides (HF-183), MS2 Coliphage, and Somatic Coliphage. Universal Bacteroides tests for fecal contamination from all sources including animals, birds, and humans, while Human Bacteroides (HF-183), MS Coliphage, and Somatic Coliphage are fecal indicators of human influence particularly from wastewater. Human Bacteroides (HF-183) are a genus of bacteria that predominantly thrive in the lower gastrointestinal tract of humans and are therefore directly associated with fecal contamination. MS2 and Somatic Coliphage are bacteriophage viruses that infect *E. coli* bacterial cells. There are no current regulations for MST as they are primarily used as indicators of human influence in recreation and source water. Storm event MST analysis was added to WY 2021 to further evaluate storm water quality for treatment at the GHWTP.

As shown in Table 8 and in Figures 33-36, MST results are variable throughout the year. Human Bacteroides, MS2 Coliphage, and Somatic Coliphage concentrations were generally higher during the wet season, suggesting that there is a greater human microbial influence during winter storms, potentially from septic systems in the San Lorenzo Valley located along the SLR. Felton Diversion had the highest Human Bacteroides result of 1,959 GC/mL on January 28, 2021. Tait St. Diversion had the highest MS2 Coliphage result of 15 PFU/100 mL on January 28, 2021 as well as the highest Somatic Coliphage result of 242 PFU/mL on November 18, 2020. Universal Bacteroides concentrations were found to be high during the dry season when there are lower rates of flow and an increase in animal activity, as well as human recreation occurring in the SLR. Tait St. Diversion had the highest Universal Bacteroides result of 439,370 GC/mL on May 5, 2021.

As shown in Figures 33-36, the concentrations of Human Bacteriodes, MS2 Coliphage, and Somatic Coliphage at SLR Tait St. Diversion for WY 2021 were lower than in previous WYs while the concentration of Universal Bacteroides was the highest result recorded since 2016.

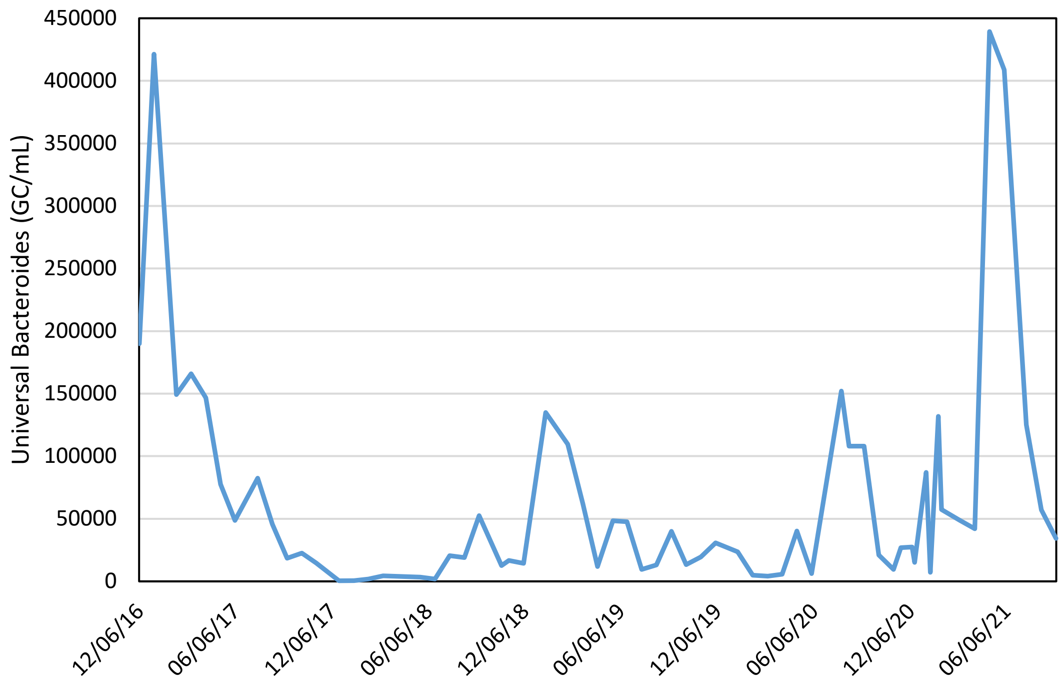


Figure 33. Summary of Universal Bacteroides data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

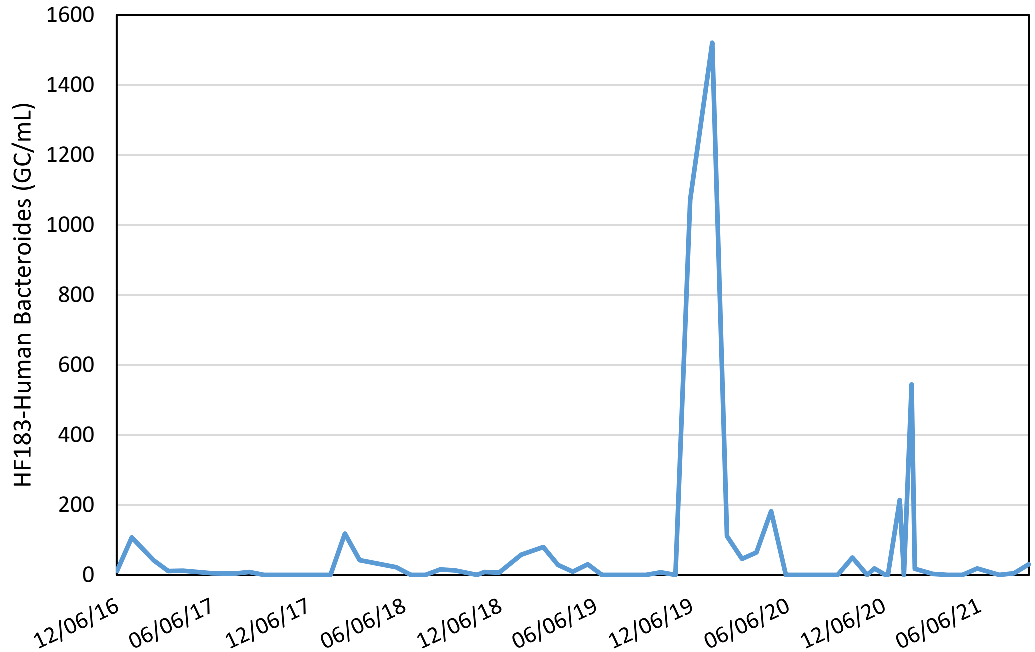


Figure 34. Summary of HF183-Human Bacteroides data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

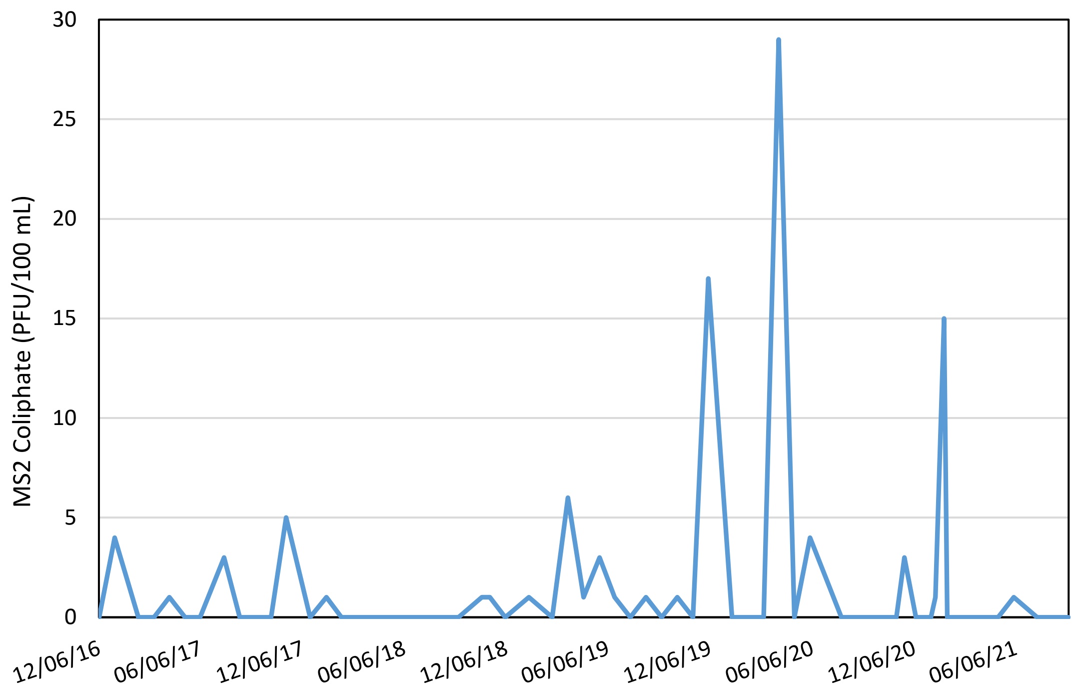


Figure 35. Summary of MS2 Coliphage data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

