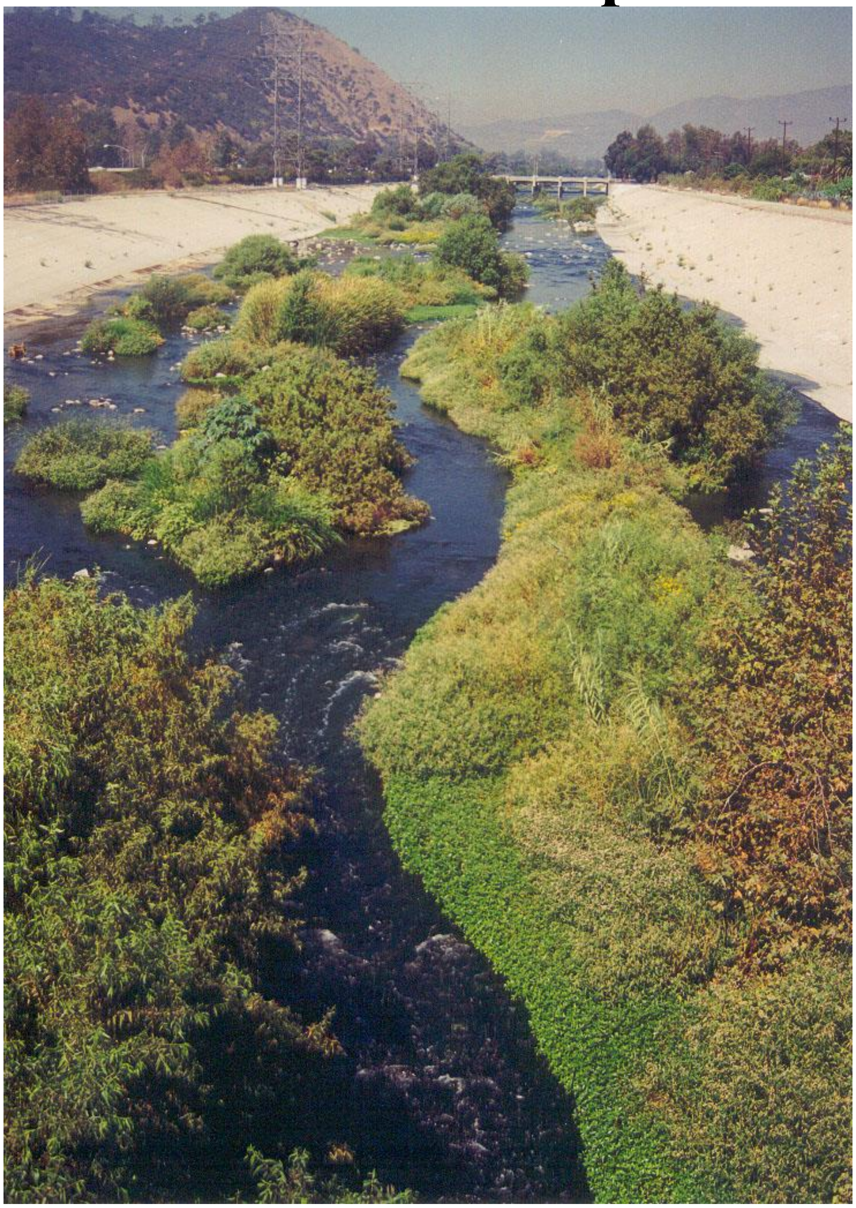
Los Angeles River Watershed Monitoring Program
2020 Annual Report



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Agencies and Organizations
City of Burbank
City of Los Angeles
Los Angeles County Flood Control District
Los Angeles Regional Water Quality Control Board
Council for Watershed Health
Southern California Coastal Water Research Project
U.S. Environmental Protection Agency (USEPA)
U.S. Forest Service
Heal the Bay
Friends of the LA River (FOLAR)
L.A. Waterkeeper

