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

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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

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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 supply 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.

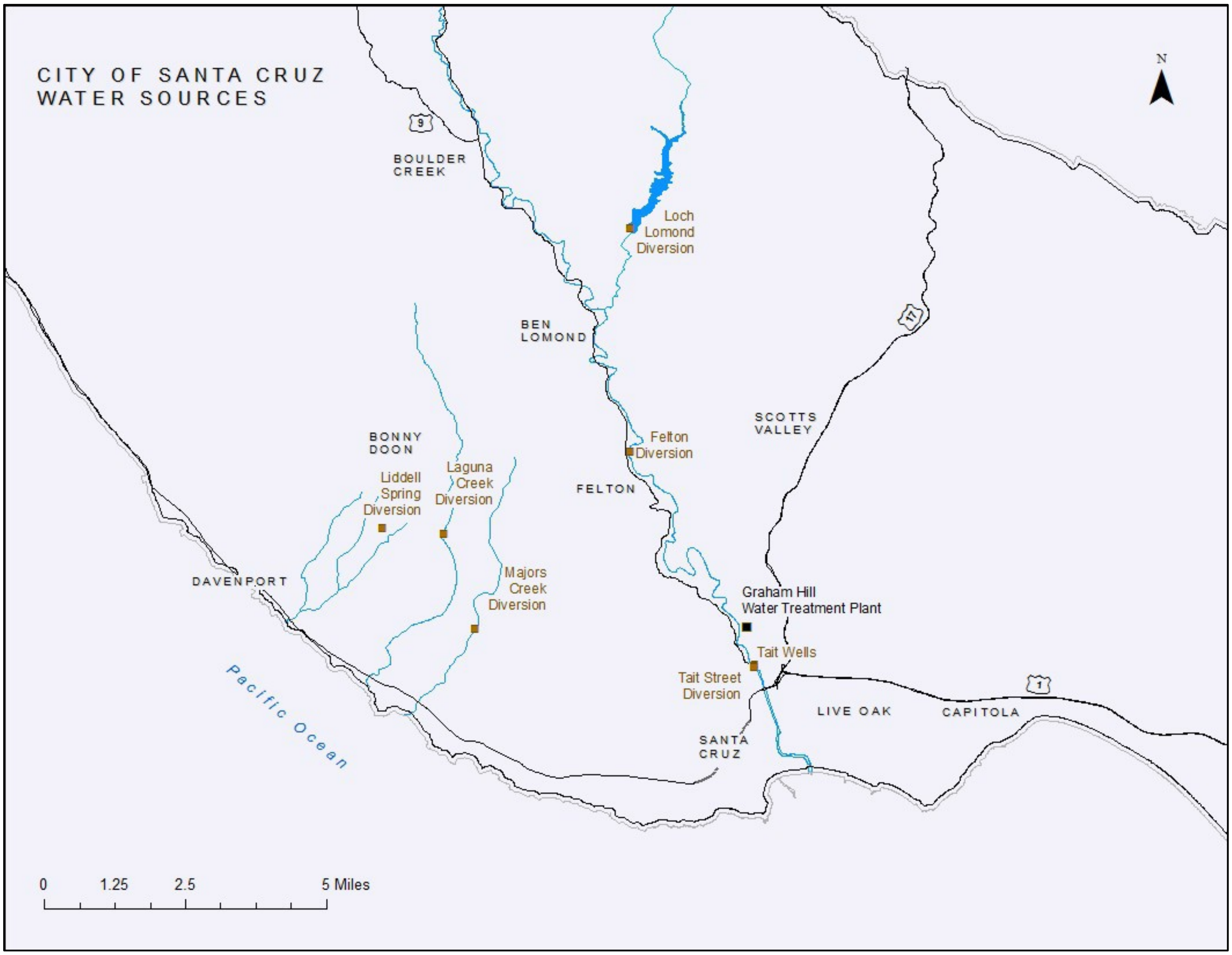


Figure 1. Map of Source Waters to the Graham Hill Water Treatment Plant

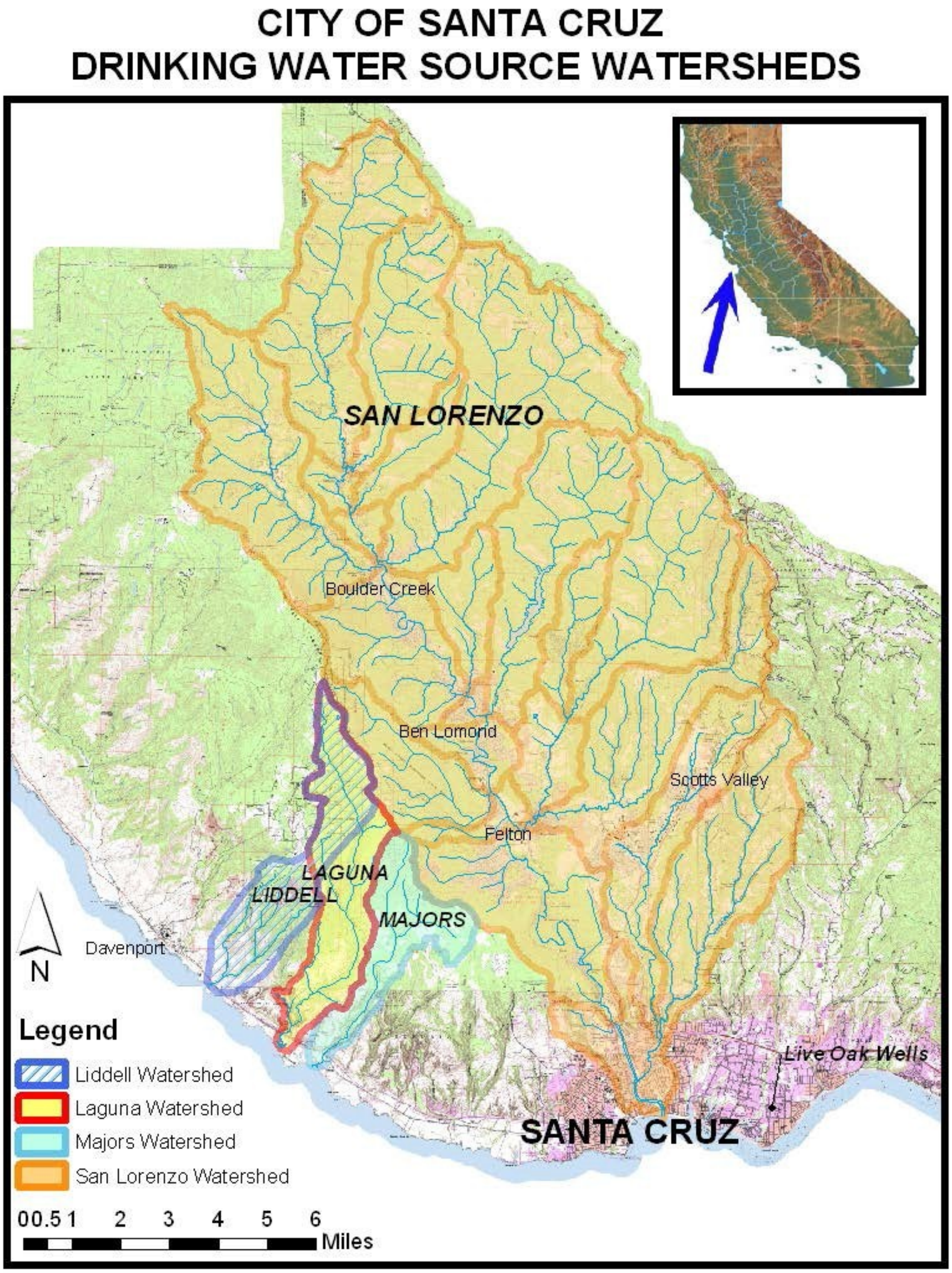


Figure 2. Map of Santa Cruz Water Department's Drinking Water Source Watersheds

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).

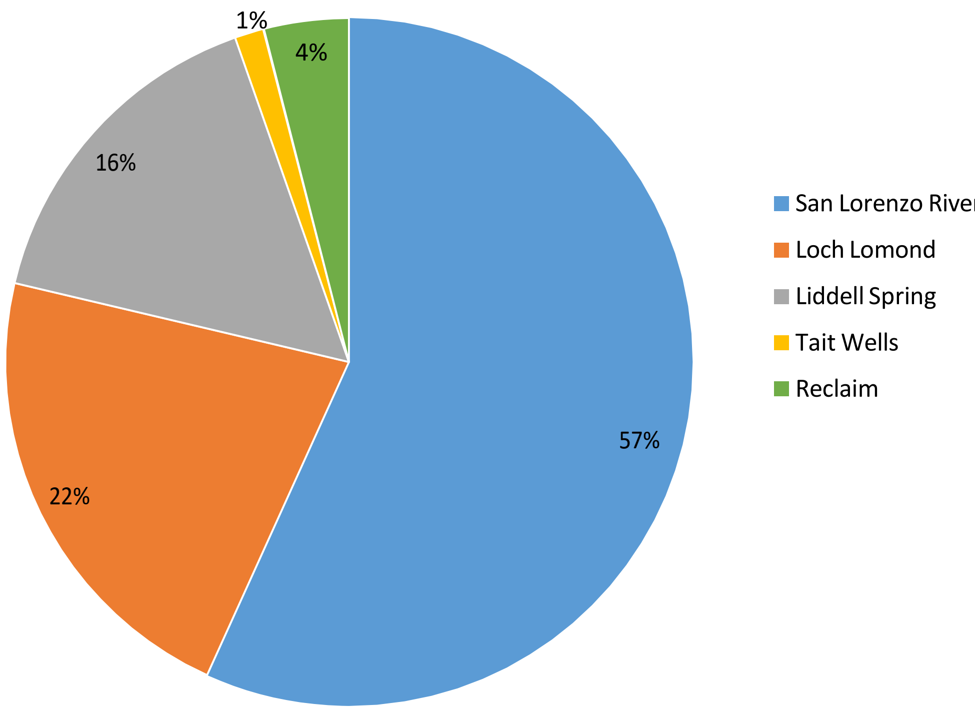


Figure 3. Contributions of various source waters to the raw blend at the Graham Hill Water Treatment Plant during Water Year WY 2021 (October 2020 – September 2021)

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.

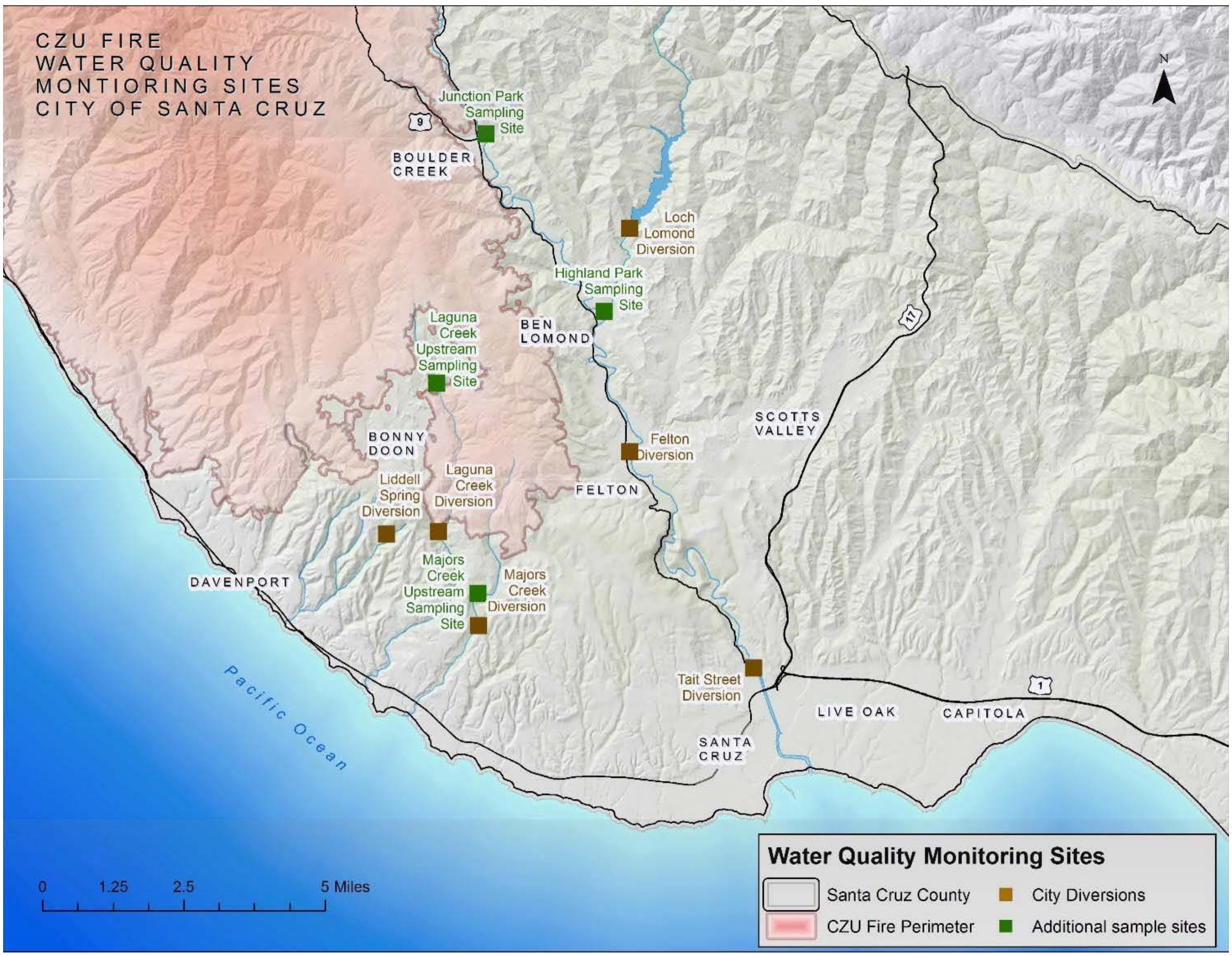


Figure 4. Map of Santa Cruz Water Department's Source and Upper Watershed Sampling Locations in relation to the CZU Lightning Complex Fire Perimeter

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 Complex 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:

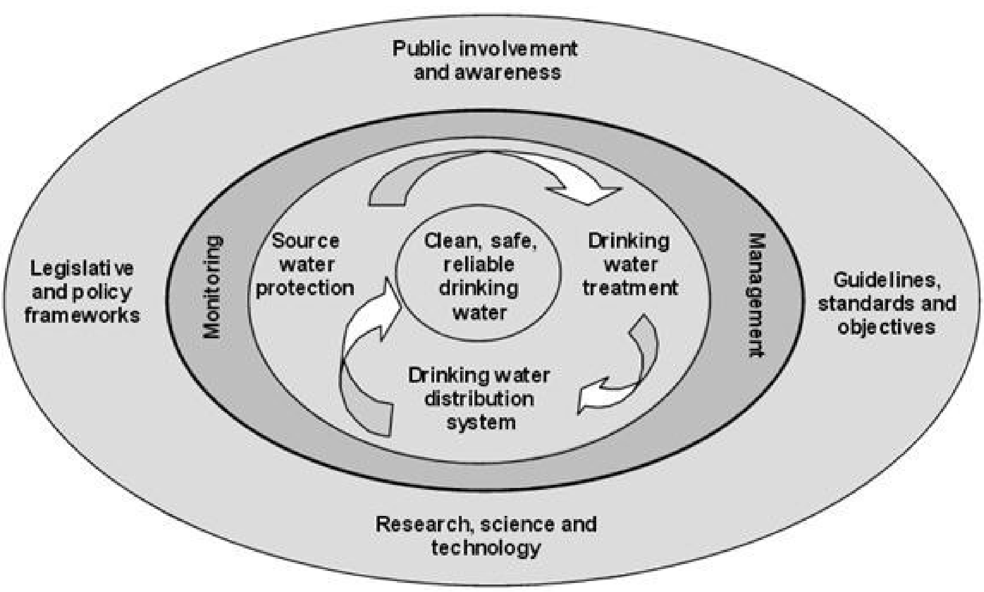
- Any rise of the SLR cubic feet per second (CFS) at the United States Geological Survey (USGS) Big Trees gage (Felton Diversion) after a rain event has started. (First flush rain event runoff is expected at the SLR intake (Tait St. Diversion) within hours.)
- SLR turbidity >25 NTU at the SLR intake (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.