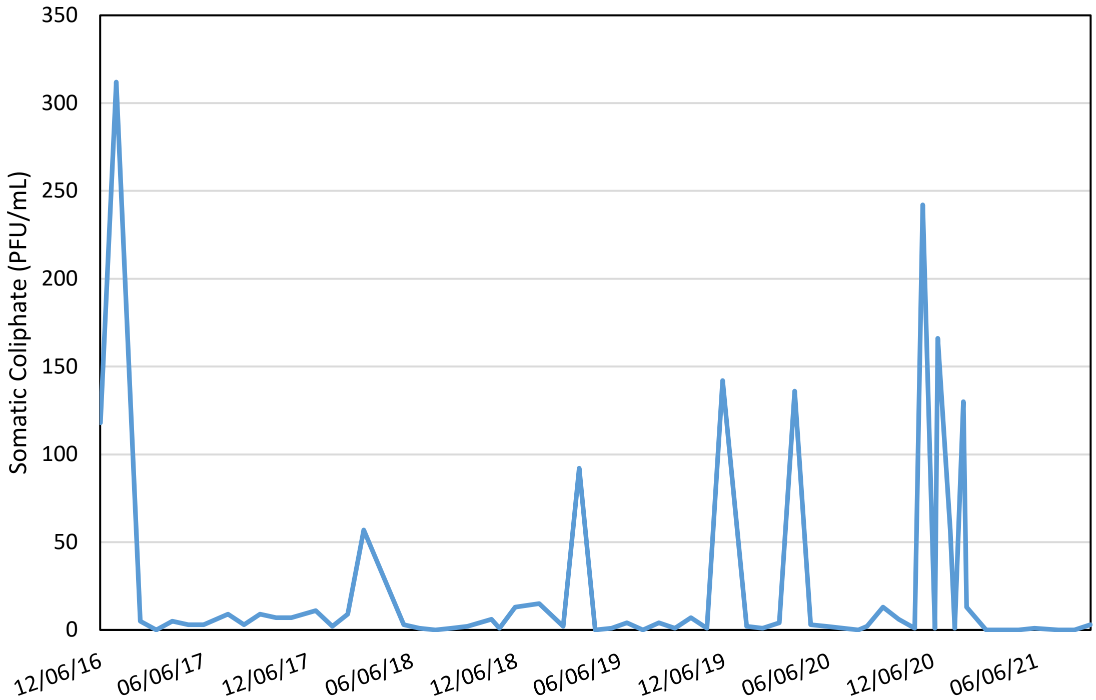


Figure 36. Summary of Somatic Coliphage data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

Table 8. Summary of Microbial Parameters Measured in Source Waters between October 2020 and September 2021. Values presented are minimum and maximum concentrations.

	Raw Blend		Liddell Spring		Laguna Creek		Loch Lomond		SLR Tait St. Diversion		SLR Felton Diversion	
Parameter	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Total Coliform (MPN/100 mL)	162 – 4,611	2 – 1,046.2	<1 - 18.9	<1 -18.7	260 – 1,553.1	74 – 7,270	12 - 11,199	2 - 261	613 – 9,208	225 - 54,750	1,553 – 8,664	435 - 92,080
E. *coli* (MPN/100 mL)	<1 - 260	<1 - 33	<1	<1	<1 - 50.4	<1 - 164	<1 - 1	<1 - 3.1	27.5 - 727	12 - 2,430	34.5 - 727	25.6 - 5,794
Enterococci (MPN/100 mL)	3.1 - 98.5	<1 - 158	<1	<1	<1 - 21.3	<1 - 266	<1 - 2	<1 - 1	5.2 - 159.7	6.3 - 7,540	18.3 - 816.4	30 - 12,340
Human Bacteroides (GC/mL)									ND - 49.3	ND - 544.2	ND - 29	5 – 1,959
Universal Bacteroides (GC/mL)									9,524 - 439, 370	7,102.5 - 131,733	22,590 - 423,275	16,938.3 - 301,127.5
MS2 Coliphage (PFU/100 mL)									ND - 1	ND - 15	ND - 1	ND - 6
Somatic Coliphage (PFU/mL)									ND - 6	ND - 242	ND - 222	ND - 155
ND=Analyte Not Detected												

Table 9. Summary of Microbial Parameters Measured in Upper Watershed Locations between October 2020 and September 2021. Values presented are minimum and maximum concentrations.

	Upper Laguna Creek		Upper Majors Creek		SLR Junction Park		SLR Highlands Park	
Parameter	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Total Coliform (MPN/100 mL)	166.4 – 1,539	152 – 6,131	435.2 – 1,553.1	754 - 1,986	1,935 - 6,488	7,270 - 173,289	2,014 - 7,701	770 - 141,361
E. *coli* (MPN/100 mL)	2 - 98	9.7 - 260	3 - 114	42.2 - 228	40 - 125.9	86.5 - 3,255	96 - 155.3	57 - 6,488
Enterococci (MPN/100 mL)	1 - 275.5	3.1 - 365	4.1 - 14.8	24.3 - 435	52 - 316.9	228.2 - 1,986	49 - 435.2	32.7 - 15,531

2.5 Regulated Chemistry Parameters

2.5.1 Metals

The presence of metals can be a concern in drinking water due to health effects and aesthetic issues, particularly with respect to color and taste. Metals can be present in both total (insoluble) and dissolved (soluble) forms, however only the total (insoluble) form is regulated. Iron and manganese are regulated with secondary maximum contaminant levels (SMCLs) of 0.3 and 0.05 mg/L respectively. Arsenic, copper, and lead are regulated with primary maximum contaminant levels (MCLs) of 10 µg/L, 1.3 mg/L, and 0.015 mg/L, respectively, and aluminum has both a primary and secondary MCL of 1 mg/L and 0.2 mg/L. While the primary and secondary MCLs are for the total concentration, the implications for removal are different for the total (insoluble) versus dissolved (soluble) forms. The total (insoluble) metals can easily be removed through conventional water treatment processes such as coagulation, flocculation, sedimentation, and filtration but conventional water treatment processes cannot remove the dissolved (soluble) metals from the water.

As shown in Table 10, total metals increased during storm events and are therefore consistently higher during the wet season at all of the source water locations, except for Liddell Spring. Total (insoluble) forms of aluminum, iron, and manganese did exceed their SMCLs during the wet season at Laguna Creek, Loch Lomond, and both San Lorenzo River (SLR) locations, but again, SMCLs are only applicable to treated water and not source waters. The majority of the measured concentrations existed in the particulate or total form (Figure 37). The dissolved fractions of each metal did not exceed drinking water standards. Arsenic was the only metal detected during both the dry and wet season, from the source at Liddell Spring. All metals were below their respective primary and secondary MCLs at the GHWTP finished water during the WY. As shown in Figures 38-40, the aluminum, iron, and manganese concentrations detected on January 27, 2021 at the SLR Tait St. Diversion were the highest levels measured since 2015. Even though winter storms were more frequent and stronger in previous years, event based storm sampling was not consistently conducted. Additionally, aluminum was not previously analyzed during storm events and was added to the WY 2021 sampling following the CZU Lightning Complex Fire.

As shown in Table 11, metals concentrations typically increased during storm events and are therefore consistently higher during the wet season at all upper watershed locations. The upper SLR watershed locations at Junction and Highlands Park are more susceptible to an increase in metals during winter storms. Copper and lead were only detected at Junction and Highlands Park during the November 18, 2021 and January 27, 2021 storms.

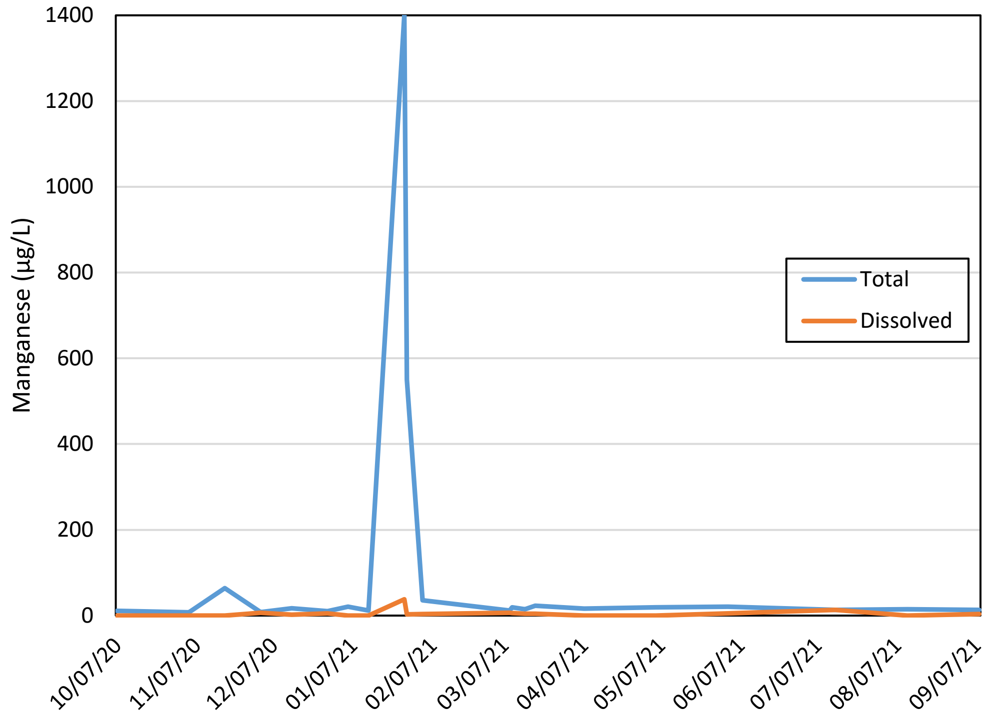


Figure 37. Summary of total and dissolved manganese from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