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List of Acronyms

Algal IBI	Algal Index of Biological Integrity
ATL	Advisory Tissue Levels
BMI	Benthic Macroinvertebrate
BOD	Biochemical Oxygen Demand
BWRP	Burbank Water Reclamation Plant
COD	Chemical Oxygen Demand
CRAM	California Rapid Assessment Method
CRM	Certified Reference Material
CSCI	California Stream Condition Index
CTR	California Toxics Rule
DCTWRP	Donald C. Tillman Water Reclamation Plant
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DQO	Data Quality Objective
EWMP	Enhanced Watershed Management Plan
FCG	Fish Contaminant Goals
IBI	Index of Biological Integrity
LAGWRP	Los Angeles Glendale Water Reclamation Plant
LARWMP	Los Angeles River Watershed Monitoring Program
MDL	Method Detection Limit
MLOE	Multiple Lines Of Evidence
MQO	Measurement Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ND	Non-detect
OEHHA	Office of Environmental Health and Hazard Assessment (CA)
PAH	Polycyclic Aromatic Hydrocarbons
PCA	Principle Component Analysis
PCB	Polychlorinated Biphenyl
POP	Persistent Organic Pollutant. The listed constituents, PCBs and DDTs, are both persistent organic pollutants under the Stockholm Convention.
POTW	Publicly Owned Treatment Works
PPM	Parts Per Million
RPD	Relative Percent Difference
RF	Random Forest
SGRRMP	San Gabriel River Regional Monitoring Program
SQO	Sediment Quality Objective
SWAMP	Surface Water Ambient Monitoring Program
STV	Statistical Threshold Value
TDS	Total Dissolved Solids
USEPA	United States Environmental Protection Authority
VOC	Volatile Organic Compound
WQO	Water Quality Objective
WRP	Water Reclamation Plant

Executive Summary

The Los Angeles River Watershed Monitoring Program conducts annual assessments to better understand the health of a dynamic and predominantly urban watershed. The guiding questions and corresponding monitoring framework of the LARWMP provide both the public and resource managers with an improved understanding of conditions and trends in the watershed.

What is the condition of streams in the watershed?
Every year the LARWMP program assesses stream condition at random sites located in effluent, urban, and natural sub-regions. The LARWMP program began revisiting random sites to better understand trends across the entire watershed. The findings from the 2020 assessments are summarized below.

- A pattern of better biotic conditions, as demonstrated by higher scores, in the natural regions of the watershed compared to the effluent dominated and urban reaches is consistently seen across bioassessment methods (CSCI, ASCI, and CRAM). Water quality and physical habitat assessments mirror this patterns.
- The majority of sites are not in reference condition and have altered biological condition. Approximately 60% of all random sites were altered or were below reference condition for benthic macroinvertebrate communities (CSCI scores). In addition, riparian zone habitat condition (CRAM) was below reference thresholds at roughly 65% of sites, while for algal communities (ASCI - Hybrid) approximately 80% of sites were altered.
- Trend analysis using revisit sites showed that biological condition at stream sites is stable through time, with the exception of of LAR06216 (Big Tujunga Creek), which has significantly improved over time.
- CSCI and CRAM scores within each region are also stable. CRAM scores at natural sites appear to have improved during the 2013-2016 time period compared to the 2009-2012 time period.
- Plastic was the most common trash category across effluent, urban and natural sub-regions. When analyzing the frequency of specific trash types within each sub-region, paper/cardboard was the most prevalent trash type at natural sites, wrappers/wrapper pieces at effluent sites, and cigarette butts at urban sites.

Are conditions at areas of unique interest getting better or worse?
LARWMP conducts periodic monitoring at sites identified by the Technical Stakeholder Group (TSG) as unique areas of interest, which include confluence sites and riparian areas. Regular and recurring assessment can help build upon our understanding of site conditions and how conditions are changing over time. Findings from this monitoring effort are summarized below.