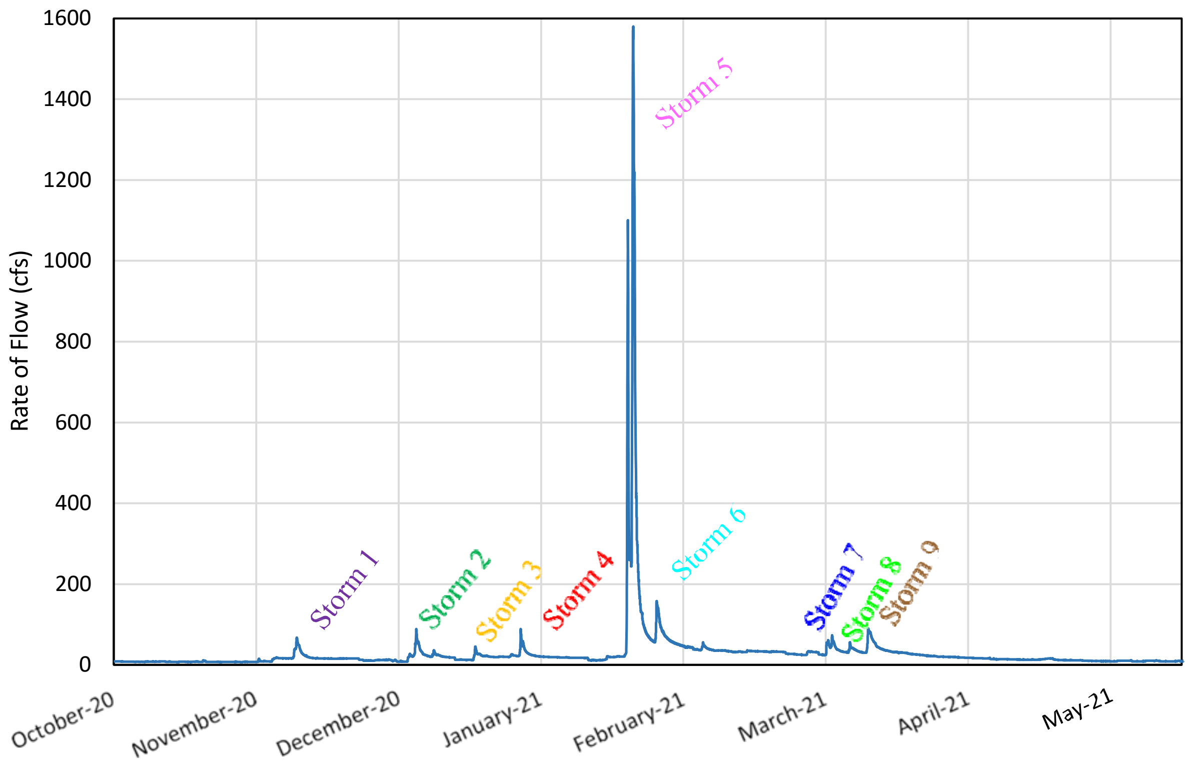


Figure 6. Assigned storms during the WY 2021 Wet Season (October 2020 – May 2021). River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

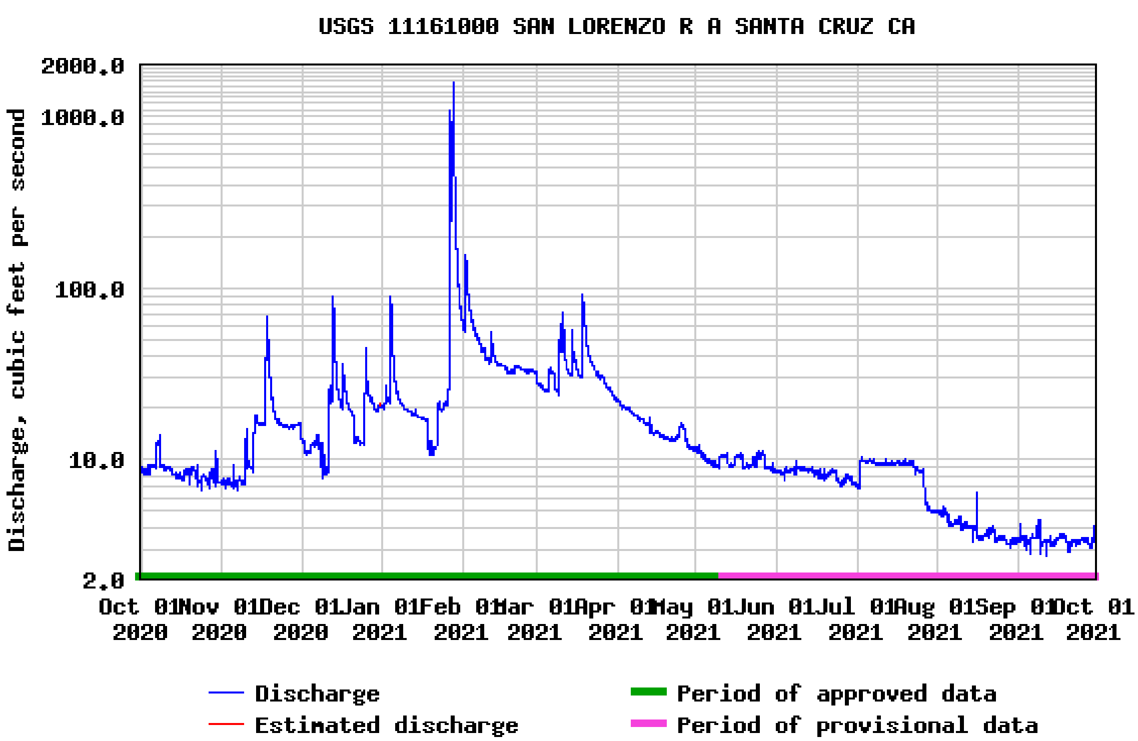


Figure 7. San Lorenzo River Discharge during WY 2021

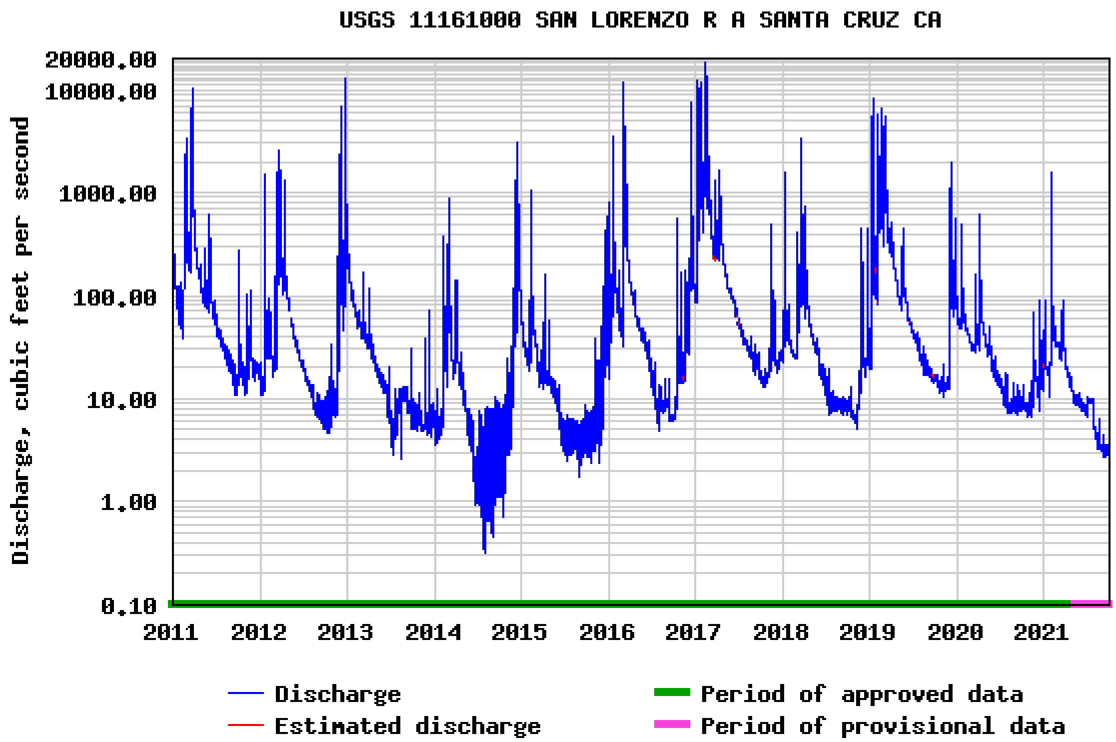


Figure 8. Historical San Lorenzo River Discharge between January 2011 and December 2021

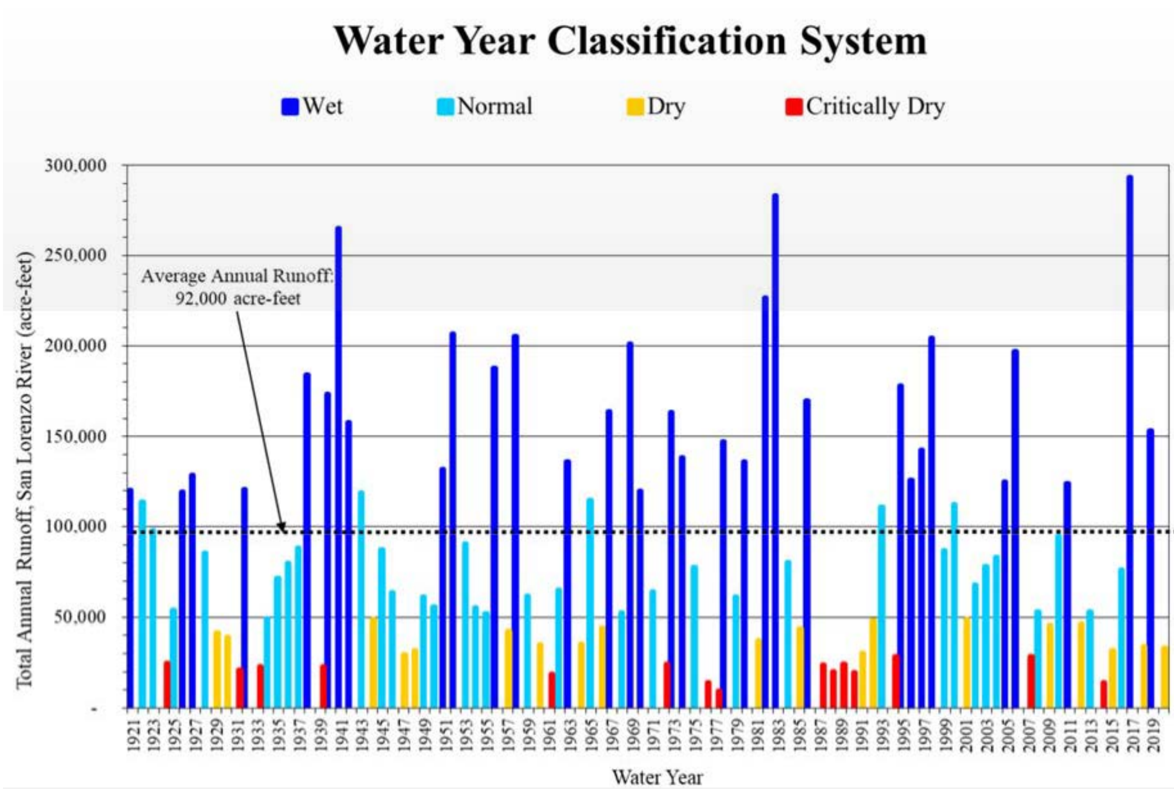


Figure 9. Santa Cruz Water Department's Water Year Classification

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 five 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.