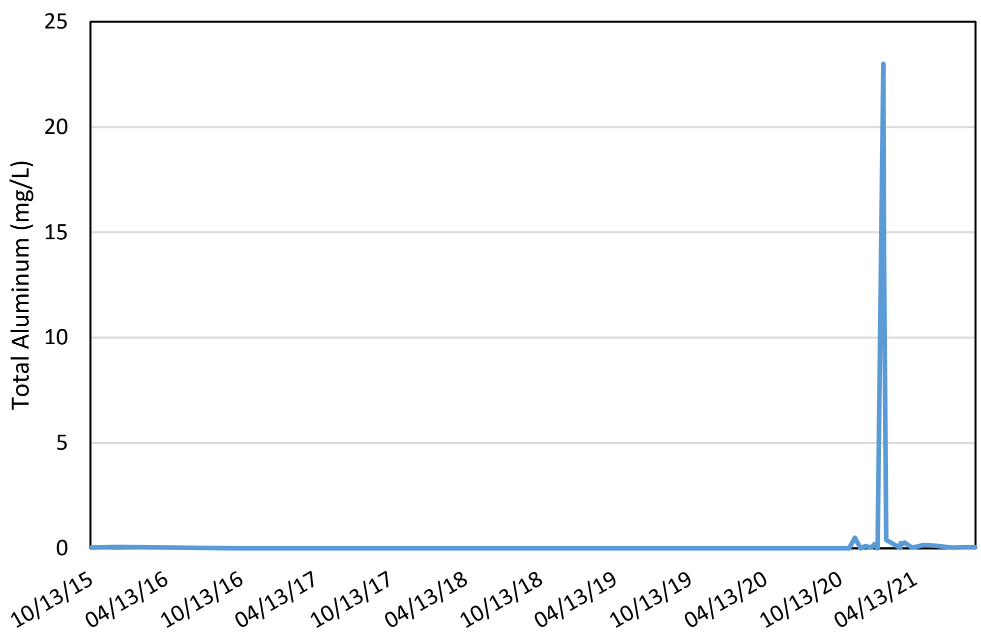


Figure 38. Summary of total aluminum from the San Lorenzo River Tait St. Diversion between January 2016 and September 2021

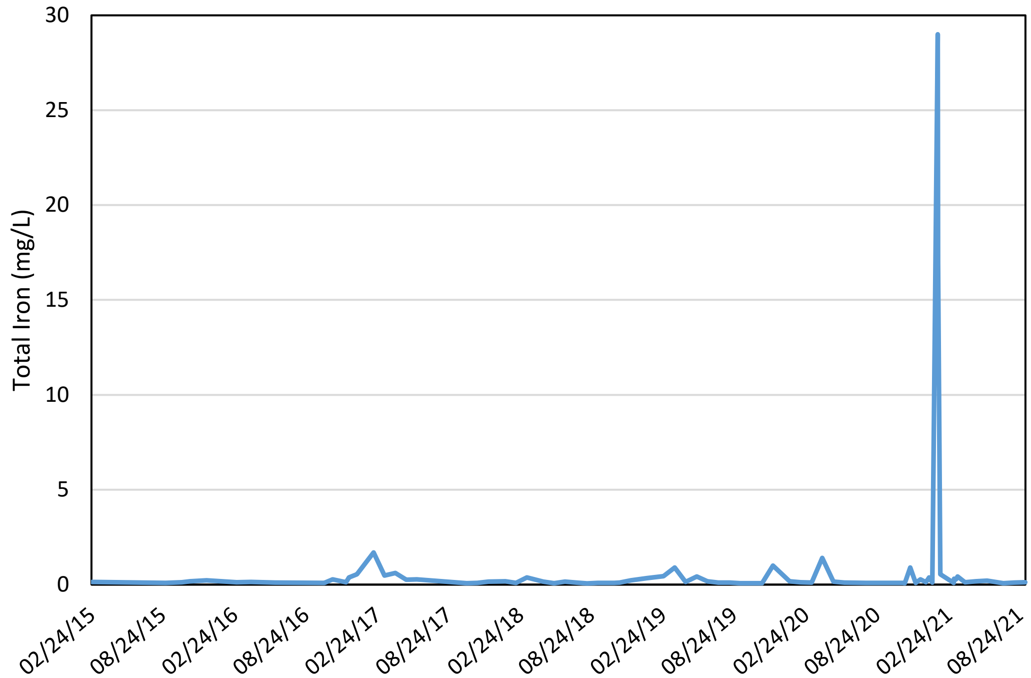


Figure 39. Summary of total iron from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

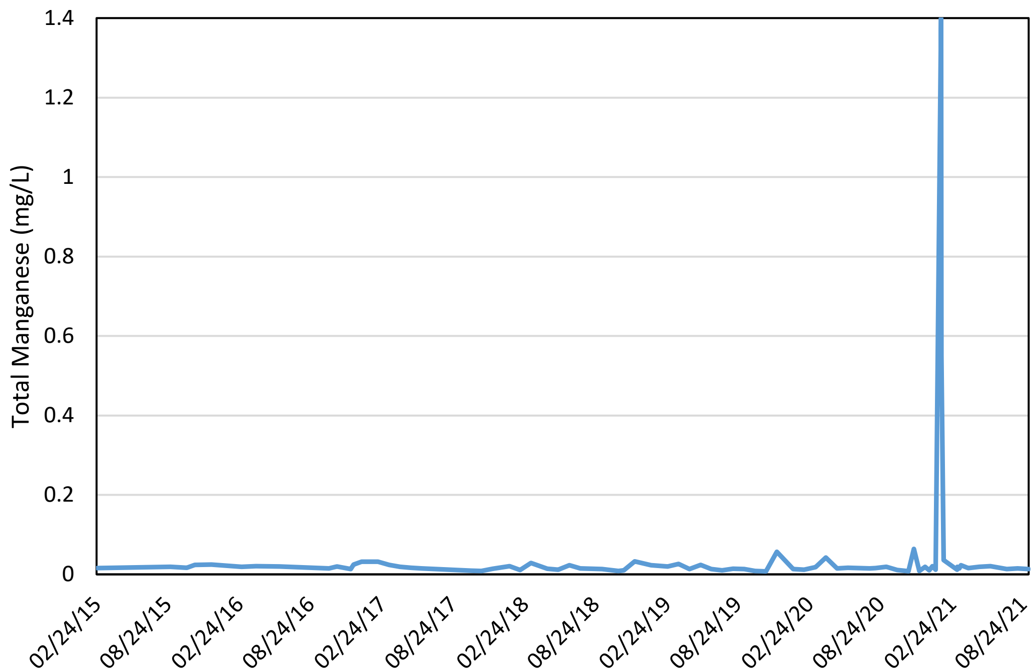


Figure 40. Summary of total manganese from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

2.5.2 Nitrate

Nitrate is regulated in drinking water as it can cause health impacts in humans and contribute to taste and odor aesthetics of the water. In some surface waters, the presence of nitrate is indicative of the potential for algae in stagnant areas and, in turn, the potential for associated taste and odor events. Nitrate as nitrogen and nitrate as NO3 are regulated with primary maximum contaminant levels (MCLs) of 10 mg/L and 45 mg/L, respectively. Nitrate as nitrogen refers to the element whereas nitrate as NO3 refers to nitrate combined with oxygen to form an ion, which is more bio-available than other forms of nitrogen, and thus has a greater effect on water quality. .

As shown in Table 10, nitrate as NO3 increased during storm events, with the exception of Laguna Creek, where nitrate as NO3 was non-detect throughout WY 2021. The highest nitrate as NO3 concentrations were detected in the San Lorenzo River (SLR), with the lowest concentrations at Loch Lomond and Laguna Creek. In contrast to source waters, concentrations of nitrate as NO3 was below the MCL at the finished water at the GHWTP, which illustrates the effectiveness of the treatment process for this constituent.

As shown in Figure 41, the nitrate as NO3 result of 3.0 mg/L detected at the SLR Tait St. Diversion on January 28, 2021 is the highest result measured since 2015. Nitrate as NO3 was not previously included in storm water analysis and was added in WY 2021 to evaluate the effects from the CZU Lighting Complex Fire.

As shown in Table 11, nitrate as NO3 concentrations were below the MCL during WY 2021. Nitrate as NO3 concentrations in the upper SLR watershed locations at Junction and Highlands Park and Upper Majors were higher during the dry season than the wet season. This may be due to stagnant waters during the dry season, which may foster the growth of algae and in turn contribute to nitrate as NO3 concentrations. Upper Laguna Creek was the only upper watershed location that increased in Nitrate as NO3 concentration during the wet season.