- Monitoring results from confluence sites have revealed that most confluence sites, at one point, have had sharp increase in the concentration of measured analytes. These spikes are not always sustained over time and concentrations can vary considerably between sampling periods.
- In 2020, the Lewis MacAdams Park (LAR08599) and Arroyo Seco confluence (LALT 501) were monitored.
- The Arroyo Seco site had elevated hardness, compared to other confluence sites, in 2015, 2019, and 2020 and sulfate in 2019 and 2020. Conductivity and chloride at the Arroyo Seco site, however, were stable compared to previous years.
- The Arroyo Seco (LALT 501) and Lewis MacAdams Park (LAR08599) had nitrate and total nitrogen concentrations that were between 4 to 11 times greater than concentrations than other confluence sites, which are completely channelized.

- The Arroyo Seco and Lewis MacAdams park sites continue to score higher for riparian habitat condition, as assessed by CRAM, than the other confluence sites. Overall CRAM scores at the Lewis MacAdams park site, a soft-bottom portion of the river that was dredged in 2018, are stable. However, the hydrology attribute score did decrease significantly in 2020, a drop of 25 points compared to 2019. The CRAM score at the Arroyo Seco confluence (LALT501) improved significantly, an increase of 12 points since last assessed in 2014 due to better buffer landscape context and hydrology attribute scores.

- High value sites assessed for riparian habitat condition in 2020 included the Glendale Narrows (LALT400), Golden Shore Wetlands (LALT404), and Sepulveda Basin sites (LALT405). CRAM scores at these sites are more or less stable, they have varied by less than 7 points since they were previously sampled, and are still below the 10th percentile of the reference distribution.

Are receiving waters near discharges meeting water quality objectives?
Monitoring efforts assess the potential impacts of POTWs, or NPDES permitted point-source discharges, on the Los Angeles River and its tributaries and whether these discharges meet the Water Quality Objectives detailed by the Los Angeles Basin Plan. The monitoring program assesses common contaminants in wastewater effluent to determine whether effluents are impacting water quality. Results are summarized below.

Donald C. Tillman Water Reclamation Plant (DCTWRP)

- The statistical threshold value (STV) water quality objective of 320 MPN/100mL for REC-1 beneficial use was attained for approximately 90% of upstream samples and 95% of the downstream samples at DCTWRP during the 2020 sampling year.
- There were no exceedances of established ammonia WQO upstream or downstream of DCTWRP.
- Downstream concentrations of arsenic, zinc, lead, copper, zinc and cadmium were below both chronic and acute CTR criteria. Effluent from the DCTWRP does not contribute to metal exceedances downstream of the DCTWRP discharge.

Los Angeles Glendale Water Reclamation Plant (LAGWRP)

- Approximately 35% of the *E. coli* samples met the WQO at the upstream site, while approximately 80% of the samples met the WQO at the downstream site. *E. coli* concentrations are generally lower downstream of LAGWRP indicating a dilution effect as a result of the LAGWRP effluent.
- There were no exceedances of the NH_3-nitrogen WQO upstream or downstream of DCTWRP.
- Treated wastewater from LAGWRP is not causing elevated concentrations of metals downstream of discharge locations and metal concentrations are below regulatory objectives.

Burbank Water Reclamation Plant (BWRP)

- Approximately 25% of upstream samples met the WQO, compared to approximately 40% of the downstream samples. *E. coli* concentrations are lower downstream of the BWRP effluent.
- Metal concentrations were below the CTR chronic and acute standards for all metals, on all occasions.
- About 12% samples collected downstream of the BWRP during the 2020 year exceeded established ammonia-nitrogen WQO for the Burbank Channel.

Is it safe to recreate?

The LARWMP program monitors permitted and informal recreational sites, including kayak sites, in the watershed for *E. coli*. Monitoring occurs from Memorial Day to Labor day at informal sites and through September and permitted sites. Results are summarized below.