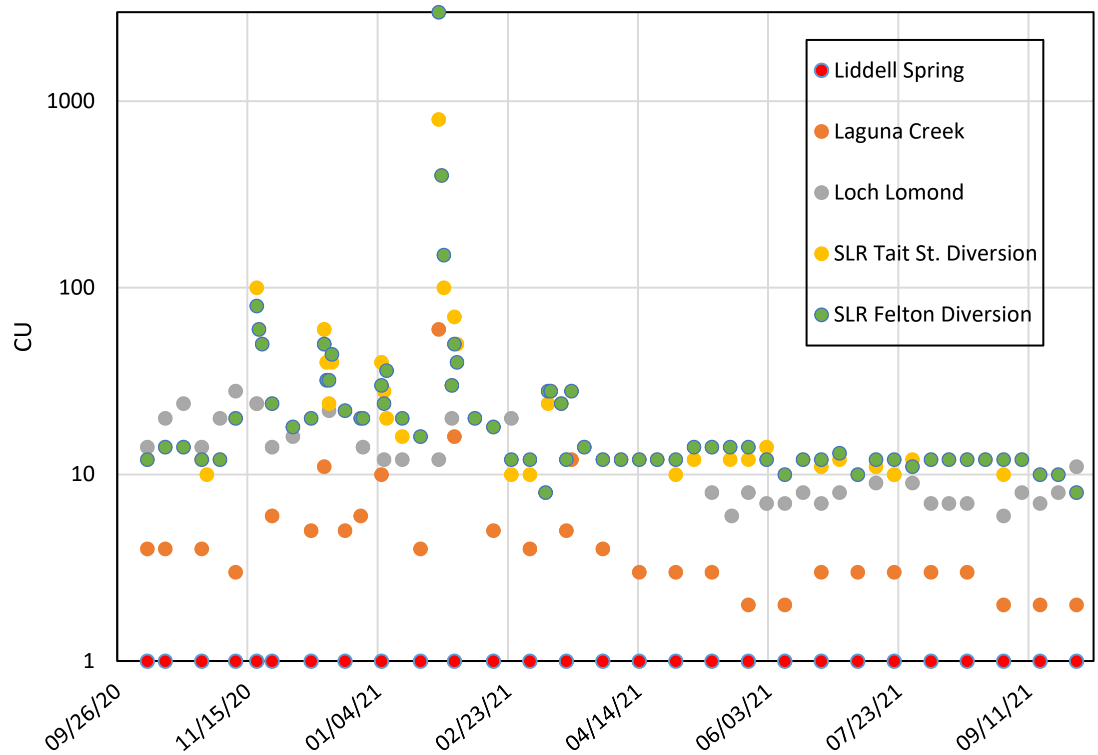


Figure 10. Color of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

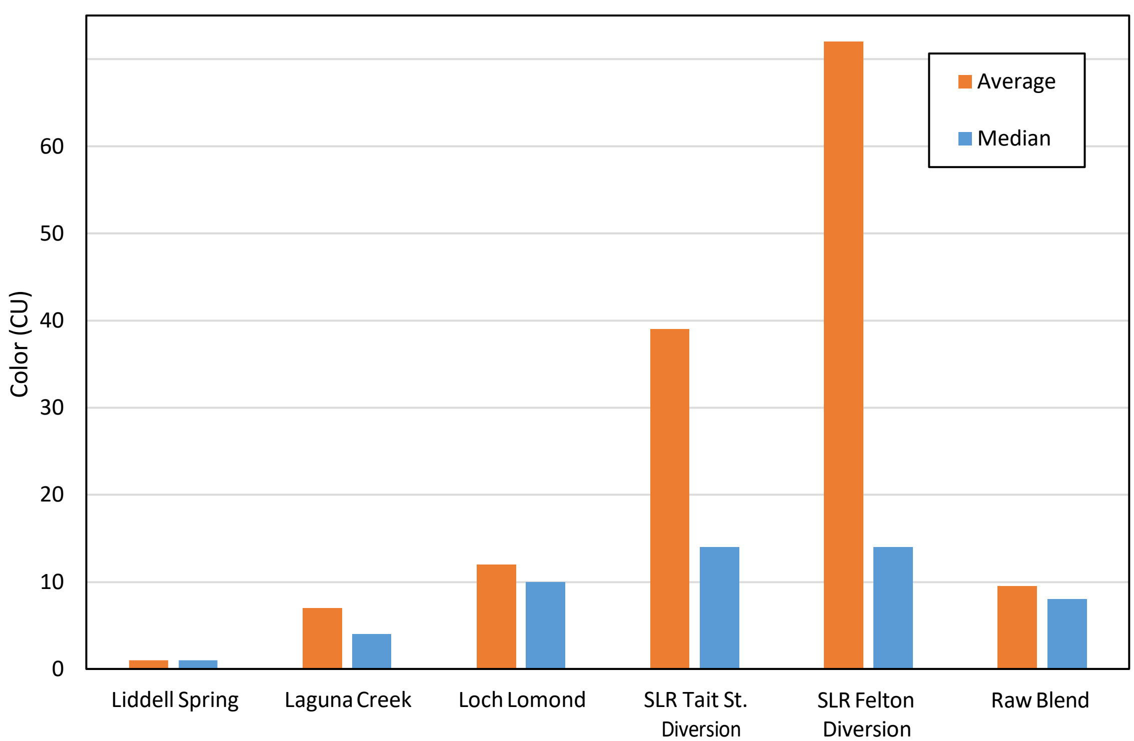


Figure 11. Average and median source water color data for WY 2021

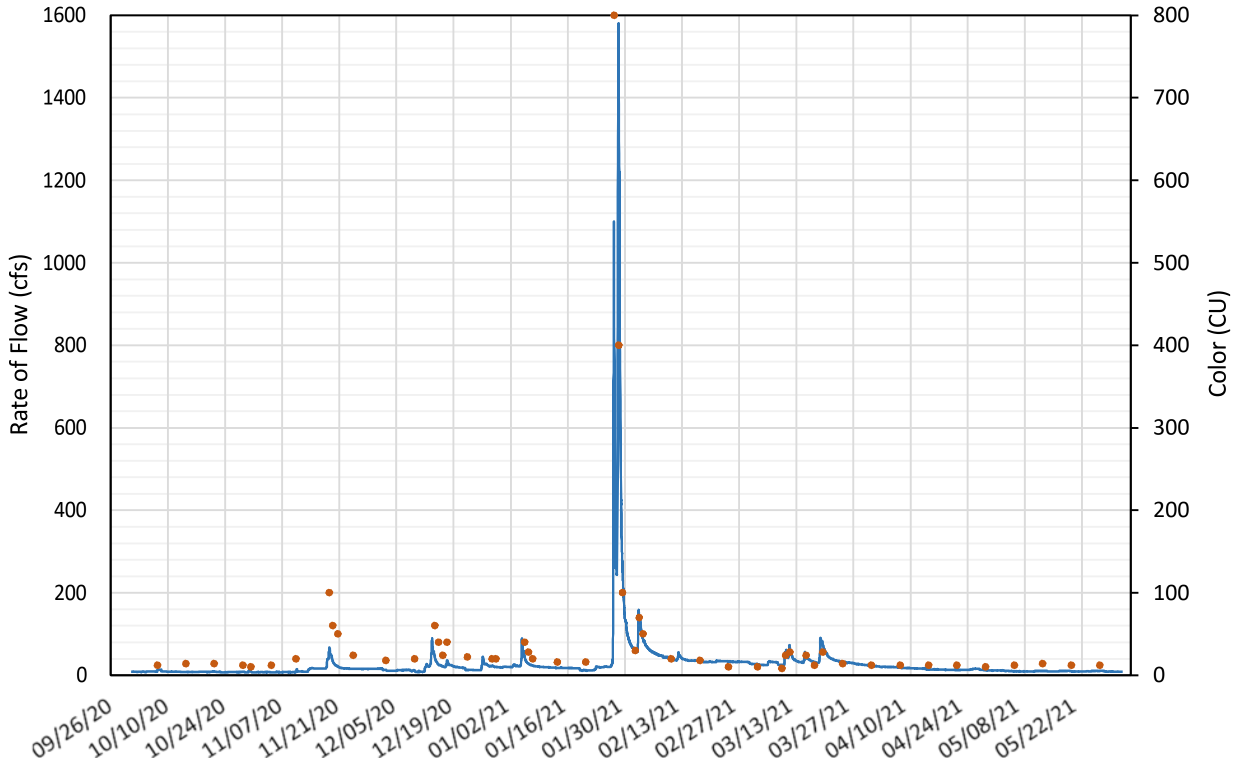


Figure 12. Summary of the San Lorenzo River rate of flow and color data during the Wet Season (October 2020 – May 2021). Color data are from grab samples taken by the Santa Cruz Water Department's Water Quality Laboratory. River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

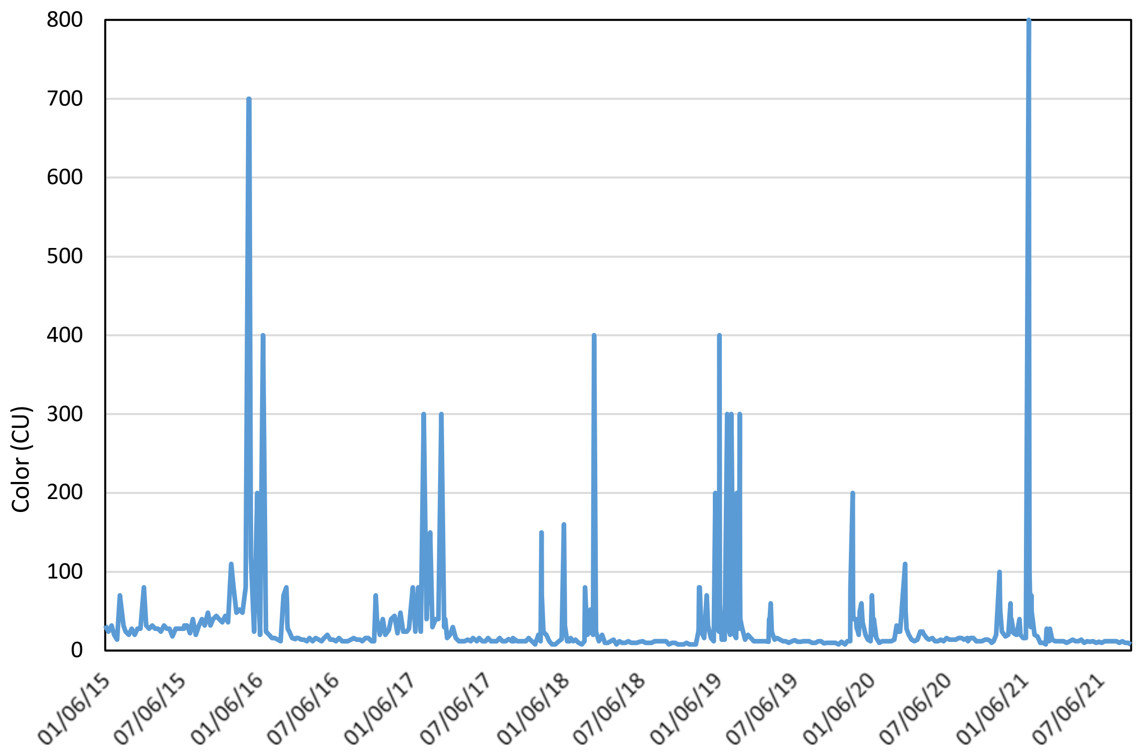


Figure 13. Summary of color data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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 January 27, 2021. 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.