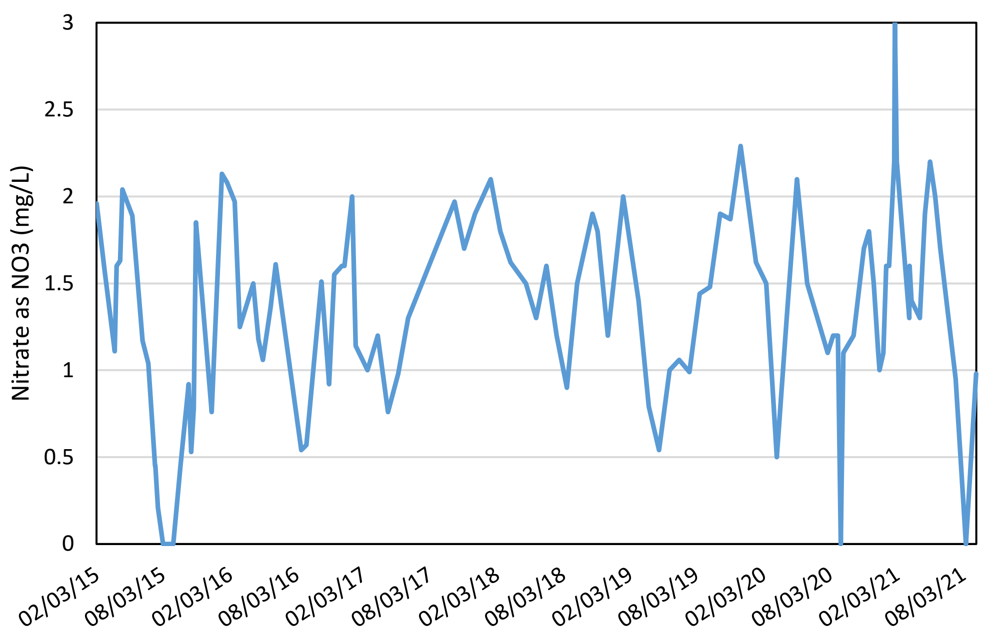


Figure 41. Summary of nitrate as NO3 from the San Lorenzo River Tait St. Diversion during January 2015 and September 2021

2.5.3 Asbestos

Asbestos at certain levels can pose a significant health risk as it has been linked to several health complications. Natural occurring asbestos deposits can enter a water source by wind, flood, landslide, and storm water runoff. Asbestos particles can also be introduced into the water following demolition after fires, floods, or other natural disasters. The Santa Cruz Water Department's (SCWD) current monitoring requirement for asbestos occurs every nine years from all water sources, however, asbestos was added to the source water monitoring program for WY 2021 to evaluate potential impacts from the CZU Lighting Complex Fire. Asbestos is regulated and has a primary maximum contaminant level (MCL) of 7 million fibers per liter (MFL).

As shown in Table 10 and Table 11, asbestos was not detected at any of the source water or upper watershed locations during WY 2021.

2.5.4 Radiological

Radionuclides are types of atoms that are radioactive and are regulated in drinking water. The regulated radionuclides in drinking water are combined radium-226+228, gross alpha particle activity and uranium with primary maximum contaminant levels (MCL) of 5 pCi/L, 15 pCi/L and 20 pCi/L respectively. Most of the radionuclides present in drinking water are from natural sources including certain types of rocks that contain trace amounts of radioactive isotopes such as uranium. However, many human-made devices and processes such as color televisions, medical instruments (x-ray and chemotherapy), coal/lignite power plants, industrial processes and cigarette smoking are sources of radionuclides that can be introduced in the water supply. The Santa Cruz Water Department's (SCWD) regulated radiological monitoring frequency occurs every 9 years at all surface sources and historically, radiological results have not been detected in the source water or in the Graham Hill Water Treatment Plant (GHWTP) finished water. The SCWD's Water Quality Laboratory (WQL) added monthly and storm event radiological monitoring in WY 2021 to evaluate potential impacts from the CZU Lightning Complex Fire. The source water locations that were monitored include Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion. The GHWTP finished water was also monitored for radiological compounds as well as Upper Laguna and SLR Highlands Park.

As shown in Table 12, combined radium 226+228, gross alpha particle activity, and uranium were detected in both San Lorenzo River (SLR) locations during the wet season. All results detected were from the January 27, 2021 storm and were below their associated primary MCLs. Radiological results were not detected in the GHWTP finished water.

As shown in Table 13, uranium was detected at SLR Highlands Park during the January 27, 2021 storm and was below the primary MCL, which again, does not apply to source waters.

Table 10. Summary of Regulated Chemistry Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021. Values presented are average (minimum – maximum).

			GHWTP Finished Water		Liddell Spring		Laguna Creek		Loch Lomond		SLR Tait St. Diversion		SLR Felton Diversion	
Parameter	**Primary MCL**	**Secondary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Aluminum (mg/L)	1	0.2	0.03 (ND - 0.04)	0.03 (0.02 - 0.06)	ND	ND	ND	0.15 (ND - 1.2)	0.12 (ND - 0.30)	0.33 (0.03 - 0.90)	0.03 (ND - 0.12)	2.4 (ND - 23)	0.05 (ND - 0.10)	5.2 (ND - 61)
Arsenic (µg/L)	10		ND	ND	2.1 (1.9 - 2.6)	2.1 (2.0 - 2.2)	2.3 (2.0 - 2.8)	2.1 (1.4 -2.8)	0.40 (ND - 1.2)	1.0 (ND - 1.4)	1.4 (1.2 - 1.6)	2.0 (ND - 6.9)	0.94 (ND - 1.4)	0.82 (ND - 5.9)
Asbestos (MFL)	7				ND	ND	ND	ND			ND	ND	ND	ND
Copper (mg/L)	Action Level 1.3		ND	ND	ND	ND	ND	ND	0.010 (0.007 - 0.012)	0.008 (0.007 - 0.009)	ND	0.003 (ND - 0.021)	ND (ND - 0.003)	0.005 (ND - 0.059)
Iron (mg/L)		0.3	ND	ND	ND	ND	0.018 (ND - 0.023)	0.22 (0.018 - 1.6)	0.18 (0.013 - 0.46)	0.38 (0.070 - 0.91)	0.12 (0.071 – 0.21)	3.5 (0.090 - 29)	0.18 (0.12-0.27)	6.7 (0.10 – 78)
Lead (mg/L)	Action Level 0.015		ND	ND	ND	ND	ND	ND (ND - 0.0006)	ND	ND	ND	0.002 (ND - 0.022)	ND	0.003 (ND – 0.041)
Manganese (mg/L)		0.05	ND (ND - 0.002)	ND (ND - 0.002)	ND	ND	0.004 (0.003 - 0.004)	0.009 (0.003 - 53)	0.021 (0.002 - 0.048)	0.021 (0.007 - 0.039)	0.014 (0.008 - 0.021)	0.16 (0.008 - 1.4)	0.038 (0.022 - 0.047)	0.29 (0.025 - 3.3)
Nitrate as NO3 (mg/L)	45		0.95 (ND - 1.9)	0.52 (ND - 1.1)	1.1 (1.0 - 1.1)	1.1 (1.0 - 1.2)	ND	ND	0.43 (ND - 1.3)	0.58 (ND - 1.4)	1.4 (ND - 2.2)	1.6 (1.0 - 3.0)	2.4 (1.9 - 2.8)	1.9 (ND - 3.3)
ND=Analyte Not Detected														

Table 11. Summary of Regulated Chemistry Parameters Measured in Upper Watershed Locations between October 2020 and September 2021. Values presented are average (minimum – maximum).

			Upper Laguna Creek		Upper Majors Creek		SLR Junction Park		SLR Highlands Park	
Parameter	**Primary MCL**	**Secondary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Aluminum, Total (mg/L)	1	0.2	0.008 (ND - 0.038)	0.11 (ND - 0.64)	0.009 (ND - 0.026)	0.64 (0.071 - 1.2)	0.10 (ND - 0.28)	0.48 (0.25 - 0.72)	0.060 (0.022 - 0.14)	2.0 (0.029 - 13)
Arsenic, Total (µg/L)	10		0.76 (ND - 1.4)	0.31 (ND - 1.2)	1.2 (1.2 - 1.2)	1.6 (1.4 - 1.8)	ND	0.95 (ND - 1.9)	0.28 (ND - 1.1)	0.84 (ND - 5.4)
Asbestos (MFL)	7		ND	ND					ND	ND
Copper, Total (mg/L)	Action Level 1.3		ND	ND	ND	ND	ND	ND (ND - 0.003)	ND	0.003 (ND - 0.016)
Iron, Total (mg/L)		0.3	0.003 (ND - 0.016)	0.11 (ND - 0.69)	0.020 (0.015 - 0.23)	0.60 (0.11 - 1.1)	0.17 (0.053 - 0.40)	0.68 (0.37 - 1.0)	0.19 (0.14 - 0.30)	2.3 (0.14 - 17)
Lead, Total (mg/L)	Action Level 0.015		ND	ND	ND	ND	ND	ND (ND - 0.001)	ND	0.001 (ND - 0.011)
Manganese, Total (mg/L)		0.05	ND	0.003 (ND - 0.016)	0.003 (0.003 - 0.004)	0.010 (0.007 - 0.015)	0.022 (0.008 - 0.043)	0.047 (0.023 - 0.071)	0.080 (0.050 - 0.099)	0.11 (0.031 - 0.55)
Nitrate as NO3 (mg/L)	45		0.14 (ND - 0.72)	0.30 (ND - 1.8)	1.9 (1.8 - 2.0)	1.1 (1.0 - 1.2)	1.2 (ND - 2.2)	0.75 (ND - 1.5)	3.2 (2.1 - 4.0)	2.0 (0.93 - 3.1)
ND=Analyte Not Detected										

Table 12. Summary of Radiological Chemistry Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021. Values presented are minimum and maximum concentrations.

		GHWTP Finished Water		Laguna Creek		SLR Tait St. Diversion		SLR Felton Diversion	
Radiological Parameter	**Primary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Combined Radium 226+228 (pCi/L)	5	ND	ND	ND	ND	ND	ND	ND	ND - 3.9
Gross Alpha particle activity (pCi/L)	15	ND	ND	ND	ND	ND	ND - 3.3	ND	ND - 7.1
Uranium (pCi/L)	20	ND	ND	ND	ND	ND	ND - 1.6	ND	ND - 3.7
ND=Analyte Not Detected									

Table 13. Summary of Radiological Chemistry Parameters Measured in Upper Watershed Locations between October 2020 and September 2021. Values presented are minimum and maximum concentrations.