- During the summer of 2020, a total of 220 water samples were successfully collected from fourteen recreational swim sites popular with visitors and residents of the LA River watershed. This monitoring season was shortened due to b -19 related forest closures and fire.
- We found that the Tujunga Wash Site at Hansen Dam (LALT 214) exceeded the STV all four months of sampling, including 100% exceedance of samples during the second month of sampling. Bull Creek (LALT200) and Eaton Canyon (LALT204) exceeded the STV during two of the four months of sampling.
- Kayak sites were compared to the single sample LREC standard of 526 CFU/100 mL and we found that exceedances were generally low and infrequent across sites. The highest percentage of exceedances was 11% at the Upper Elysian Valley site (LALT218) followed by the Lower Sepulveda Basin site (LALT217) exceedance rate of 6%.
- The geometric mean is meant to capture persistently high FIB. We observed persistently high FIB at Bull Creek (LALT200) and Tujunga Wash at Hansen Dam (LALT214), each with 100% exceedance of the 6-week rolling geometric mean. With the exception of Switzer falls, which had a single exceedance of the 6-week geometric mean, all other swim sites did not exceed the REC-1 rolling average WQO.
- We found persistently high levels of bacteria, when compared to the 30-day geometric mean LREC-1 standard, at the Upper Elysian Valley (LALT218, 100% exceedance). The Middle Sepulveda Basin (LALT216) had 50% of samples exceed the geometric mean and the Lower Sepulveda Basin (LALT217) had 25% exceedance of collected samples.
- Trash assessments were also completed at recreation sites, with the exception of kayak sites. We found that plastic, biodegradable items, and biohazardous materials were the most common categories of trash types across all sites. Hansen Dam at the Tujunga Wash (LALT214) and Sturtevant Falls (LAUT210) were the recreation sites with the highest trash counts.

Are locally caught fish safe to eat?

The goal of this portion of the monitoring program is to improve our understanding of the health risks associated with consuming fish in water bodies popular among anglers. Fish tissue contaminant monitoring for 2020 revealed that common carp and channel catfish collected from Lake Balboa are all safe to eat at a consumption level of three 8-oz servings a week. OEHHA recommends eating smaller fish as they generally are younger and contain lower levels of contaminants. If consuming a larger fish, OEHHA suggests freezing and eating the fish in smaller portions and spaced out over time. They also recommend eating only the filet of the fish and avoiding the skin, organs, guts, and eggs.

Introduction

a. 1. Background: The Los Angeles River Watershed

The Los Angeles River watershed (Figure 1) is a highly urbanized watershed that encompasses western and central portions of Los Angeles County. Los Angeles River's headwaters originate in the Santa Monica, Santa Susana, and San Gabriel Mountains and bound the River to the north and west. The river terminates at the San Pedro Bay/Los Angeles and Long Beach Harbor complex, which is semi-enclosed by a 7.5-mile breakwater. The river's tidal prism/estuary begins in Long Beach at Willow Street and runs approximately three miles before joining with Queensway Bay.