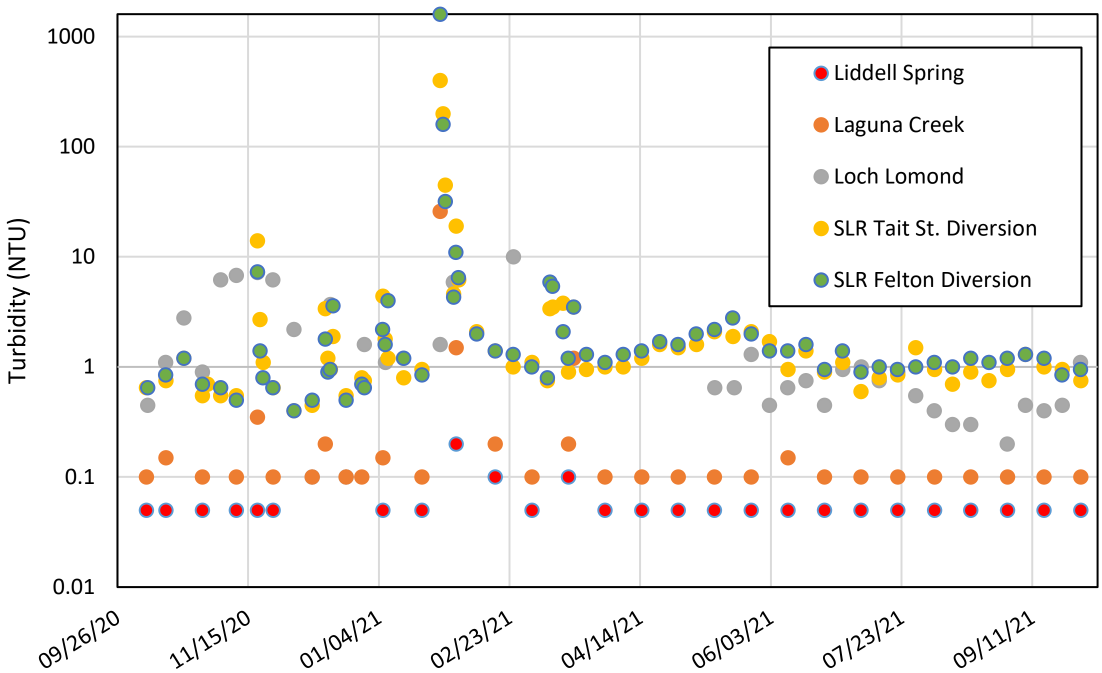


Figure 14. Turbidity of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

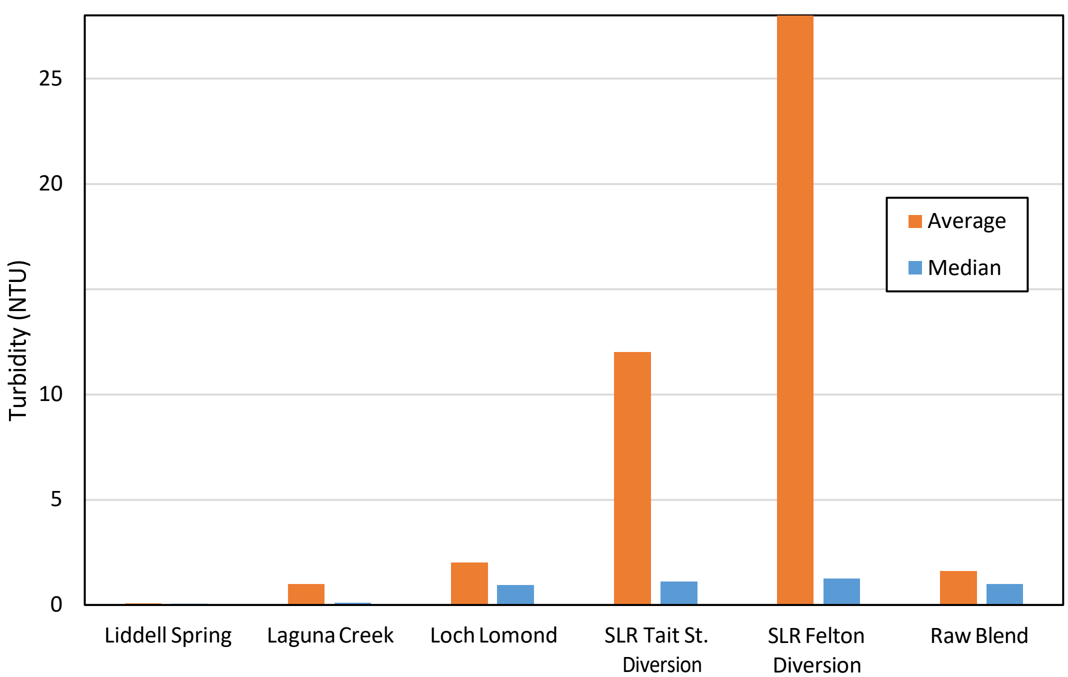


Figure 15. Average and median source water turbidity data for WY 2021

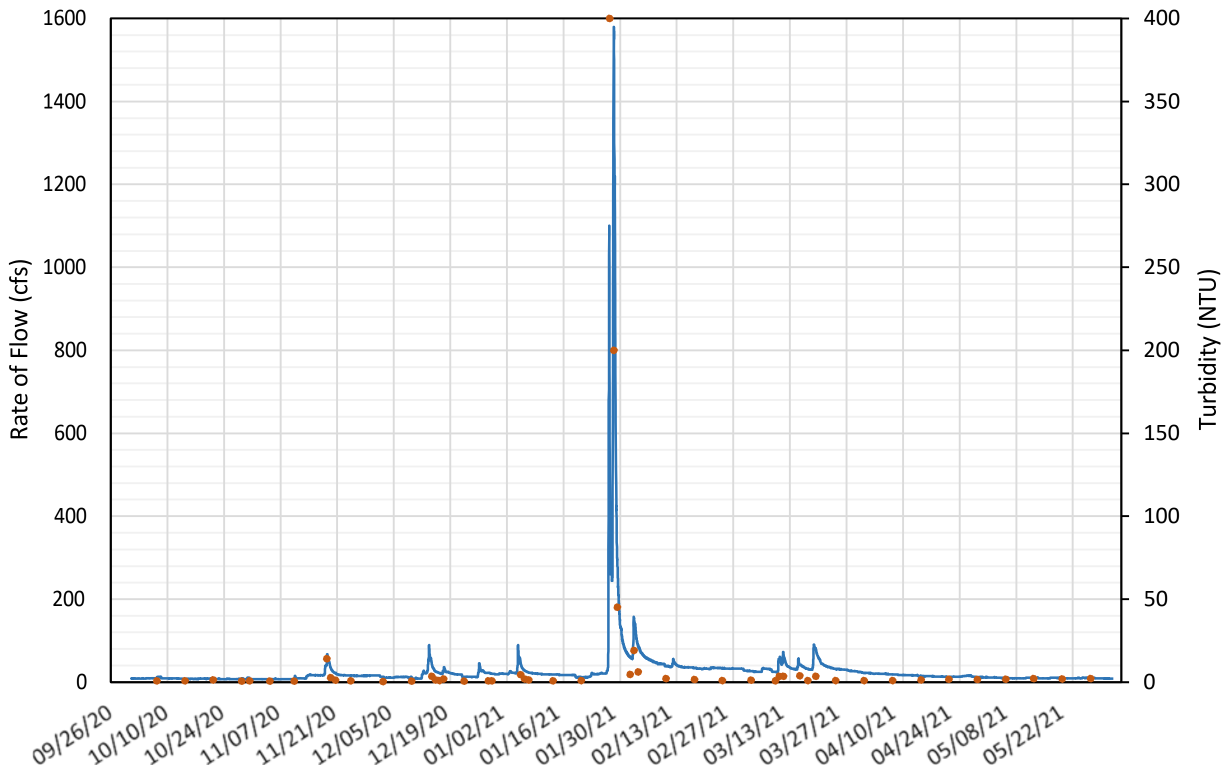


Figure 16. Summary of the San Lorenzo River rate of flow and turbidity data during the Wet Season (October 2020 – May 2021). Turbidity data are from grab samples taken by the Santa Cruz Water Department's Water Quality Laboratory. River rate of flow data were obtained from the USGS 11161000 San Lorenzo R A Santa Cruz CA stream gage.

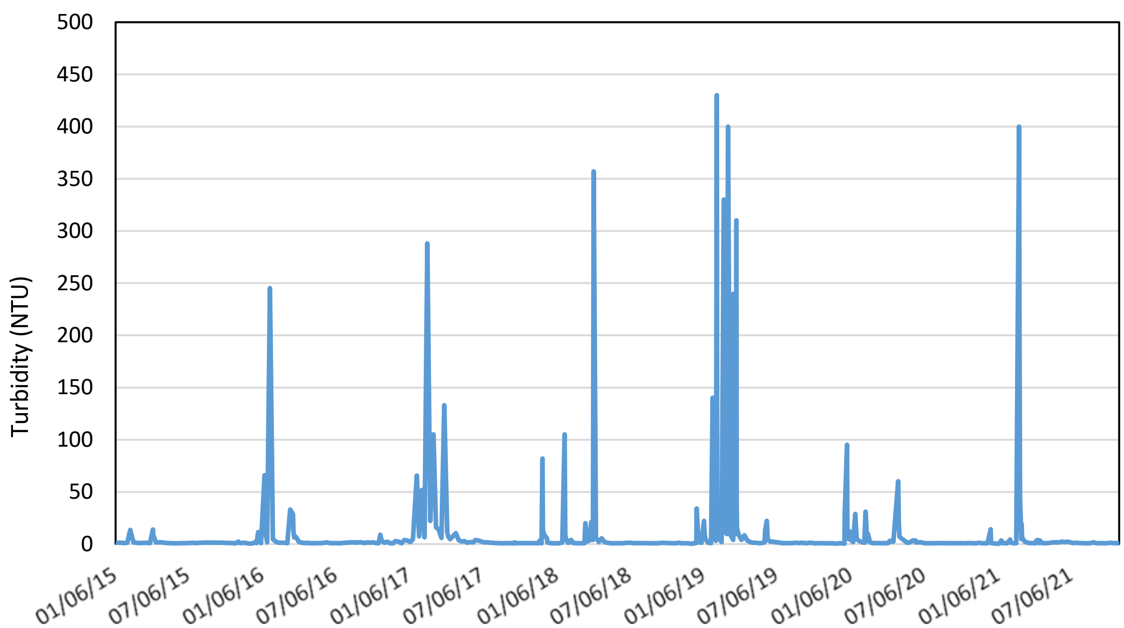


Figure 17. Summary of turbidity data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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.

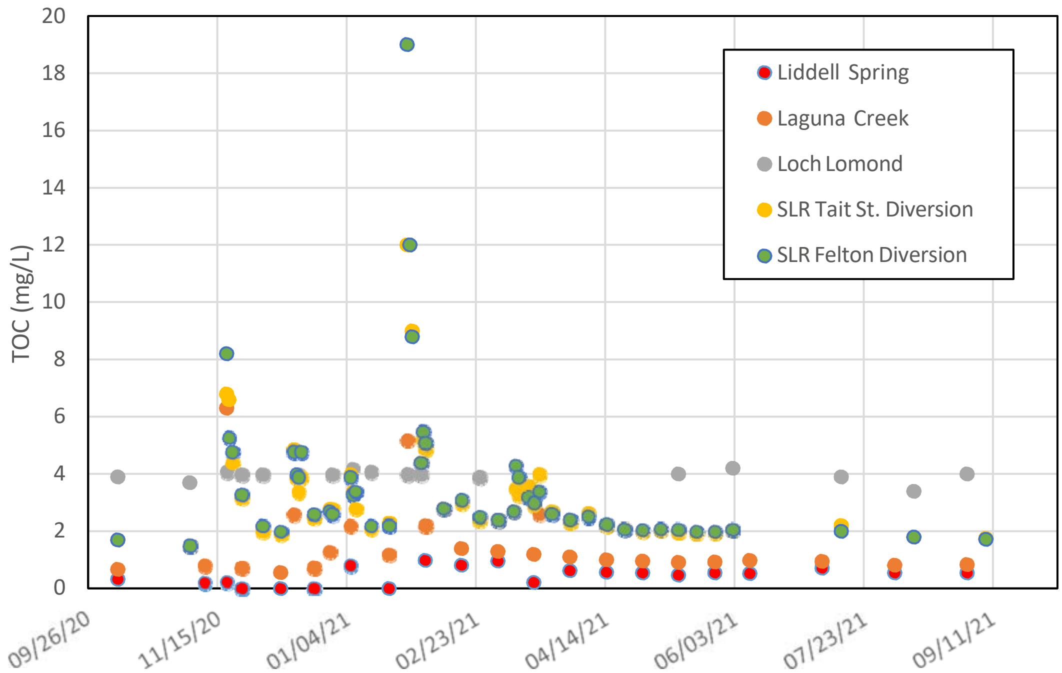


Figure 18. Total organic carbon (TOC) of source waters between October 2020 and September 2021

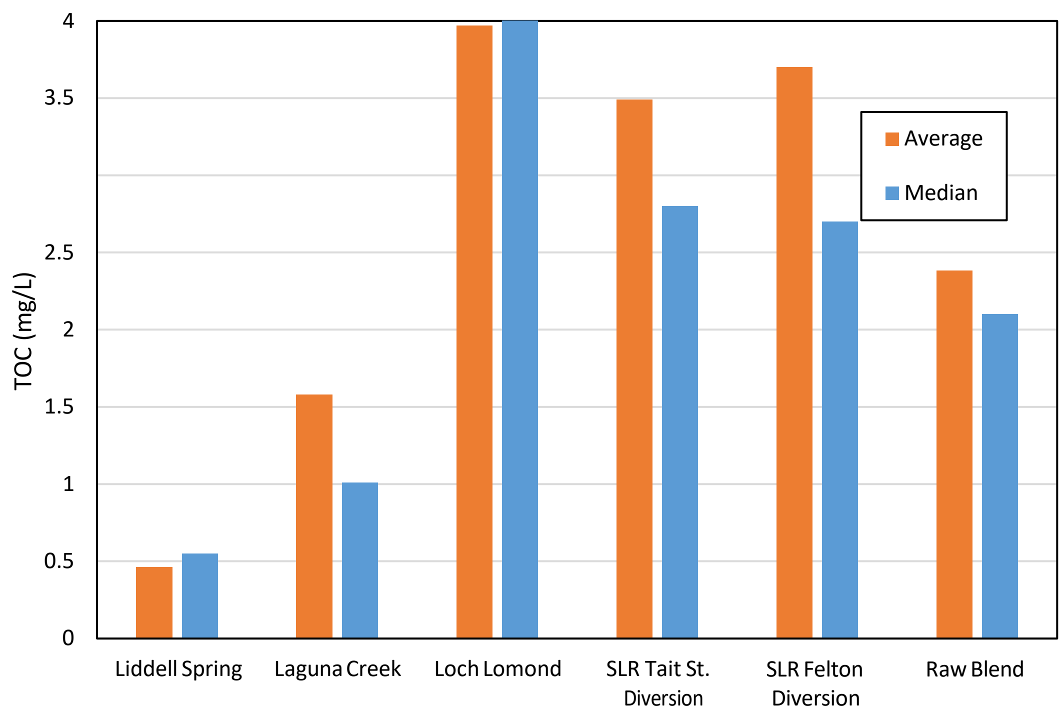


Figure 19. Average and median source water total organic carbon (TOC) data for WY 2021

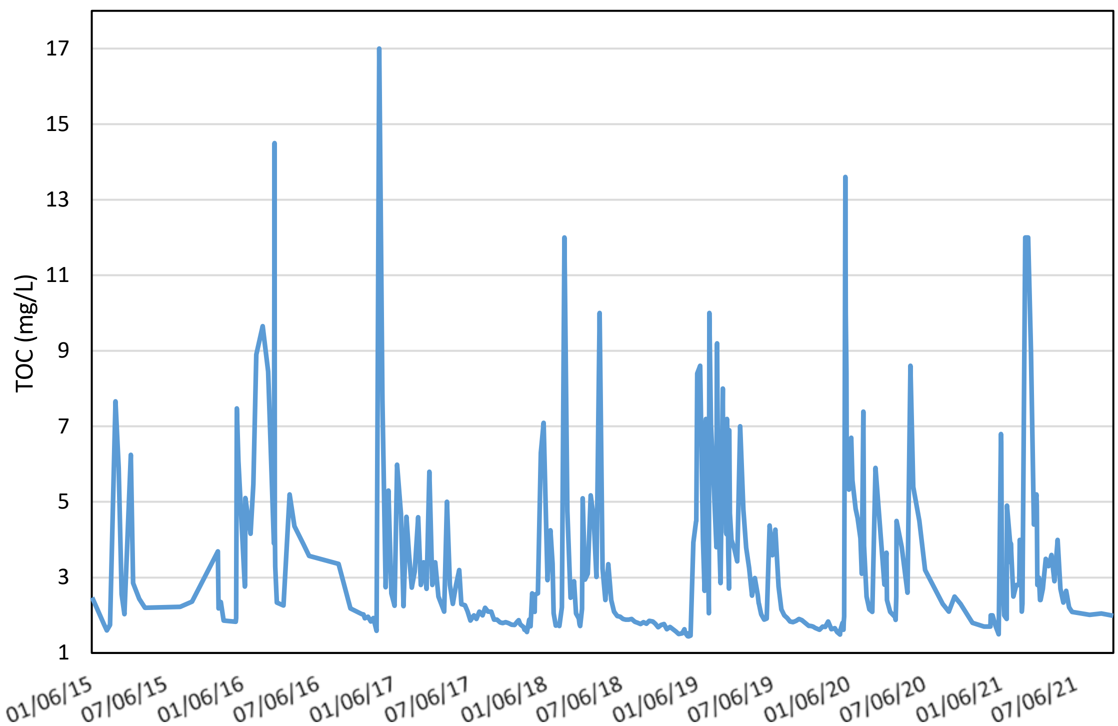


Figure 20. Summary of total organic carbon (TOC) data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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.