		Upper Laguna Creek		SLR Highlands Park	
Radiological Parameter	**Primary MCL**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Combined Radium 226+228 (pCi/L)	5	ND	ND	ND	ND
Gross Alpha particle activity (pCi/L)	15	ND	ND	ND	ND
Uranium (pCi/L)	20	ND	ND	ND	ND - 1.0
ND=Analyte Not Detected					

2.5.5 Synthetic Organic Compounds

Synthetic organic compounds (SOCs) are man-made carbon-based chemicals such as pesticides, defoliants, and fuel additives. Table 14 provides a list of the SOC compounds analyzed during WY 2021 and their associated primary maximum contaminant levels (MCLs). The Santa Cruz Water Department's (SCWD) current monitoring requirement for SOCs occurs triennially at all raw sources and consists of 12 compounds. Historically, SOCs have not been detected in the source water or in the Graham Hill Water Treatment Plant (GHWTP) finished water.

The SCWD's Water Quality Laboratory (WQL) increased the source water monitoring of SOCs following the CZU Lightning Complex Fire to include monthly and storm event sampling and added 2,3,7,8-TCDD (Dioxin). TCDD, commonly referred to as dioxin, is a chemical that is mainly a byproduct of industrial and manufacturing processes such as chlorine bleaching of paper, uncontrolled waste incinerators, and manufacturing of some herbicides and pesticides. TCDD can also result from natural processes including volcanic eruptions and forest fire. In a wildfire or structure fire setting, the volume of building materials, chemicals, pesticides, cleaners, automotive components, electronics, appliances, and other household items manufactured with chlorinated products such as polyvinyl chloride (PVC) can create immense amounts of TCDD. The SCWD previously analyzed for a larger SOC list, including TCDD, but was granted a waiver from the State Water Resources Control Board Division of Drinking (SWRCB-DDW) to reduce the list by removing compounds that were not detected.

During WY 2021, all SOC results were non-detect except for one result of 0.12 µg/L 2,4-D at SLR Highlands Park on January 27, 2021.

Table 14. Synthetic Organic Compounds List

Synthetic Organic Compounds (SOCs)	
SOC Compound	**Primary MCL (mg/L)**
1,2,3-Trichloropropane (TCP)	0.000005
2,3,7,8-TCDD (Dioxin)	0.00000003
2,4-D	0.07
Alachlor	0.002
Atrazine	0.001
Bentazon	0.018
Carbofuran	0.018
Diquat	0.02
Endothall	0.1
Ethylene Dibromide (EDB)	0.00005
Lindane	0.0002
Oxamyl	0.05
Simazine	0.004

2.5.6 Volatile Organic Compounds

Volatile organic compounds (VOCs) are a variety of compounds composed primarily of carbon and hydrogen and are predominantly used as solvents, degreasers, cleaning solutions, dry cleaning fluids, and components of pesticides and plastics. VOCs can enter drinking water systems through spills and improper disposal. Table 15 provides the list of the 27 VOC compounds sampled as well as their associated primary maximum contaminant levels (MCLs). The Santa Cruz Water Department's (SCWD) current VOC monitoring requirement consists of annual monitoring from all surface sources.

The SCWD's Water Quality Laboratory (WQL) added monthly, quarterly, and storm event monitoring in WY 2021 to evaluate potential impacts from the CZU Lightning Complex Fire. The source water locations that were monitored include Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion. The GHWTP finished water was also monitored for VOC compounds as well as Upper Laguna and SLR Highlands Park. All VOC compounds collected from the Graham Hill Water Treatment Plant (GHWTP) finished water, source water and upper watershed locations were non-detect for WY 2021.

Table 15. Volatile Organic Compound List

Volatile Organic Compounds (VOCs)	
VOC Compound	**Primary MCL (mg/L)**
1,1,1-Trichloroethane	0.2
1,1,2,2-Tetrachloroethane	0.001
1,1,2-Trichloroethane	0.005
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1.2
1,1-Dichloroethane	0.005
1,1-Dichloroethylene	0.006
1,2,4-Trichlorobenzene	0.005
1,2-Dichlorobenzene	0.6
1,2-Dichloroethane	0.0005
1,2-Dichloropropane	0.005
1,3-Dichloropropene	0.0005
1,4-Dichlorobenzene	0.005
Benzene	0.001
Carbon Tetrachloride	0.0005
cis-1,2-Dichloroethylene	0.006
Dichloromethane	0.005
Ethylbenzene	0.3
Methyl-tert-butyl ether (MTBE)	0.013
Monochlorobenzene	0.07
Styrene	0.1
Tetrachloroethylene	0.005
Toluene	0.15
trans-1,2-Dichloroethylene	0.01
Trichloroethylene	0.005
Trichlorofluoromethane (Freon 11)	0.15
Vinyl Chloride	0.0005
Xylenes (total)	1.75

2.6 Unregulated Chemistry Parameters

In addition to performing routine monitoring of source water, treatment plant finished water, and the distribution system to comply with State and Federal regulations, the Santa Cruz Water Department's (SCWD) Water Quality Laboratory (WQL) also voluntarily performs monitoring for unregulated chemistry parameters as well as unregulated chemicals for which monitoring is required. The Unregulated Contaminant Monitoring Rule (UCMR) was developed to address the Safe Drinking Water Act (SDWA) Amendment of 1996 that requires USEPA to monitor for 30 unregulated contaminants every five years. Essentially, the UCMR reflects a data gathering phase of regulation before either primary or secondary MCLs are established for the different contaminants. The proposed fifth UCMR (UCMR5) was published in March 2021, and as proposed, would require sampling for lithium and 29 different per- and polyfluoroalkyl substances (PFAS) between 2023 and 2025.

Since 2001, the WQL has conducted four (UCMR) studies and the SCWD voluntarily monitors other unregulated chemicals including bromide, lithium, dioxins, furans, per- and polyfluoroalkyl substances (PFAS), and constituents of emerging concern (CECs). During Water Year (WY) 2021, increased monitoring frequency of unregulated constituents was performed to evaluate potential impacts from the CZU Lighting Complex Fire to the SCWD's source water. A summary of each unregulated chemical and results are provided below.

Advancements in laboratory technology have increased the ability to accurately measure and detect drinking water contaminants including dioxins, furans, CECs, and PFAS at very low concentrations, such as part per trillion (ppt) and parts per quadrillion (ppq). A result of 1 ppt is equivalent to a single drop of water in 20 olympic-sized swimming pools.

2.6.1 Bromide

Bromide is a naturally occurring element found in surface waters and groundwater. During the water treatment process, bromide can combine with chlorine or other disinfectants, contributing to the formation of brominated disinfection byproducts (DBPs). Bromide is unregulated in drinking water; however, current literature review suggests that brominated DBP formation becomes a concern if bromide concentrations in source waters exceed 300 µg/L.

Bromide has been monitored in the Santa Cruz Water Department's (SCWD) source water since 2014. In Water Year (WY) 2021, the measured bromide concentrations were below 300 µg/L in all source water and the upper watershed locations (Table 16 and Table 17). In fact, all source water and upper watershed locations, including the Raw Blend, have remained below 50% of this limit, with the highest source water bromide concentration reaching 110 µg/L at Laguna Creek on November 18, 2020. The highest upper watershed bromide concentration occurred on October 7, 2020 at SLR Junction Park.

As shown in Figure 42, the bromide concentrations in San Lorenzo River (SLR) Tait St. Diversion fluctuate over time, and decrease during storm events.

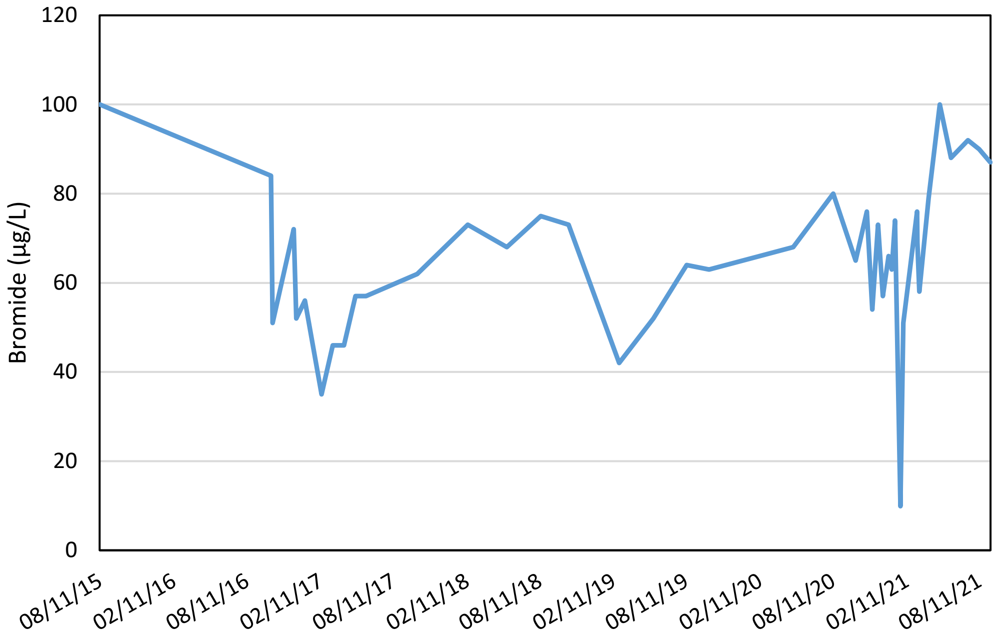


Figure 42. Summary of bromide from the San Lorenzo River Tait St. Diversion during August 2015 and September 2021

2.6.2 Lithium

Lithium is a naturally occurring element found in certain vegetables, grains, spices, and in many rock types. Lithium is currently unregulated in drinking water and was added to the source water monitoring program for Water Year (WY) 2021 to evaluate potential impacts from the CZU Lighting Complex Fire. The Santa Cruz Water Department (SCWD) does not have historical lithium data prior to WY 2021.