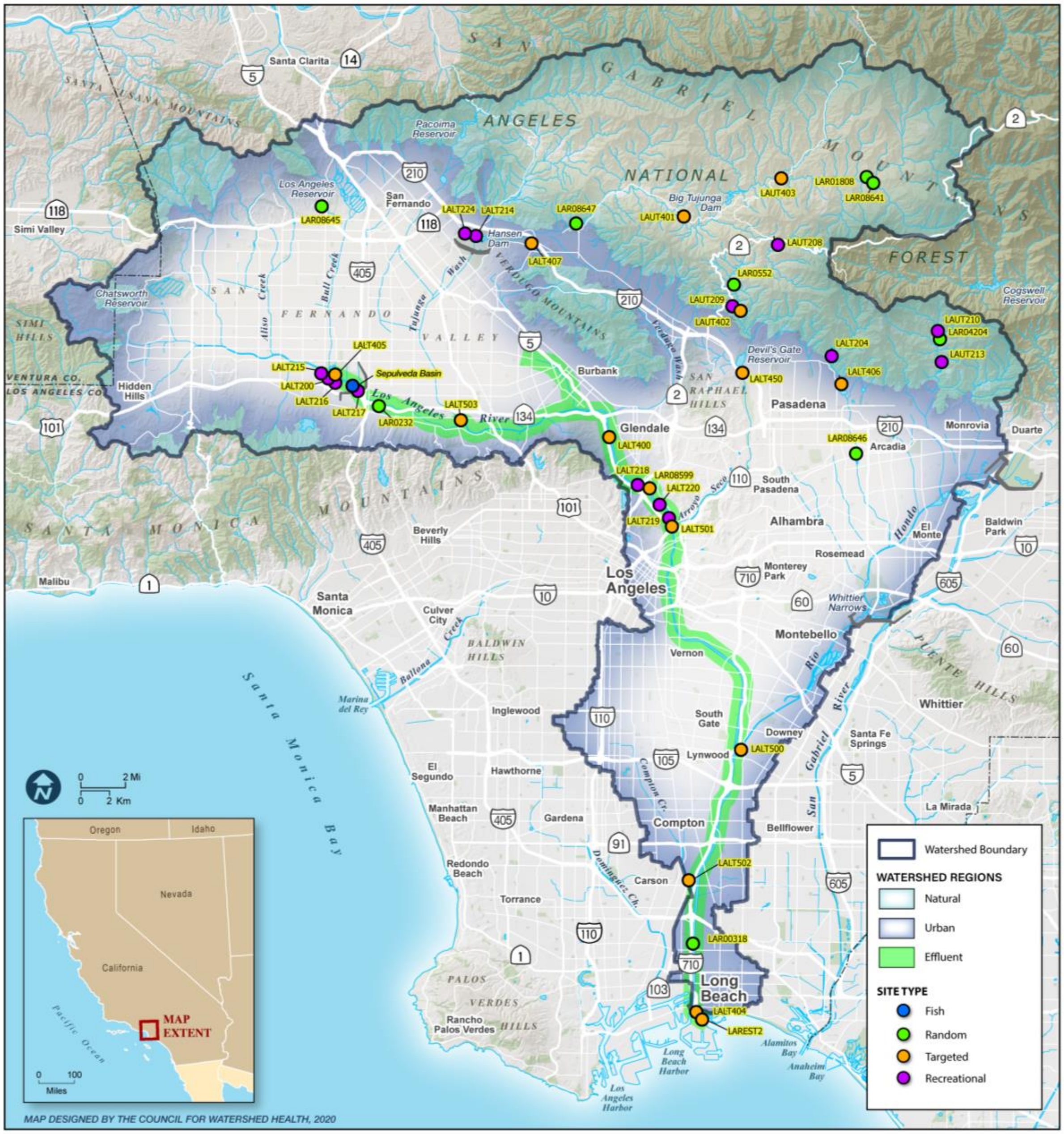

Figure 1. 2020 sampling sites in the Los Angeles River Watershed. Map include fish, random, targeted, recreational, and high-value sites. Note that targeted sites are sampled on a rotating basis. Not all targeted sites are sampled within a single year.

The 824 mi^2 of the Los Angeles River Watershed encompasses forests, natural streams, urban tributaries, residential neighborhoods, and industrial land uses. Approximately 324 mi^2 of the watershed is open space or forest, located mostly in the upper watershed. South of the mountains, the river flows through highly developed residential, commercial, and industrial areas. From the Arroyo Seco, north of downtown Los Angeles, to its confluence with the Rio Hondo, rail yards, freeways, and major commercial development border the river. South of the Rio Hondo, the river flows through industrial, residential, and commercial areas, including major refineries and storage facilities for petroleum products, major freeways, rail lines, and rail yards. While most of the river is lined with concrete, the unlined bottoms of the Sepulveda Flood

Control Basin, the Glendale Narrows, Compton Creek, and LA River estuary provide riparian habitat that enhances the ecological and recreational value of these areas.

b. 2. The Los Angeles River Watershed Monitoring Program (LARWMP)

In 2007, local, state, and federal stakeholders formed LARWMP, a collaborative monitoring effort shared by partnering agencies, permittees, and conservation organizations. Partners lend technical expertise, guidance, and support monitoring efforts and lab analysis through funding or in-kind services. The 2019 monitoring efforts for bioassessments, habitat assessment, bacteria testing, and fish tissue bioaccumulation, detailed in this report, were supported by five sampling teams, three laboratories, funding from the Cities of Los Angeles and Burbank, and the Los Angeles County Flood Control District (Table 1, Table 2, and Table 3).