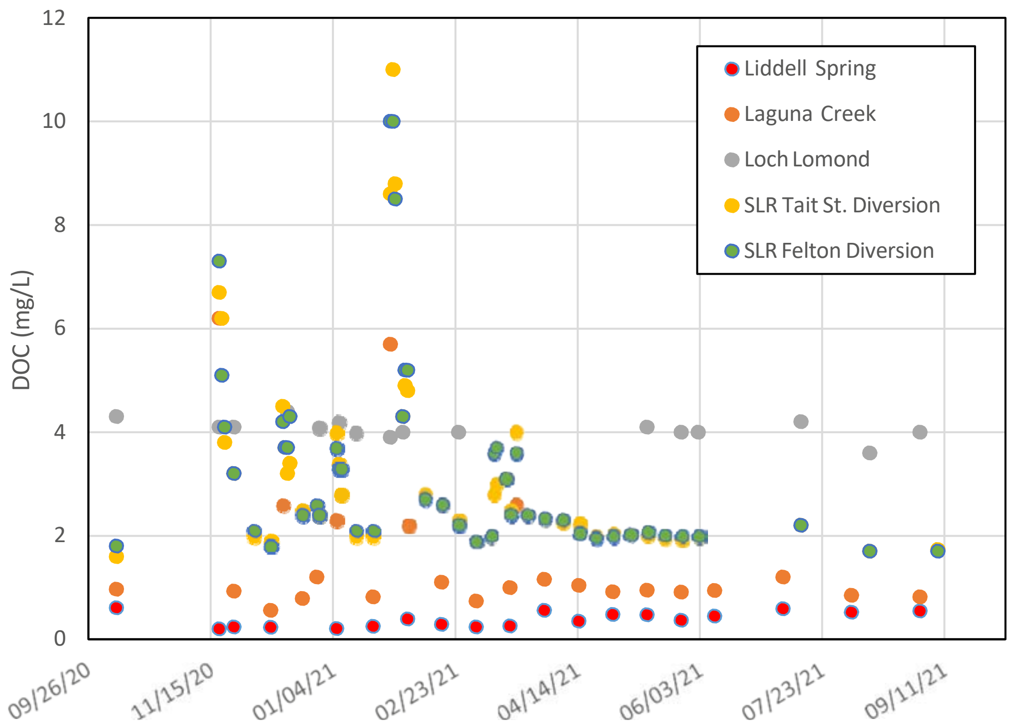


Figure 21. Dissolved organic carbon (DOC) of source waters between October 2020 and September 2021

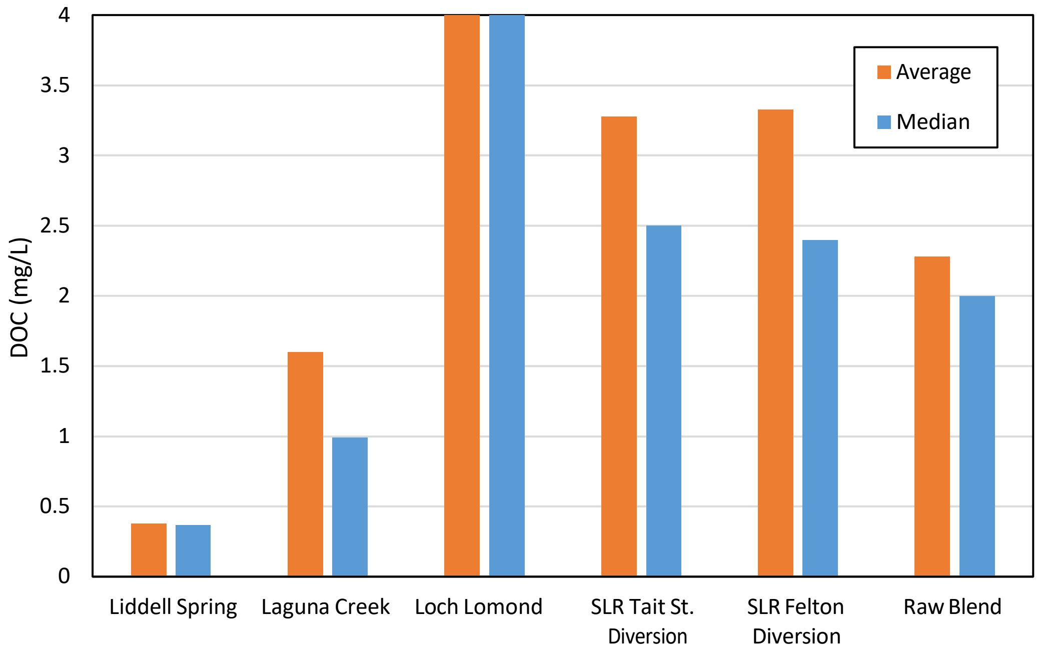


Figure 22. Average and median source water dissolved organic carbon (DOC) data for WY 2021

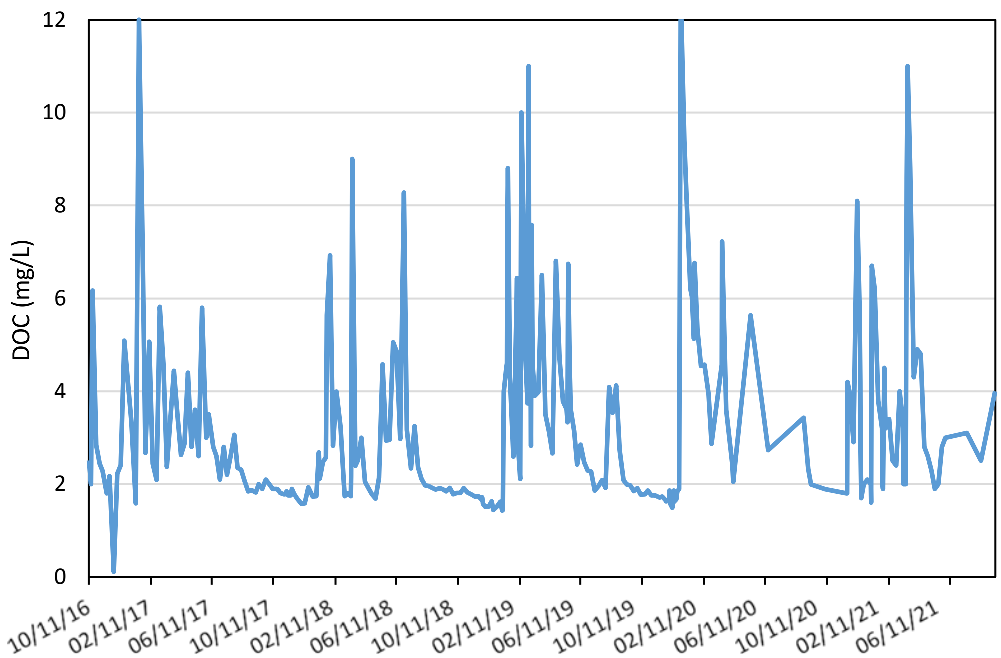


Figure 23. Summary of dissolved organic carbon (DOC) data from the San Lorenzo River Tait St. Diversion between October 2016 and September 2021

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.

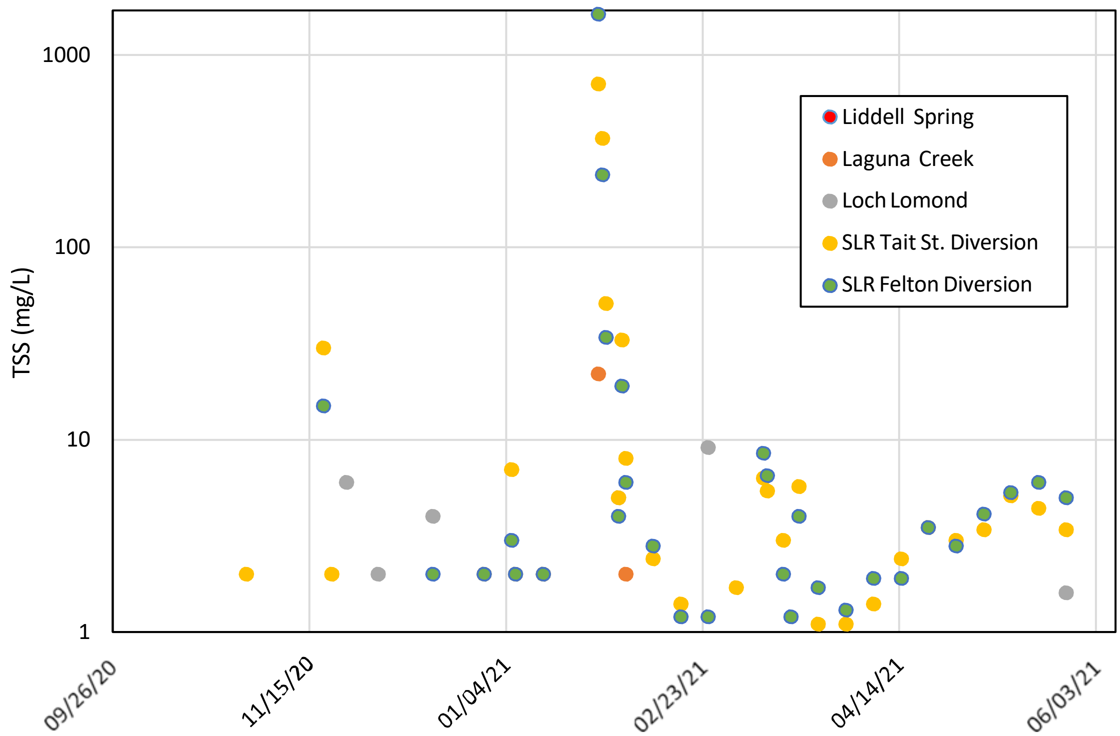


Figure 24. Total suspended solids (TSS) of source waters between October 2020 and September 2021. Data is presented using a logarithmic scale.

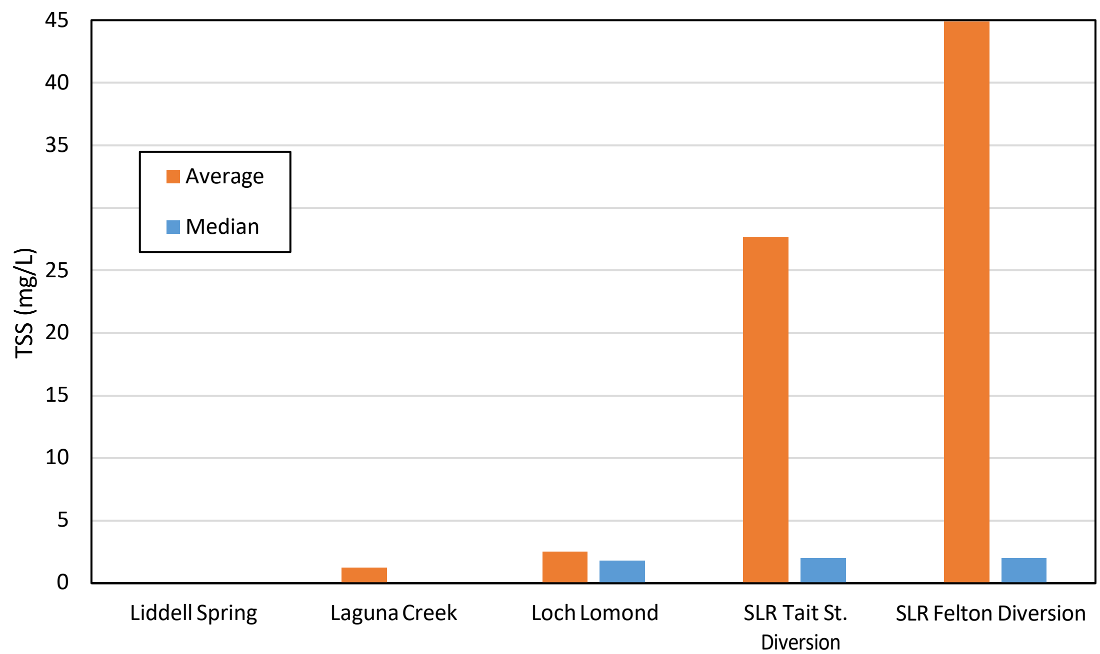


Figure 25. Average and median source water total suspended solids (TSS) data for WY 2021

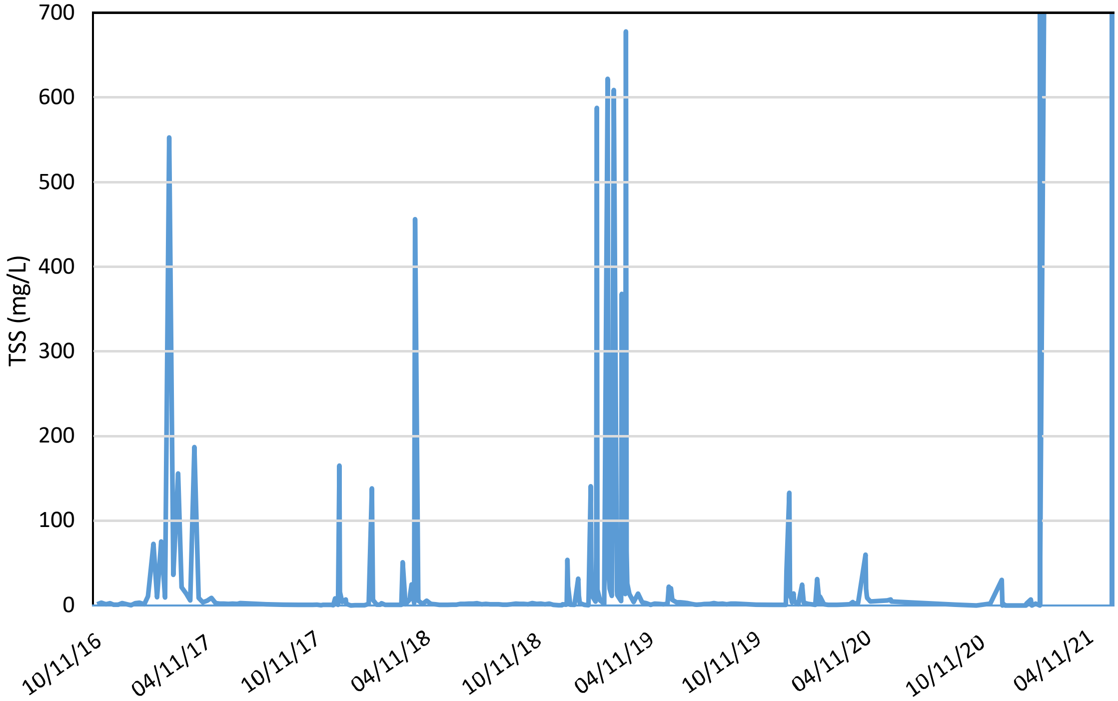


Figure 26. Summary of total suspended solids (TSS) data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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).