As shown in Table 16 and in Figure 43, lithium is present in all of the SCWD's source water with concentrations increasing during storm events. The North Coast sources including Liddell Spring and Laguna Creek consistently have the lowest lithium concentrations compared to the other sources. Loch Lomond generally had the highest concentrations, ranging between 20 and 22 µg/L, and did not exhibit a high degree of variability as a result of storm events. The San Lorenzo River (SLR), both Felton Diversion and Tait. St. Diversion locations exhibited high lithium concentrations of 77 and 34 µg/L during the January 27, 2021 storm. Lithium is also present in the Graham Hill Water Treatment Plant (GHWTP) finished water in small amounts (Figure 44).

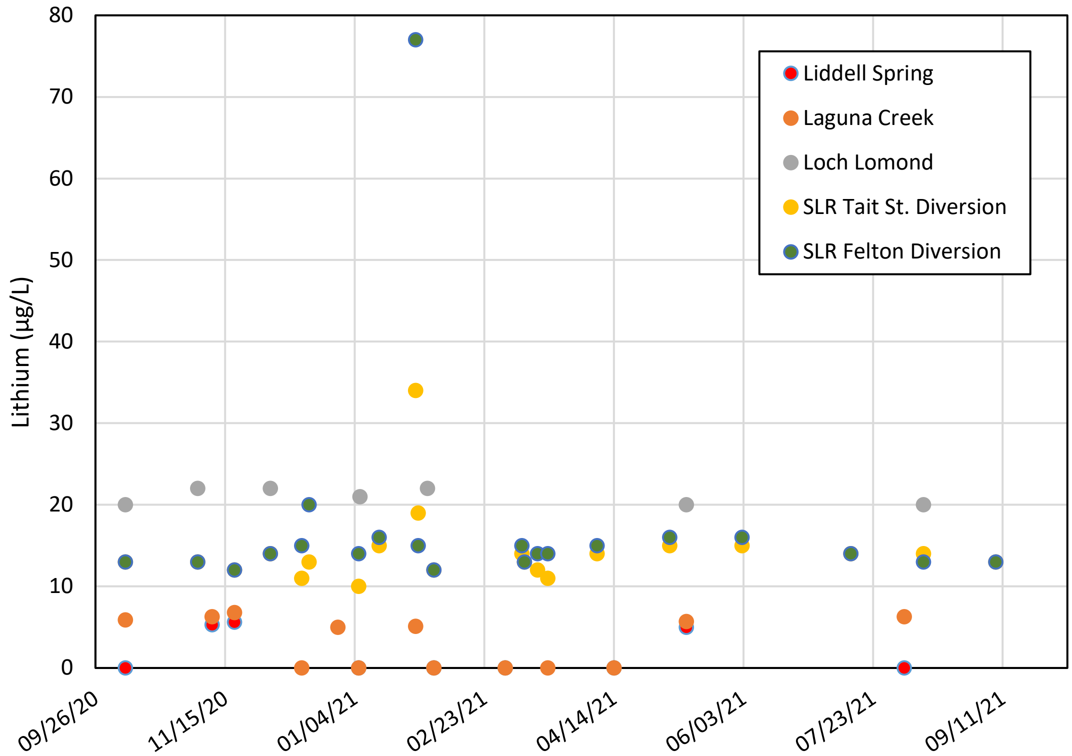


Figure 43. Lithium of source waters between October 2020 and September 2021.

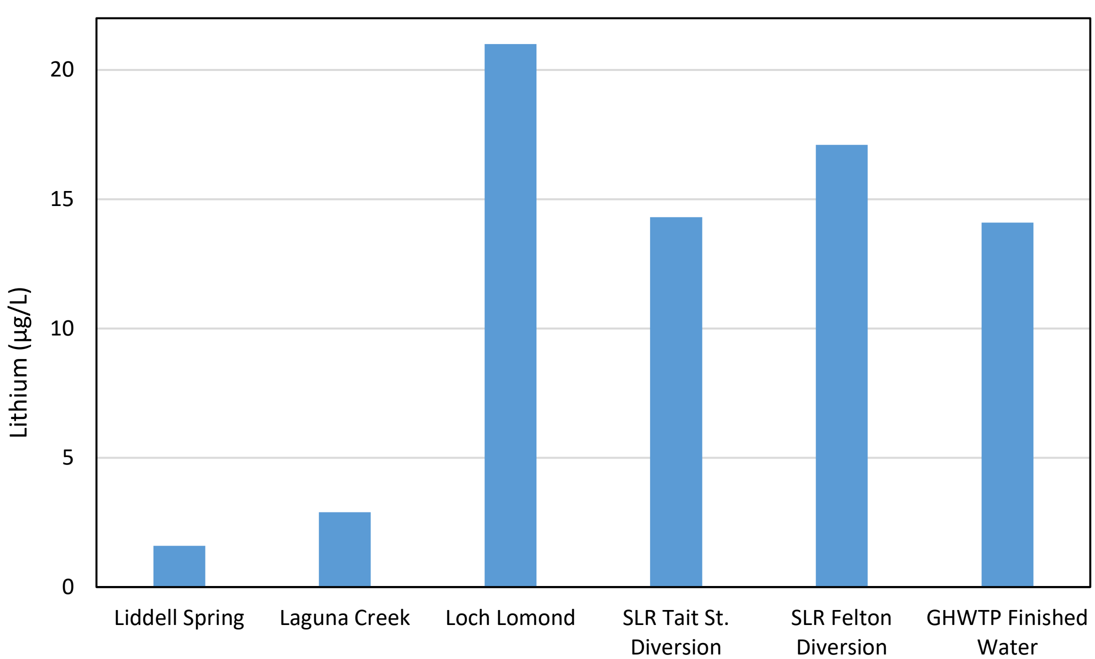


Figure 44. Average source water lithium data for WY 2021.

Table 16. Summary of Unregulated Chemistry Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021. Values presented are average (minimum – maximum)

	GHWTP Finished Water		Raw Blend		Liddell Spring		Laguna Creek		Loch Lomond		SLR Tait St. Diversion		SLR Felton Diversion	
Parameter	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Bromide (µg/L)			77 (58 - 96)	56 (42 - 69)	37 (36 - 38)	37 (36 - 37)	22 (20 - 25)	44 (22 - 110)	51 (46 - 53)	48 (47 - 50)	85 (65 - 100)	55 (9.9 - 76)	89 (80 - 98)	61 (11 - 81)
Lithium (µg/L)	14 (12 - 17)	15 (12 - 19)			2.1 (ND - 5.3)	1.1 (ND - 5.6)	4.8 (ND - 6.3)	1.9 (ND - 6.8)	20 (20 - 22)	22 (21 - 22)	14 (13 - 15)	14 (10 - 34)	14 (13 - 16)	19 (12 - 77)
ND=Analyte Not Detected														

Table 17. Summary of Unregulated Chemistry Parameters Measured in Upper Watershed Locations between October 2020 and September 2021. Values presented are average (minimum – maximum).

	Upper Laguna Creek		Upper Majors Creek		SLR Junction Park		SLR Highlands Park	
Parameter	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
Bromide (µg/L)	35 (34 - 39)	34 (34 - 39)	45 (44 - 46)	39 (37 - 42)	97 (36 - 170)	80 (61 - 98)	72 (64 - 77)	67 (54 - 76)
Lithium (µg/L)	2.2 (ND - 5.6)	0.75 (ND - 5.2)	ND	5.8 (5.7 - 6.0)	12 (5.6 - 22)	16 (16 - 16)	13 (11 - 16)	16 (12 - 25)
ND=Analyte Not Detected								

2.6.3 Dioxin and Furan

Dioxins and furans are anthropogenic compounds created as unintended byproducts from several human activities including the chlorine bleaching of paper products, incomplete or partial combustion and the production of certain types of chemicals. Dioxins and furans are chemically known as polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) and are formed when products containing carbon and chlorine burn, especially plastic, paper, pesticides, herbicides or other products where chlorine is used in the manufacturing process. According to the United States Environmental Protection Agency (EPA), the largest quantified source of dioxin emissions is the uncontrolled burning of household trash, referred to as “backyard” or “barrel burning.” More than 90 percent of human exposure is through the consumption of food, mainly meat, dairy products, fish and shellfish. The most toxic dioxin is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), which is regulated as a synthetic organic compound (SOC) contaminant and has a primary maximum contaminant level (MCL) of 0.00000003 mg/L. As previously discussed in Section 2.5.5, TCDD was not detected during Water Year (WY) 2021.

Table 18 summarizes the sixteen unregulated dioxin and furan chemicals that were analyzed from the Santa Cruz Water Department’s (SCWD) source water and upper watershed locations. Three unregulated dioxin and furan chemicals were detected during WY 2021 at Laguna Creek, SLR Tait St. Diversion, and SLR Highlands Park during the January 27, 2021 storm (Table 19).