Prior to the implementation of the LARWMP, the majority of monitoring efforts in the watershed were focused on point source NPDES compliance monitoring and little was known about the ambient condition of streams in the rest of the watershed. Recognizing this shortfall, the Los Angeles Water Quality Control Board (LAWQCB) negotiated with the NPDES permittees to reduce their sampling efforts at redundant sampling sites and to lower sampling frequencies in exchange for greater sampling coverage throughout the watershed. LARWMP's sampling design provides the ability to assess ambient condition throughout the watershed using probabilistically chosen sites and to track trends at fixed (target) sites (Table 4). The watershed-scale effort improves the cost effectiveness, standardization, and coordination of various monitoring efforts in the Los Angeles region. The LARWMP strives to be responsive to the River's evolving beneficial uses and impairments (Table 5, Table 6) and to provide managers and the public with a more complete picture of conditions and trends in the Los Angeles River watershed.

The objectives of the program are to develop a watershed-scale understanding of the condition (health) of surface waters using a monitoring framework that supports comprehensive and periodic assessments of sites along natural and urban streams, the main channel, estuarine habitats, and downstream of treatment works. The strategies of this program often mirror the activities of the larger region-wide monitoring program led by the Stormwater Monitoring Coalition (SMC). This report summarizes the monitoring activities and results for 2020. It is one of a series of annual monitoring reports produced for the Los Angeles River Watershed Monitoring Program (LARWMP) since 2008.

LARWMP is designed to answer the following five questions:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to recreate?
5. Are locally caught fish safe to eat?

Each year, the technical stakeholder group guides the implementation of the program to ensure efforts are responsive to the priorities of both the public and managers. Stakeholders also ensure that the program is consistent in both design and methodology with regional monitoring and assessment efforts.

A more complete description of LARWMP regional setting, motivating questions, its technical design, and its implementation approach can be found in the Los Angeles River Watershed Monitoring Program Monitoring Plan, Annual Reports, the 2018 State of the Watershed, and Quality Assurance Project Plans, which are posted on the project webpage: https://www.watershedhealth.org/reports.

Table 1. Sampling and laboratory analysis responsibilities for random and target sites for 2020.

Spring/Summer 2020 Sampling		Chemistry			Benthic Macroinvertebrates			Algae			CRAM	
	Site ID	sampling	lab analysis	funding	sampling	lab analysis	funding	sampling	lab analysis	funding	assessment	funding
Targeted Sample												
Confluence of Rio Hondo and mainstem of LA River	LALT500	-	-	-	-	-	-	-	-	-	-	-
Confluence of Arroyo Seco and mainstem of LA River	LALT501	ABC	EMD	Cities	Weston	Weston	LACDPW	-	-	-	ABC	Cities
Confluence of Compton Creek and mainstem of LA River	LALT502	-	-	-	-	-	-	-	-	-	-	-
Confluence of Tujunga Creek and mainstem of LA River	LALT503	-	-	-	-	-	-	-	-	-	-	-
Los Angeles River at Marsh Park	LAR08599	ABC	EMD	Cities	Weston	Weston	LACDPW	-	-	-	ABC	Cities
Random Samples												
Big Tujunga Creek (Natural)	LAR08655	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Los Angeles River (Effluent)	LAR08656	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Arroyo Seco (Urban)	LAR08658	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Los Angeles River (Effluent)	LAR08659	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Trend Revisit Sites												
Los Angeles River (Effluent)	LAR0232	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Arroyo Seco (Natural)	LAR0552	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Revisit Sites												
Los Angeles River (Urban)	LAR01208	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Big Tujunga Creek (Natural)	LAR06216	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Arroyo Seco (Natural)	LAR05020	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Big Tujunga (Natural)	LAR05640	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities

Table 2. Sampling and laboratory analysis responsibilities for bacteria monitoring in 2020.