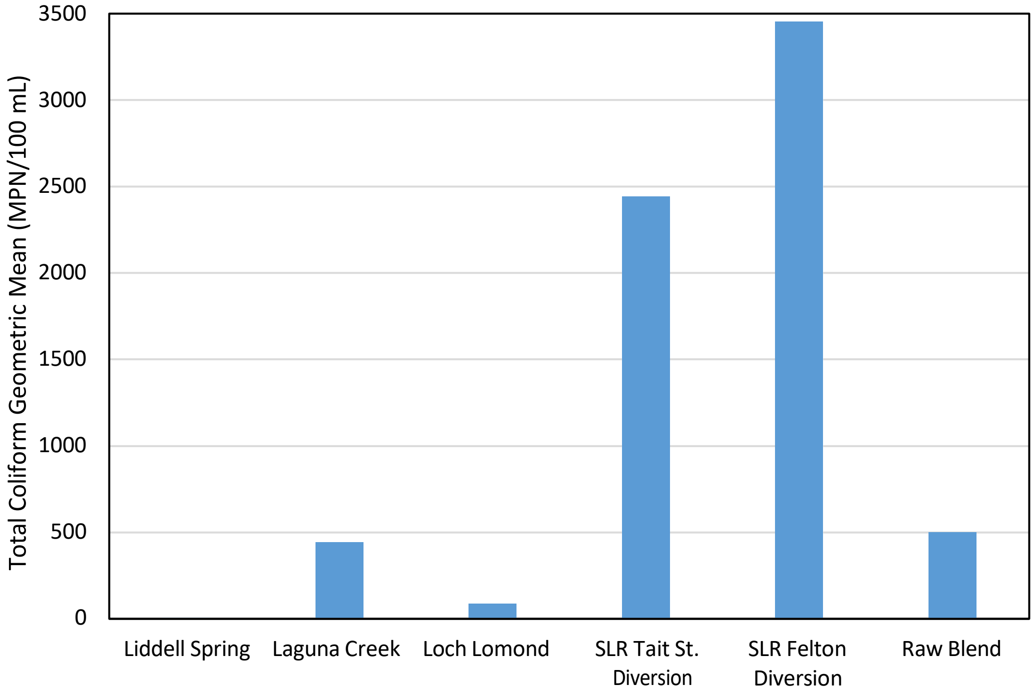


Figure 27. Summary of total coliform geometric mean of source waters between October 2020 and September 2021

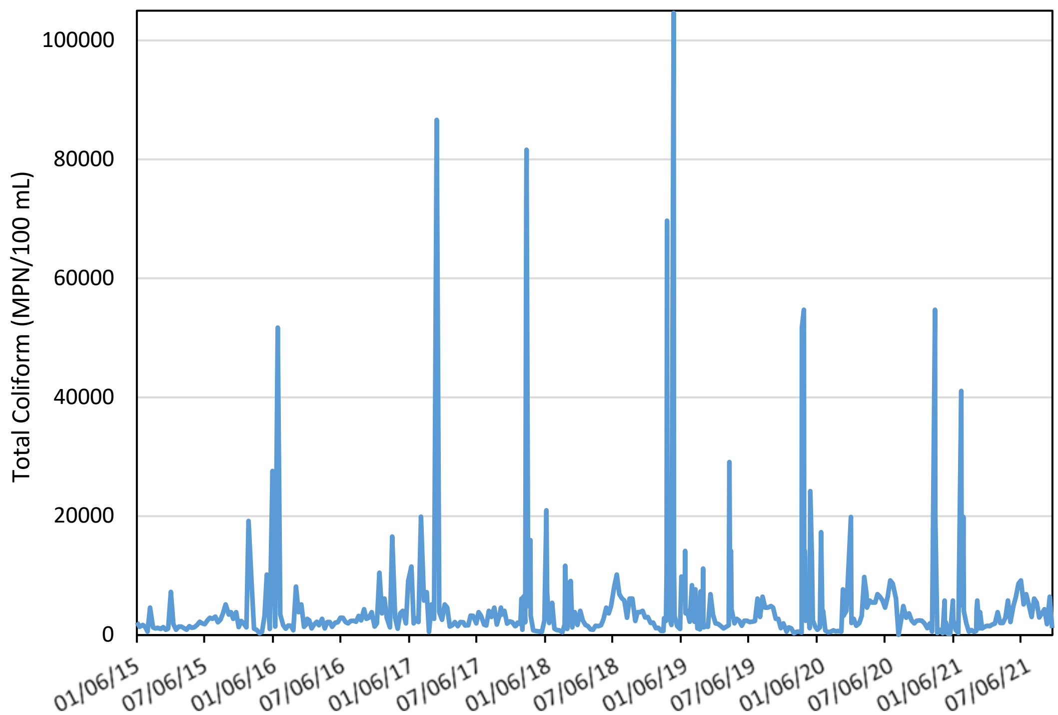


Figure 28. Summary of total coliform data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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 ~~p~~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).

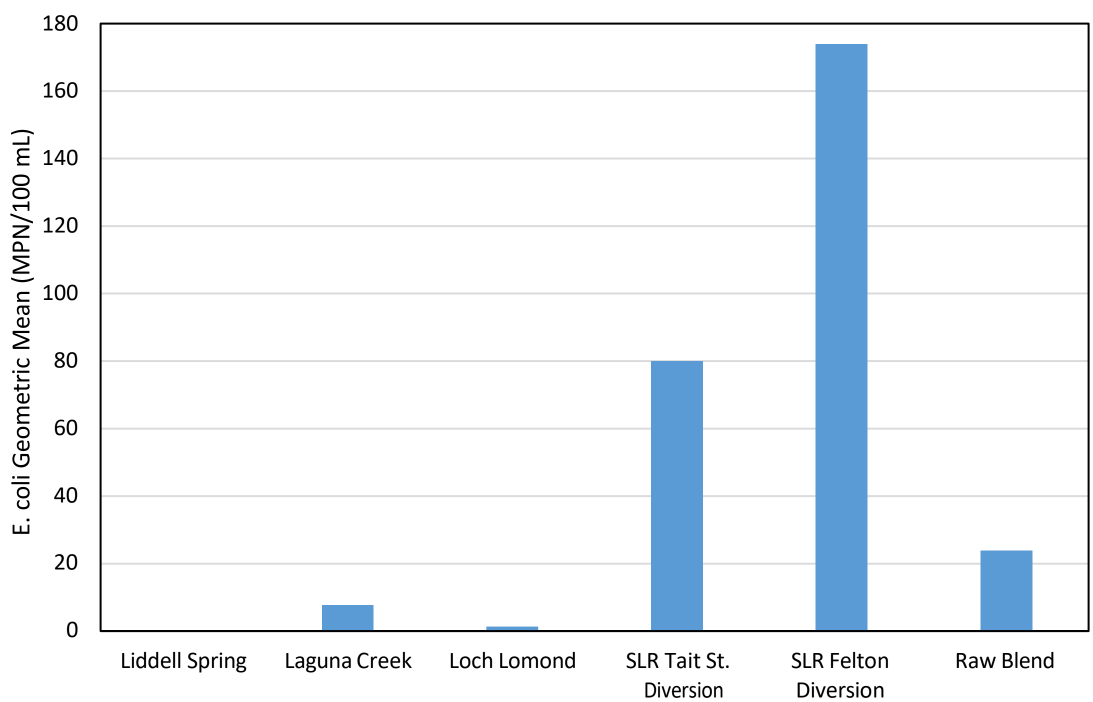


Figure 29. Summary of *E. coli* geometric mean of source waters between October 2020 and September 2021

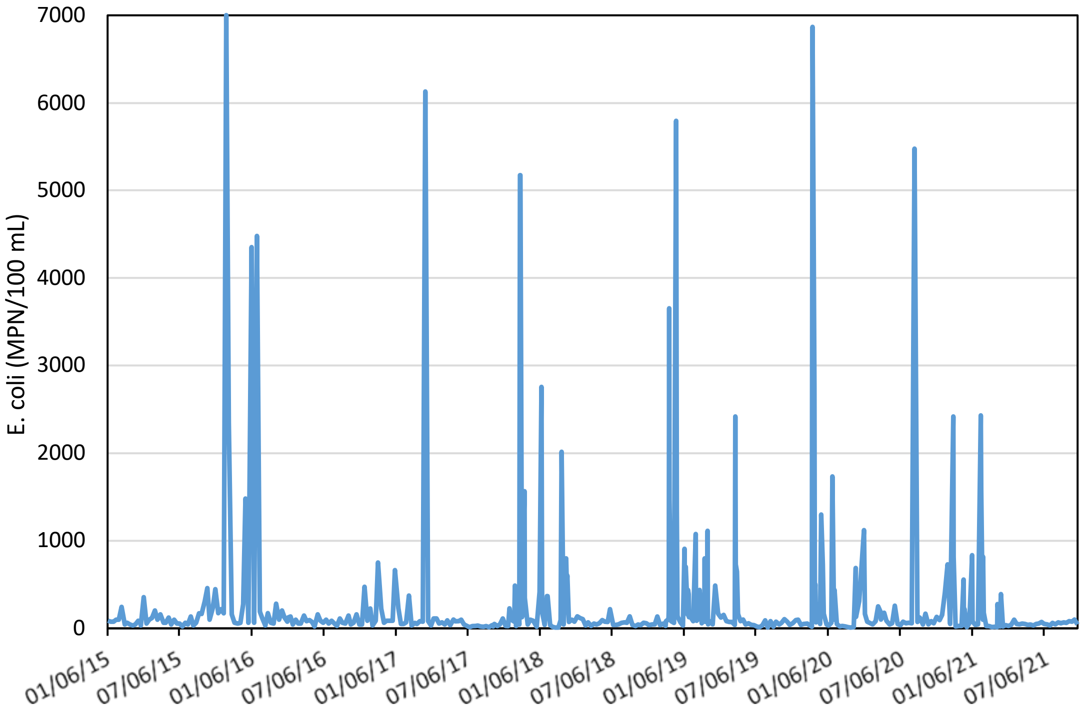


Figure 30. Summary of *E. coli* data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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.

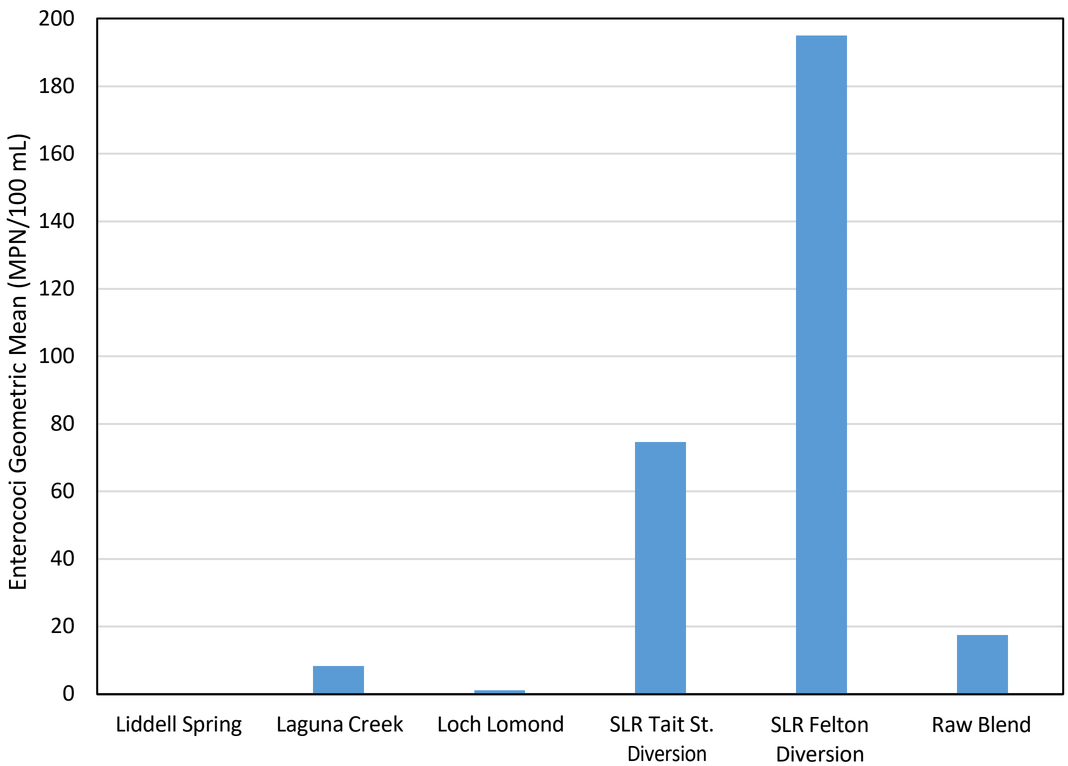


Figure 31. Summary of Enterococci geometric mean of source waters between October 2020 and September 2021

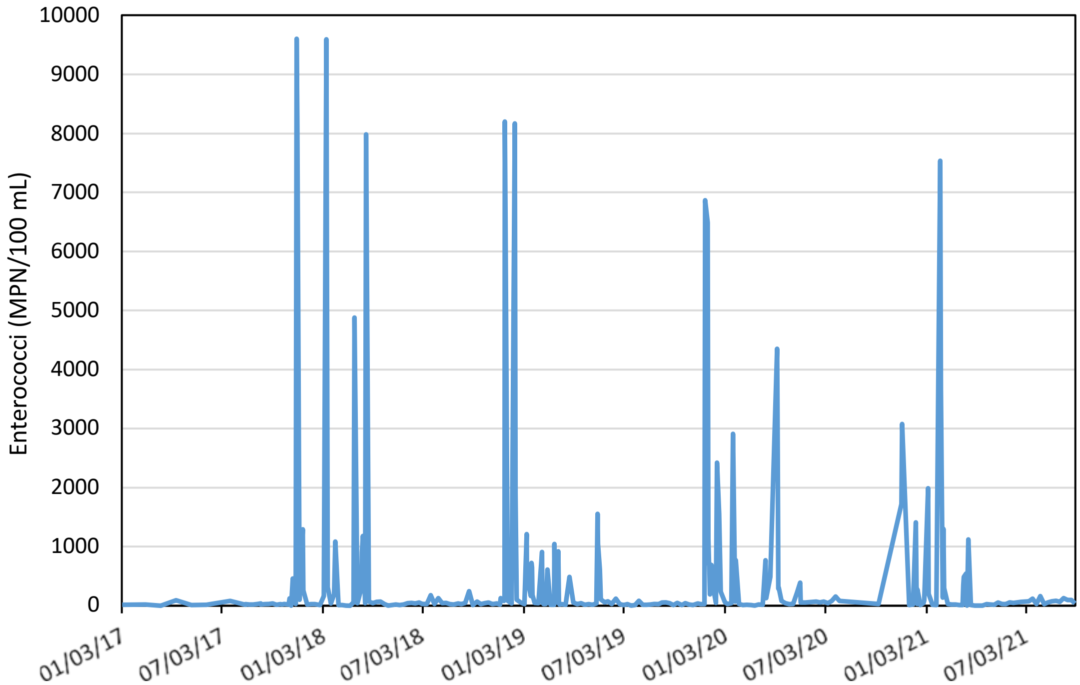


Figure 32. Summary of Enterococci data from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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.