Table 18. Dioxin and Furan Compound List

Dioxin and Furan
1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8-HxCDD
1,2,3,4,7,8-HxCDF
1,2,3,4,7,8,9-HpCDF
1,2,3,6,7,8-HxCDD
1,2,3,6,7,8-HxCDF
1,2,3,7,8-PeCDD
1,2,3,7,8-PeCDF
1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDF
2,3,4,6,7,8-HxCDF
2,3,4,7,8-PeCDF
2,3,7,8-TCDF
OCDD
OCDF

Table 19. Summary of Unregulated Dioxin and Furan compounds measured in Source Waters and Upper Watershed Locations between October 2020 and September 2021

Sample Location	Date	Analyte	Result (ppq)
Santa Cruz Water Department Source Water			
Laguna Creek	01/27/21	1, 2, 3, 4, 6, 7, 8-HpCDD	46
	01/27/21	OCDD	360
SLR Tait St. Diversion	01/27/21	1, 2, 3, 4, 6, 7, 8-HpCDD	57
	01/27/21	OCDD	520
	01/27/21	OCDF	50
Upper Watershed Locations			
SLR Highlands Park	01/27/21	1, 2, 3, 4, 6, 7, 8-HpCDD	40
	01/27/21	OCDD	300

2.6.4 Per- and Polyfluoroalkyl Substances

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that do not occur naturally in the environment. Since the 1940's, PFAS has been used extensively throughout the world in surface coating and protectant formulations due to their ability to reduce the surface tension of liquids. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are two types of PFAS that are no longer manufactured or imported into the United States, however, other PFAS materials are still being produced. PFAS are persistent in the environment, can accumulate in the human body over time, and are toxic at relatively low levels. PFAS can be introduced into the body by eating or drinking contaminated food or liquid, breathing in or touching products treated with PFAS, such as carpet or clothing. The four major sources of PFAS in drinking water are fire training/fire response sites, industrial sites, landfills, and wastewater treatment plants. The Santa Cruz Water Department's (SCWD) source waters are located in areas that are not routinely exposed to this type of activity; however, the San Lorenzo River (SLR) does experience some impact from septic systems, which could be sources of low levels of PFAS. Although PFAS chemicals are currently unregulated in drinking water, the United States Environmental Protection Agency (EPA) has established a lifetime health advisory level (HAL) of 70 parts per trillion (ppt) for the combined concentration of PFOS and PFOA. Additionally, in March 2021, the State Water Resources Control Board Division of Drinking Water (SWRCB-DDW) established notification levels (NLs) for three PFAS chemicals including PFOA (5.1 ppt), PFOS (6.5 ppt), and Perfluorobutanesulfonic acid (PFBS) (500 ppt).

As part of the Water Year (WY) 2020 source water monitoring program, the WQL began PFAS monitoring at source water locations. In WY 2021, PFAS monitoring was increased to evaluate potential impacts from the CZU Lightning Complex Fire. A summary of the source water detected PFAS results for WY 2021 are shown in Table 20. PFAS were detected in three SCWD's source waters including Laguna Creek, SLR Felton Diversion, and SLR Tait St. Diversion, as well as in the Graham Hill Water Treatment Plant (GHWTP) finished water. PFAS were detected in small amounts throughout the WY in the SLR but were only detected during storm events at Laguna Creek. The highest PFAS result of 46.0 ppt Perfluorobutanoic acid was detected at Laguna Creek during the first storm of the year (November 18, 2020). Perfluorobutanoic acid (PFBA) does not have a California NL. PFAS were not collected at Loch Lomond and were not detected in Liddell Spring. Out of the twenty-five PFAS compounds analyzed, only two were detected in the GHWTP finished water. With the exception of the high PFBA result from Laguna Creek in November 2020, all other results are considered low, and below their respective NLs.

Storm event PFAS monitoring was conducted at two upper watershed locations including Upper Laguna and SLR Highlands Park. A summary of the detected PFAS results for Upper Laguna and SLR Highlands are shown in Table 21. PFAS were only detected during the November 18, 2020 and January 27, 2021 storms and all results were below their NLs.

Table 20. Summary of Unregulated PFAS Parameters Measured in Source Waters and Finished Water between October 2020 and September 2021

Sample Location	Date	Analyte	Acronymn	California Notification Level (ng/L)	Result (ng/L)
GHWTP Finished Water	04/07/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.3
	05/05/21	Perfluorooctanesulfonic acid		6.5	2.0
	07/14/21	Perfluorohexanoic acid	PFHxA		6.4
Laguna Creek	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.8
	11/18/20	Perfluorobutanoic acid	PFBA		46.0
	11/18/20	Perfluorohexanoic acid	PFHxA		3.6
	11/18/20	Perfluoropentanoic acid	PFPeA		3.1
	12/14/20	Perfluorobutanoic acid	PFBA		6.6
	01/27/21	Perfluorobutanoic acid			4.7
SLR Tait St. Diversion	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.7
	11/18/20	Perfluorobutanoic acid	PFBA		4.1
	11/18/20	Perfluorohexanoic acid	PFHxA		3.5
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	6.1
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	3.7
	11/18/20	Perfluoropentanoic acid	PFPeA		4.2
	12/14/20	Perfluorobutanoic acid	PFBA		4.3
	12/14/20	Perfluorohexanoic acid	PFHxA		2.3
	12/14/20	Perfluorooctanesulfonic acid	PFOS	6.5	2.8
	12/14/20	Perfluorooctanoic acid	PFOA	5.1	2.3
	12/14/20	Perfluoropentanoic acid	PFPeA		2.8
	12/28/20	Perfluorobutanesulfonic acid	PFBS	500	2.2
	12/28/20	Perfluorobutanoic acid	PFBA		2.1
	12/28/20	Perfluoropentanoic acid	PFPeA		2.0
	01/05/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.4
	03/10/21	Perfluorooctanesulfonic acid			3.5
	03/10/21	Perfluorooctanoic acid	PFOA	5.1	2.2

SLR Tait St. Diversion	03/15/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.7
	04/07/21	Perfluorooctanesulfonic acid			2.0
	05/05/21	Perfluorooctanesulfonic acid			2.2
	06/02/21	Perfluorooctanesulfonic acid			2.3
	07/14/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	07/14/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.4
	07/14/21	Perfluorooctanoic acid	PFOA	5.1	2.1
	07/14/21	Perfluoropentanoic acid	PFPeA		2.0
	09/08/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.1
SLR Felton Diversion	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	2.4
	11/18/20	Perfluorobutanoic acid	PFBA		4.5
	11/18/20	Perfluorohexanoic acid	PFHxA		3.2
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	5.0
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	3.9
	11/18/20	Perfluoropentanoic acid	PFPeA		3.5
	12/14/20	Perfluorobutanesulfonic acid	PFBS	500	2.9
	12/14/20	Perfluorobutanoic acid	PFBA		3.8
	12/14/20	Perfluorooctanesulfonic acid	PFOS	6.5	2.2
	12/14/20	Perfluoropentanoic acid	PFPeA		3.0
	02/03/21	Perfluorobutanoic acid	PFBA		2.0
	03/10/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.6
	03/10/21	Perfluorooctanoic acid	PFOA	5.1	2.0
	03/15/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.3
	04/07/21	Perfluorooctanesulfonic acid			2.1
	06/02/21	Perfluorooctanesulfonic acid			2.5
	07/14/21	Perfluorohexanoic acid	PFHxA		2.0
	07/14/21	Perfluorooctanesulfonic acid	PFOS	6.5	3.3
	07/14/21	Perfluorooctanoic acid	PFOA	5.1	2.4
	07/14/21	Perfluoropentanoic acid	PFPeA		2.0
	09/08/21	Perfluorooctanesulfonic acid	PFOS	6.5	2.1

Table 21. Summary of Unregulated PFAS Parameters Measured in Upper Watershed locations between October 2020 and September 2021

Upper Watershed Locations					
Sample Location	**Date**	**Analyte**	**Acronym**	**California Notification Level (ppt)**	**Result (ppt)**
Upper Laguna	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	10.0
	11/18/20	Perfluorobutanoic acid	PFBA		12.0
	11/18/20	Perfluorohexanesulfonic acid	PFHxS		4.9
	11/18/20	Perfluorohexanoic acid	PFHxA		4.5
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	2.7
	11/18/20	Perfluoropentanoic acid	PFPeA		4.0
	01/27/21	Perfluorobutanesulfonic acid	PFBS	500	2.1
	01/27/21	Perfluorobutanoic acid	PFBA		3.4
SLR Highlands Park	11/18/20	Perfluorobutanesulfonic acid	PFBS	500	3.3
	11/18/20	Perfluorobutanoic acid	PFBA		7.0
	11/18/20	Perfluorohexanoic acid	PFHxA		2.7
	11/18/20	Perfluorooctanesulfonic acid	PFOS	6.5	3.8
	11/18/20	Perfluorooctanoic acid	PFOA	5.1	2.0
	11/18/20	Perfluoropentanoic acid	PFPeA		2.6

More information on PFAS in drinking water can be found here:
https://www.waterboards.ca.gov/pfas/
https://www.epa.gov/pfas

2.6.5 Contaminants of Emerging Concern

Compounds identified as contaminants of emerging concern (CEC) is a somewhat loose term, but refers to chemicals that are unregulated and originate from pharmaceuticals, personal care products, flame retardants and insect repellent. Some compounds are known or suspected to be potentially endocrine disrupting, and may produce adverse development, reproductive, neurological, and immune effects both in humans and wildlife. The presence of CECs in water indicates potential impacts from human activity including recreation and septic systems.

The Santa Cruz Water Department's Water Quality Laboratory (WQL) voluntarily began monitoring for 96 CEC compounds in 2015. In Water Year (WY) 2021, additional routine and storm event CEC monitoring was implemented to evaluate potential impacts from the CZU Lightning Complex Fire. A summary of the detected CEC results for WY 2021 are shown in Tables 22-24.

Nineteen different CECs were detected during WY 2021 from the following locations: Liddell Spring, Laguna Diversion, Upper Laguna Creek, SLR Felton Diversion, SLR Tait St. Diversion, SLR Highlands Park, and the Graham Hill Water Treatment Plant (GHWTP) finished water. Six of the 19 CECs detected were found in the GHWTP finished water including1,7-Dimethylxanthine, acesulfame-K, caffeine, DEET, salicylic acid, and sucralose. The most commonly detected CECs during WY 2021 were acesulfame-K and sucralose (artificial sweeteners), caffeine, and DEET (insect repellent).

CECs were detected throughout the WY in the San Lorenzo River (SLR), with the most diversity found in the first flush event of the WY (November 18, 2020) and also during the dry season when there are lower rates of flow and an increase in animal activity, as well as human recreation occurring in the SLR. During the largest storm of the year (January 27, 2021), CEC detections were less frequent, likely a result of dilution by rainwater.

In August 2016, the SCWD published a report on CECs. The report can be found here:
https://www.cityofsantacruz.com/home/showpublisheddocument/85113/637605783033530000

More information on CECs in drinking water can be found here:
https://www.epa.gov/wqc/contaminants-emerging-concern-including-pharmaceuticals-and-personal-care-products

Table 22. Summary of Unregulated Contaminants of Emerging Concern (CECs) Measured in Source Waters, Upper Watershed Locations, and Finished Water between October 1, 2020 and January 5, 2021. All results are reported in parts per trillion (ppt).

		11/18/20			**12/02/20**			**12/14/20**				**12/28/20**			**01/05/21**		
Detected Analytes	Compound Class	Liddell Spring	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St Intake	SLR Felton Diversion	Upper Laguna	SLR at Highlands	Laguna Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Highlands
1,7-Dimethylxanthine	Caffeine Degradate		0.01	0.009													
Acesulfame-K	Sugar Substitute		0.06	0.05					0.03		0.03						
Caffeine	Stimulant		0.17	0.11				0.07	0.08		0.06		0.03	0.02	0.05	0.03	0.03
Carbamazepine	Anti-Seizure																
Cotinine	Nicotine Degradate			0.01													
DEET	Mosquito Repellant		0.11	0.04	0.02	0.03		0.02	0.03		0.02		0.02	0.02	0.01	0.02	0.01
Diuron	Herbicide			0.009				0.01							0.01		
Erythromycin	Antibiotic									0.01		0.01					
Iohexol	X-ray Contrast Agent																
Metolachlor	Herbicide																
Propylparaben	Preservative																
Quinoline	Phosphate Pesticide												0.02	0.02			
Salicylic Acid	Antiseptic	0.52					1.2						0.36			0.27	
Sucralose	Sugar Substitute		0.18	0.17					0.14		0.12				0.11	0.14	
Sulfadiazine	Sulfa Antibiotic																
TCEP	Flame Retardant		0.02					0.02									
TCPP	Flame Retardant																
Theophylline	Caffeine Degradate		0.02	0.01													
Triclocarban	Antibacterial																

Table 23. Summary of Unregulated Contaminants of Emerging Concern (CECs) Measured in Source Waters, Upper Watershed Locations, and Finished Water between January 13, 2021 and March 17, 2021. All results are reported in parts per trillion (ppt).

		01/13/21		**01/27/21**	**01/28/21**	**02/03/21**		**02/10/21**		**03/09/21**		**03/10/21**		**03/15/21**		**03/17/21**
Detected Analytes	Compound Class	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St Intake	SLR Tait St. Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water
1,7-Dimethylxanthine	Caffeine Degradate			0.16												
Acesulfame-K	Sugar Substitute					0.05	0.05	0.04	0.04	0.05	0.07	0.05	0.05	0.06	0.04	0.04
Caffeine	Stimulant				0.01	0.02	0.01			0.01	0.02	0.04	0.08	0.05	0.03	
Carbamazepine	Anti-Seizure															
Cotinine	Nicotine Degradate															
DEET	Mosquito Repellant	0.02	0.02		0.01			0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
Diuron	Herbicide				0.005								0.005			
Erythromycin	Antibiotic															
Iohexol	X-ray Contrast Agent															
Metolachlor	Herbicide															
Propylparaben	Preservative															
Quinoline	Phosphate Pesticide								0.03							
Salicylic Acid	Antiseptic									0.20		0.23	0.29	0.24	0.21	0.20
Sucralose	Sugar Substitute		0.10			0.14	0.16	0.17	0.23	0.21	0.23		0.14	0.12	0.22	0.23
Sulfadiazine	Sulfa Antibiotic												0.007			
TCEP	Flame Retardant				0.01											
TCPP	Flame Retardant															
Theophylline	Caffeine Degradate															
Triclocarban	Antibacterial		0.07			0.09										

Table 24. Summary of Unregulated Contaminants of Emerging Concern (CECs) Measured in Source Waters, Upper Watershed Locations, and Finished Water between April 7, 2021 and September 8, 2021. All results are reported in parts per trillion (ppt).

		04/07/21			05/05/21			06/02/21			07/14/21			08/11/21			09/08/2021	
Detected Analytes	Compound Class	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St. Diversion	SLR Felton Diversion	GHWTP Finished Water	SLR Tait St. Diversion	SLR Felton Diversion
1,7-Dimethylxanthine	Caffeine Degradate			0.005							0.008			0.008	0.005		0.02	
Acesulfame-K	Sugar Substitute	0.04	0.04	0.04	0.04	0.08	0.05	0.03	0.04		0.02	0.03						
Caffeine	Stimulant				0.01						0.02			0.02	0.01	0.03	0.03	
Carbamazepine	Anti-Seizure								0.005			0.005			0.005			
Cotinine	Nicotine Degradate																	
DEET	Mosquito Repellant	0.01	0.02	0.01	0.10	0.04	0.02	0.04	0.17	0.09	0.30	0.04	0.02	0.37	0.05	0.03		
Diuron	Herbicide																	
Erythromycin	Antibiotic																	
Iohexol	X-ray Contrast Agent				0.03													
Metolachlor	Herbicide							0.02	0.005									
Propylparaben	Preservative														0.04			
Quinoline	Phosphate Pesticide																	
Salicylic Acid	Antiseptic							0.32			0.35	0.41		0.33	1.0			
Sucralose	Sugar Substitute	0.17	0.18	0.12		0.12			0.12						0.11		0.11	0.16
Sulfadiazine	Sulfa Antibiotic																	
TCEP	Flame Retardant																	
TCPP	Flame Retardant										0.33	0.41	0.04	0.23	0.20			
Theophylline	Caffeine Degradate				0.01			0.01						0.01			0.03	
Triclocarban	Antibacterial																	

Section 3: Conclusions and Next Steps

During water year (WY) 2021, the Santa Cruz Water Department's (SCWD) Water Quality Laboratory (WQL) collected weekly, biweekly, monthly, and quarterly water quality samples from the source water and upper watershed locations. In addition, the rising, peak and falling limbs of the hydrograph for nine storm events were sampled between the months of October 2020 and May 2021, with the most significant rainfall occurring on January 27, 2021. As expected, elevated color, turbidity, dissolved organic carbon (DOC), total organic carbon (TOC), total coliform/*E. coli*, and metals (primarily aluminum, arsenic, iron, lead, and manganese) were observed in the SCWD's source water and upper watershed locations during the wet season, particularly during the large storm event on January 27th. Routine follow-up monitoring confirmed that within a few days, once the precipitation and streamflow rate decreased, water quality results returned to baseline levels. Water quality was generally better in the North Coast sources, including Liddell Spring and Laguna and Majors creeks. Water quality in the San Lorenzo River (SLR) reflects a greater degree of development in the watershed along with a high concentration of septic systems.

Unregulated contaminants of emerging concern (CECs) that include pharmaceuticals and personal care products such as caffeine, DEET, and sucralose and Per- and polyfluoroalkyl substances (PFAS) were detected in small amounts in the SLR throughout the WY. Fire related parameters associated with urban and rural run-off, such as asbestos, were not detected, however, three dioxin and furan chemicals were detected in Laguna Creek, SLR Tait St. Diversion, and SLR Highlands Park. Radiological compounds (including radium 226, radium 228, gross alpha, and uranium) were detected during the January 27, 2021 storm in the SLR; all results were below the primary drinking water standards. The treated water leaving the Graham Hill Water Treatment Plant (GHWTP) continuously met all State and Federal drinking water standards during the WY.

Given that the post CZU Wildfire Source Water Monitoring Plan consisted of an increased routine and storm event sampling frequency, as well as an expanded analysis list including fire related unregulated parameters, it is difficult to determine if results are influenced by runoff from the CZU Wildfire. Continued monitoring of all sources and upper watersheds will be necessary to establish trends and determine long term affects from the CZU Lightning Complex Fire. The WQL has continued the source water monitoring program in WY 2022 (October 1, 2021-September 30, 2022).

Section 4: References

Standard Methods for the Examination of Water and Wastewater 22nd Edition

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2020 Consumer Confidence Report
https://www.cityofsantacruz.com/home/showpublisheddocument/84858/637594518948170000

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https://www.cityofsantacruz.com/home/showpublisheddocument/85113/637605783033530000

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