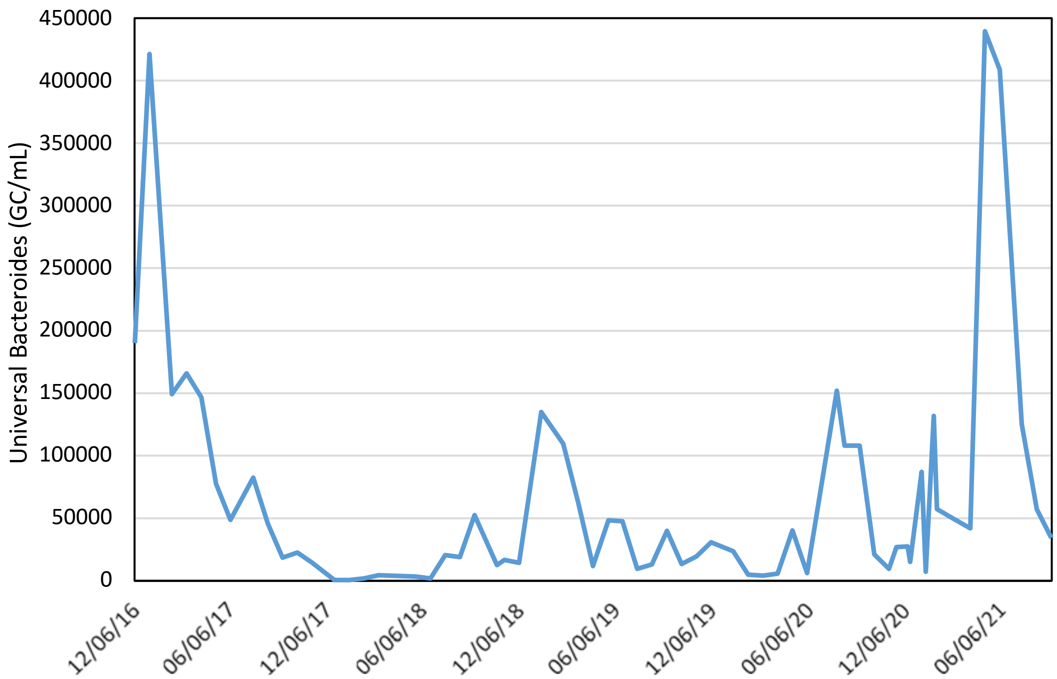


Figure 33. Summary of Universal Bacteroides data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

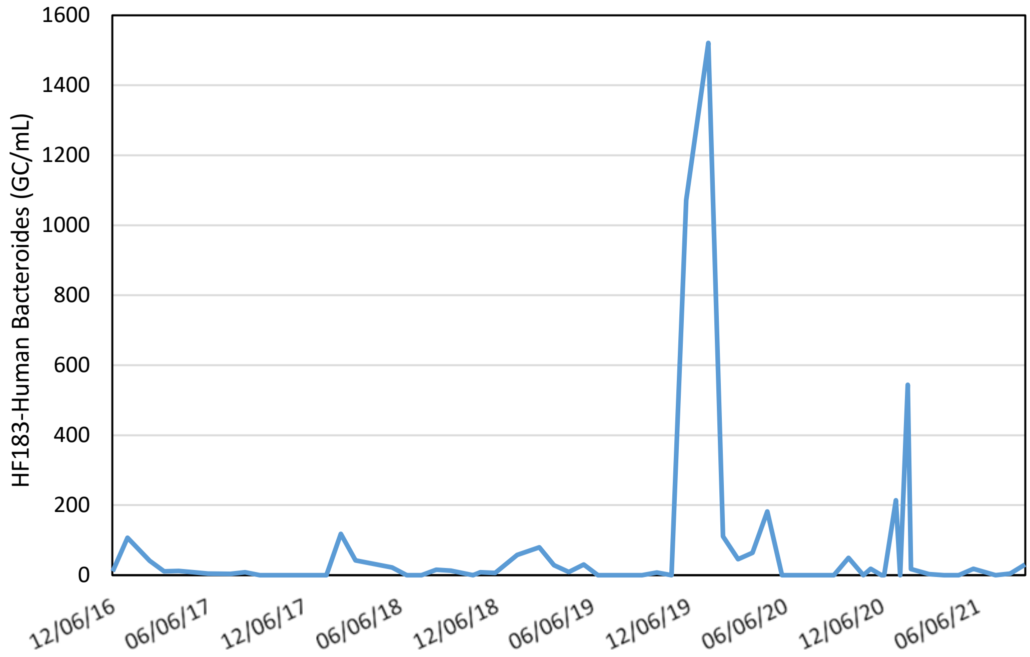


Figure 34. Summary of HF183-Human Bacteroides data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

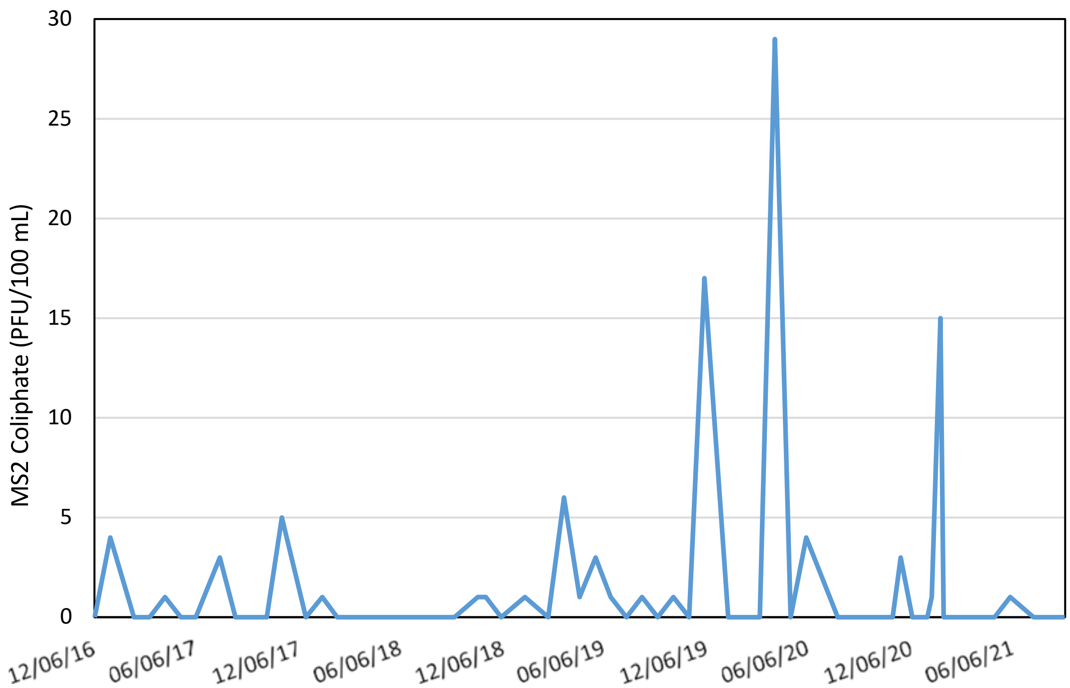


Figure 35. Summary of MS2 Coliphage data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

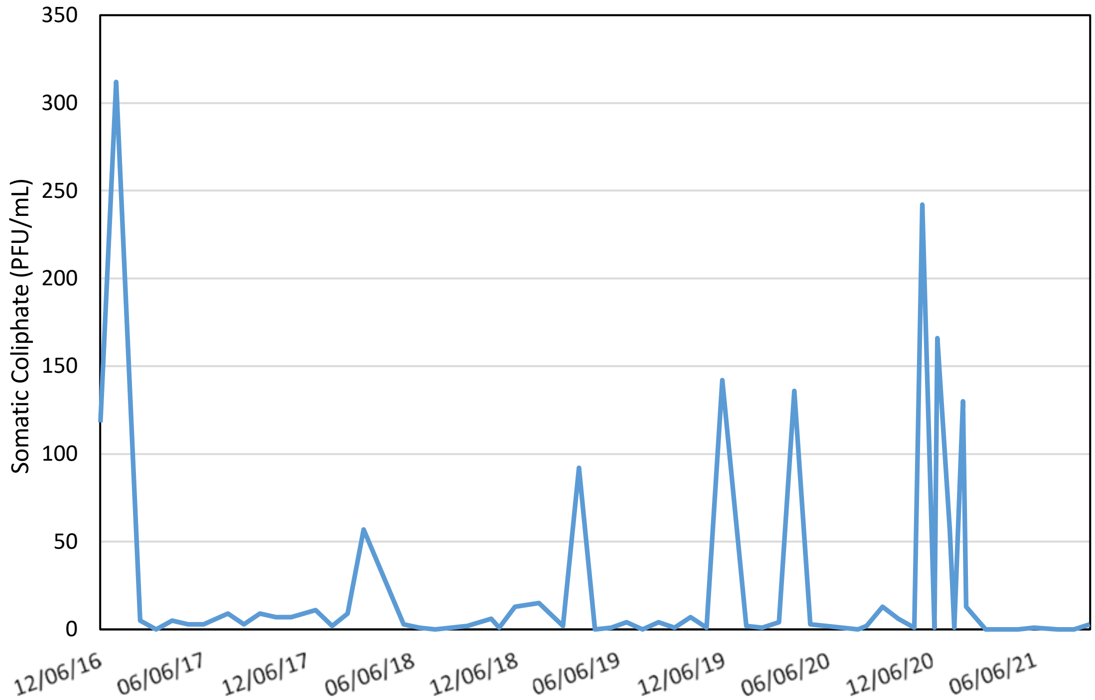


Figure 36. Summary of Somatic Coliphage data from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

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.

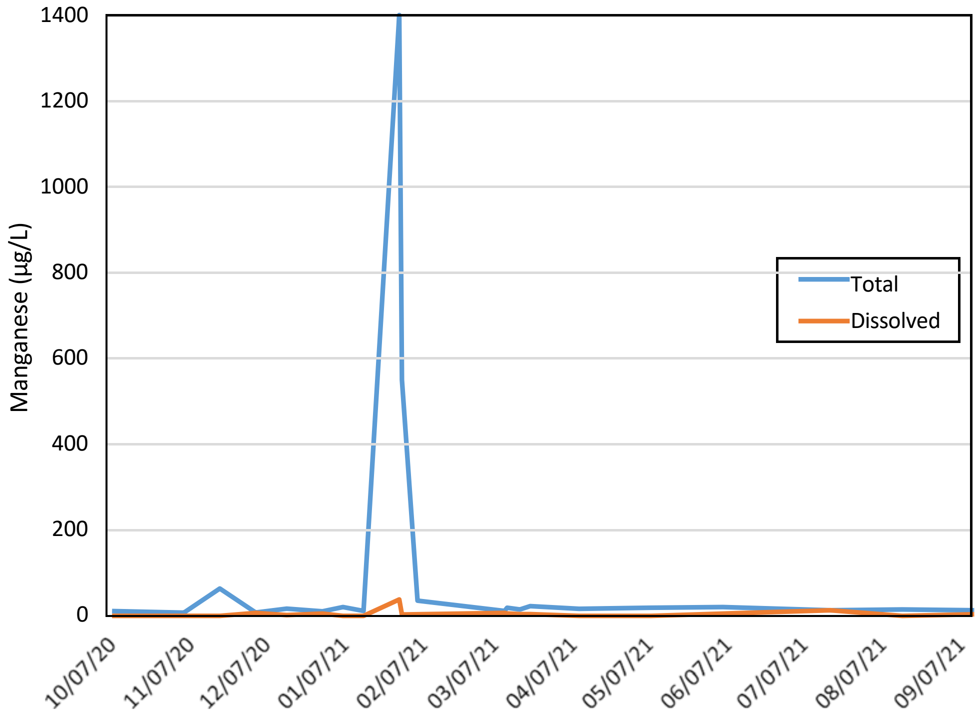


Figure 37. Summary of total and dissolved manganese from the San Lorenzo River Tait St. Diversion between December 2016 and September 2021

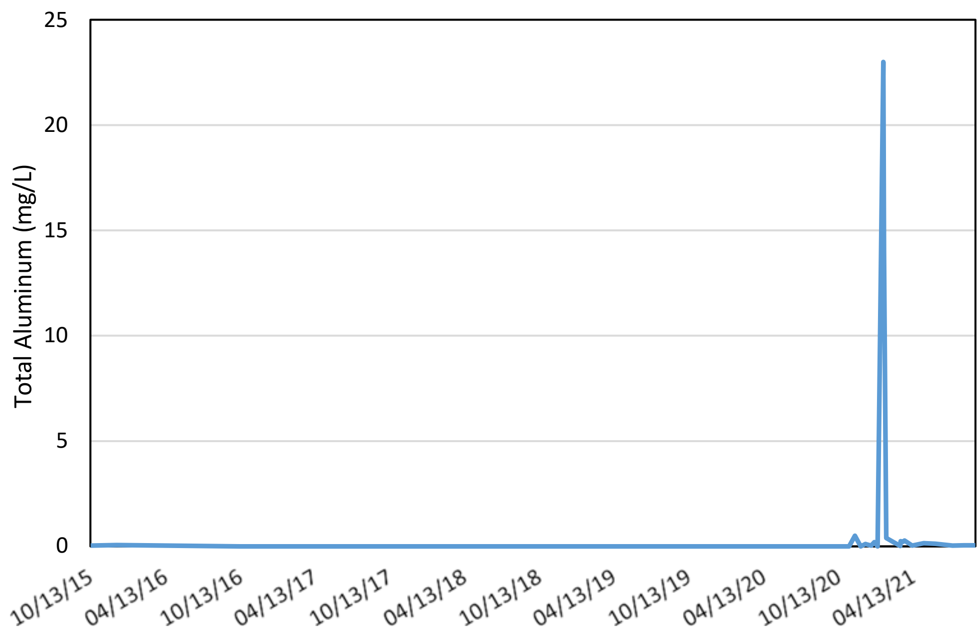


Figure 38. Summary of total aluminum from the San Lorenzo River Tait St. Diversion between January 2016 and September 2021

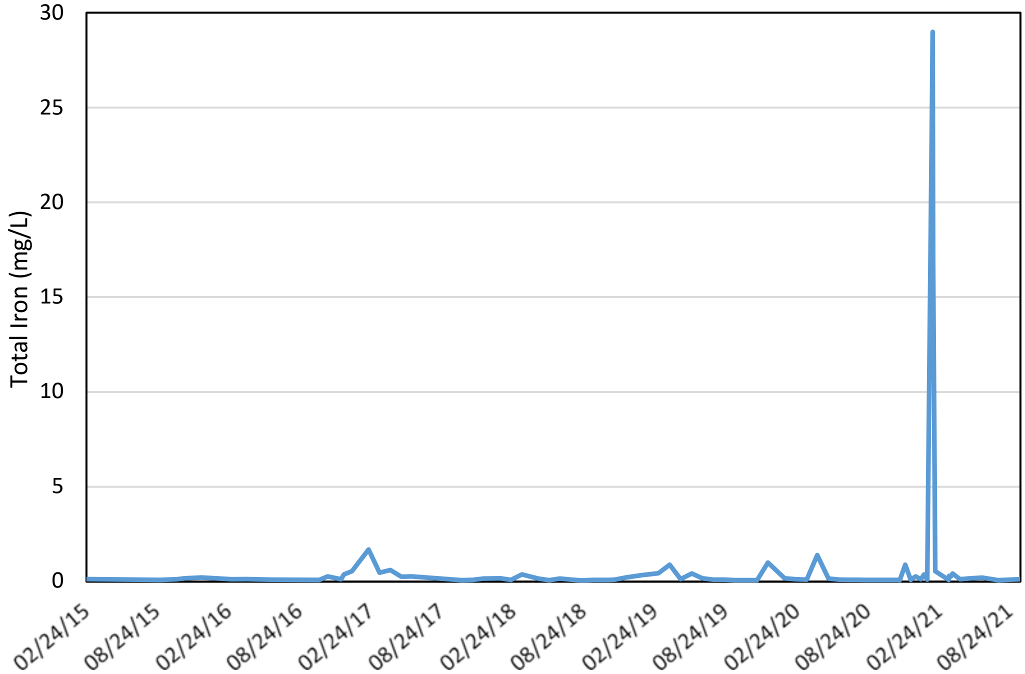


Figure 39. Summary of total iron from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

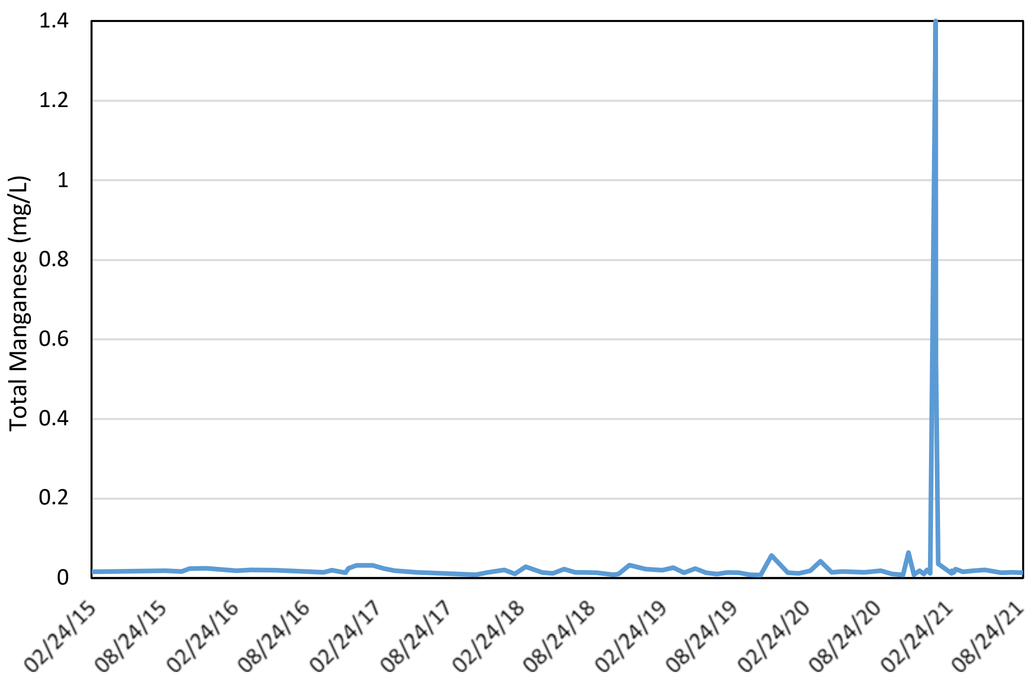


Figure 40. Summary of total manganese from the San Lorenzo River Tait St. Diversion between January 2015 and September 2021

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.

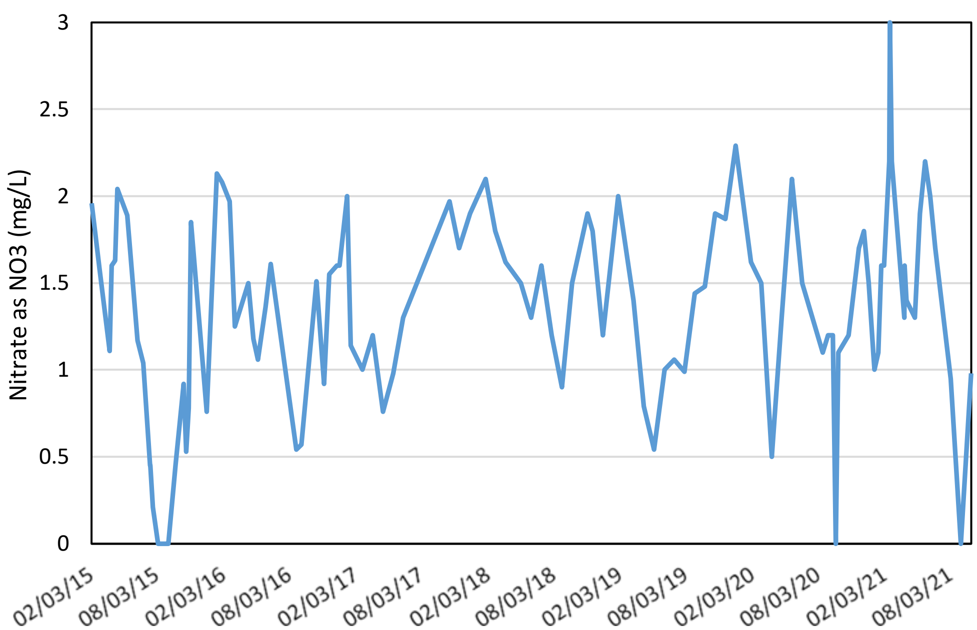


Figure 41. Summary of nitrate as NO3 from the San Lorenzo River Tait St. Diversion during January 2015 and September 2021

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 SOCs 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 VOCs 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 VOCs as well as Upper Laguna and SLR Highlands Park. All VOCs 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.

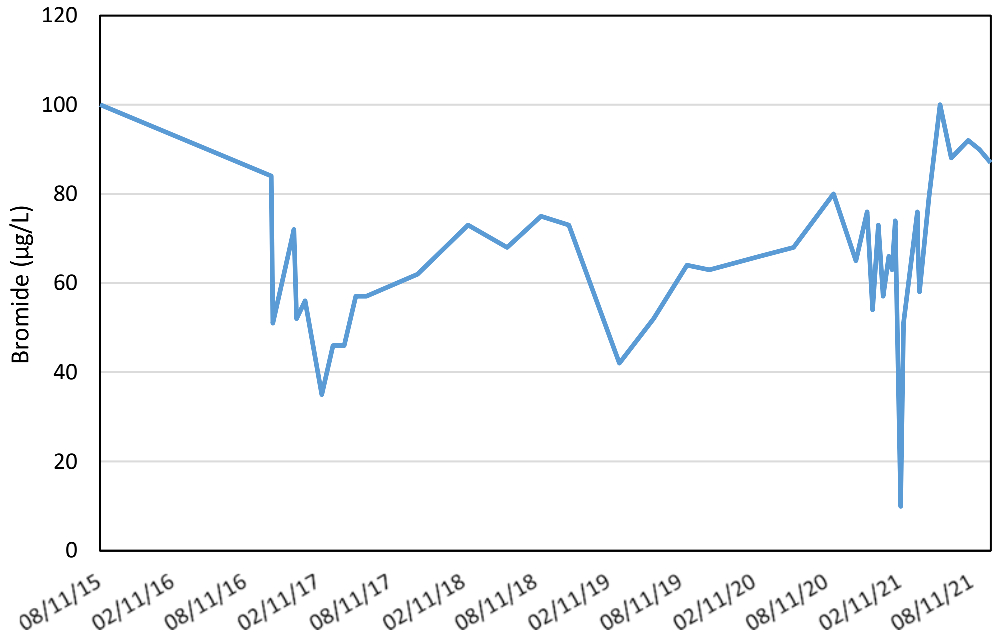


Figure 42. Summary of bromide from the San Lorenzo River Tait St. Diversion during August 2015 and September 2021

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).

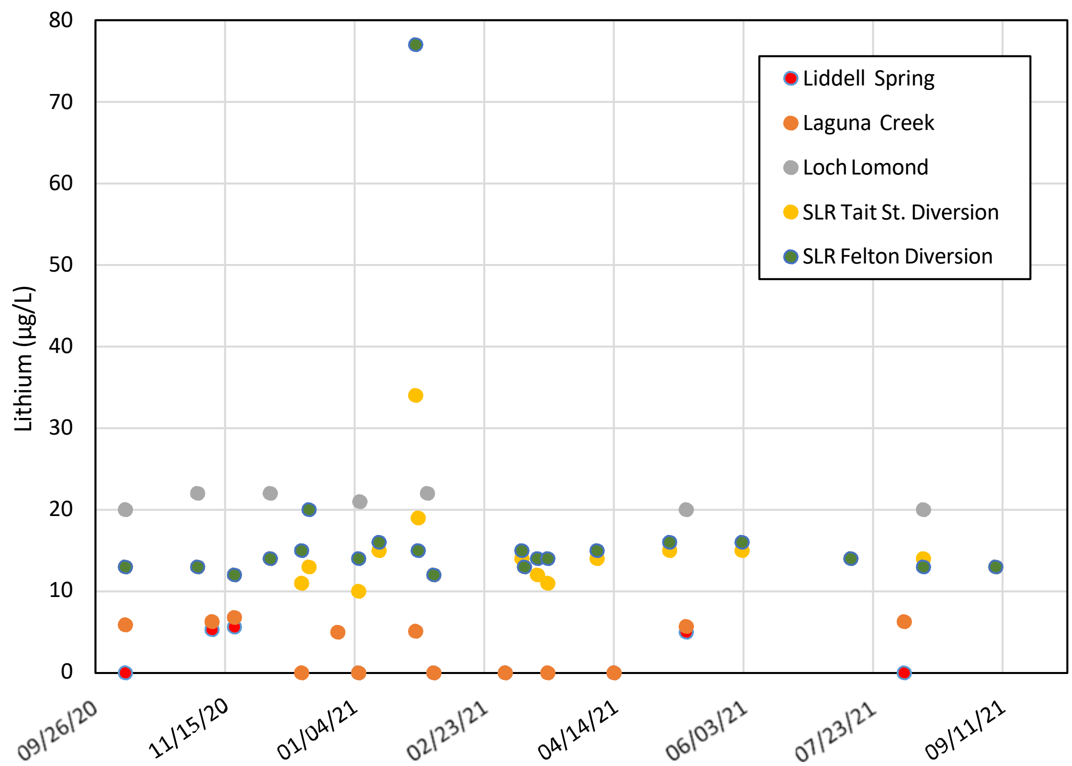


Figure 43. Lithium of source waters between October 2020 and September 2021.

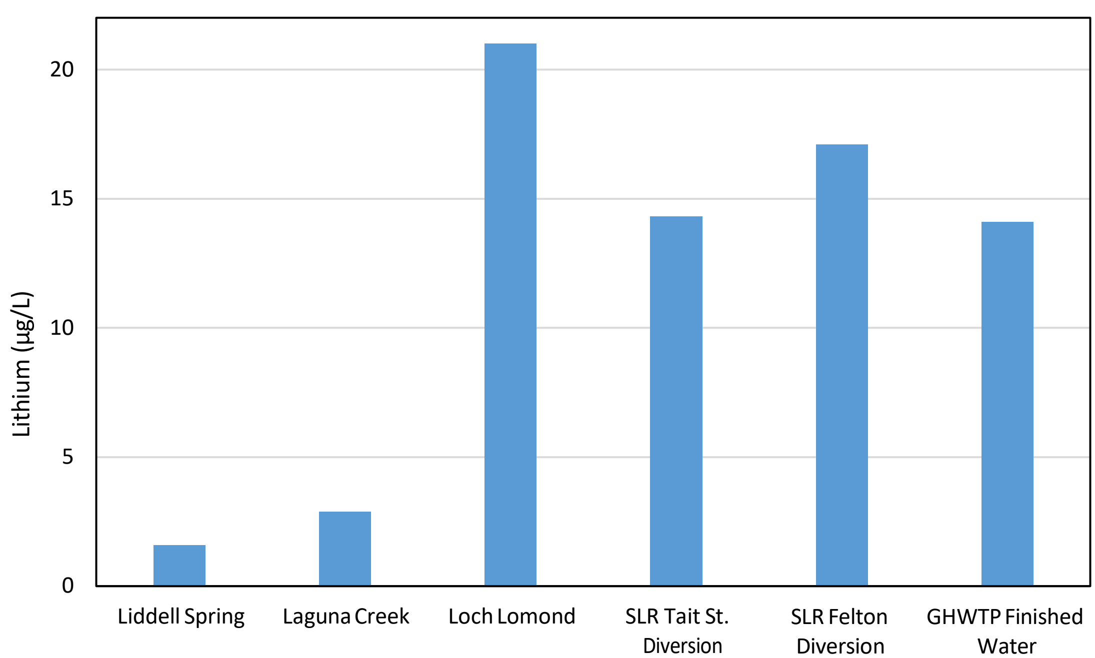


Figure 44. Average source water lithium data for WY 2021.

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

Final Report: Graham Hill Water Treatment Plant Source Water Quality Monitoring Study February 25, 2019 (Trussell Technologies)
https://www.cityofsantacruz.com/home/showpublisheddocument/85111/637605780723170000

City of Santa Cruz Graham Hill Water Treatment Plant Facility Improvements Project Technical Memorandum AECOM December 3, 2021

TMDL Report for the San Lorenzo River, Soquel Creek, and Aptos Creek Watersheds September 2021

San Lorenzo River and North Coast Watersheds Sanitary Survey Update February 2018 (Kennedy/Jenks Consultants)
https://www.cityofsantacruz.com/home/showpublisheddocument/85117/637605784635270000

2020 Consumer Confidence Report
https://www.cityofsantacruz.com/home/showpublisheddocument/84858/637594518948170000

Constituents of Emerging Concern, August 2016 Monitoring Report
https://www.cityofsantacruz.com/home/showpublisheddocument/85113/637605783033530000