Spring/Summer Sampling	Site ID	Microbiology sampling	Microbiology lab analysis	Microbiology funding
Swimming Sites				
Bull Creek Sepulveda Basin	LALT200	ABC	EMD	Cities
Eaton Canyon Natural Area Park	LALT204	CWH	EMD	Cities
LA-Glendale R7	LALT207	EMD	EMD	Cities
Hansen Dam at Tujunga Wash	LALT214	ABC	EMD	Cities
Hansen Dam	LALT224	ABC	EMD	Cities
Los Angeles River	LALT218	EMD	EMD	Cities
Los Angeles River	LALT219	EMD	EMD	Cities
Los Angeles River	LALT221	EMD	EMD	Cities
Oakwilde Campground or Switzer Falls/Campground	LAUT208	ABC	EMD	Cities
Gould Mesa Campground	LAUT209	ABC	EMD	Cities
Sturtevant Falls	LAUT210	CWH	EMD	Cities
Vogel Flats at Tujunga Creek	LAUT220	ABC	EMD	Cities

Table 3. Sampling and laboratory analysis responsibilities for fish tissue bioaccumulation monitoring.

Fish Tissue Bioaccumulaiton Sites	Site ID	Year	Bioaccumulation sampling	lab analysis	fundin g
Belvedere Lake	LALT310	2014	ABC/DFG	EMD	Cities
Debs Lake	LALT312	2015	ABC/DFG	EMD	Cities
Reseda Lake	LALT313	2015	ABC/DFG	EMD	Cities
Peck Road Park (Lake)	LALT302	2016	ABC/DFG	EMD	Cities
Balboa Lake	LALT301	2017, 2020	ABC/DFG	EMD	Cities
Echo Park (Lake)	LALT300	2018	ABC/DFG	EMD	Cities
Sepulveda Basin (River)	LALT314	2019	ABC/DFG	EMD	Cities

Table 4. Monitoring design, indicators, and sampling frequency.

Question	Approach	Sites	Indicators	Frequency
Q1: What is the condition of streams?	Probabalistic design with streams assigned to natural, effluent dominated, urban runoff dominated sub-regions	10 randomly selected each year including 4 new random sites, 4 random sites previously sampled and 2 random sites sampled annually.	Bioassessment using BMIs and attached algae, physical habitat, CRAM, water chemistry	Annually, in spring/summer
Q2: What is the trend of condition at unique areas?	Fixed target sites located to detect changes over time	9 high value habitat sites	Riparian habitat condition: CRAM	2 to 4 sites rotating annually in summer
		1 confluence sites to major tributaries/mainstem and 1 Los Angeles River site	Bioassessment, physical habitat, water chemistry	2 sites annually, in spring/summer
Q3: Are receiving waters below discharges meeting water quality objectives?	Use existing NPDES water quality data collected by LA River dischargers from receiving waters upstream and downstream of their discharge points.	Sites located upstream and downstream of discharges: - Los Angeles/Glendale - City of Burbank - Tillman Water Reclamation Plant	Constituents with established water quality standards, e.g. CTR for dissolved metals; *e. coli* bacteria; trihalomethane(s)	Varies depending on permit: monthly, quarterly, annual
Q4: Is it safe to swim?	Swim sites selected based on use by the public	11 sites located in ponds, reservoirs, streams and LA River	*E. coli*	Weekly May to September
Q5: Is it safe to eat locally caught fish?	Focus on popular fishing sites; commonly caught species; measuring high-risk chemicals	1 to 2 sites located in streams, reservoirs, lakes, rivers and estuary	Measure mercury, selenium, DDT and PCB in commonly caught fish at each location	Annually in summer

[1] High-value sites are locations of interest to the TSG or relatively isolated, unique habitat

Table 5. Impairments (303d listed) along the main stem of the Los Angeles River by reach (select constituents).

Reach	Reach Segment	Ammonia	Benthic Community	Copper	Lead	Nutrients (algae)	Cadmium	Indicator Bacteria	Zinc	pH	Selenium	Toxicity	Trash
LA River Estuary	Queensway Bay												
LA River Reach 1	Estuary to Carson St.												
LA River Reach 2	Carson to Figueroa St.												
LA River Reach 3	Figueroa St. to Riverside Dr.												
LA River Reach 4	Sepulveda Dr. to Sepulveda Basin												
LA River Reach 5	Sepulveda Basin												
LA River Reach 6	Above Sepulveda Basin												

Table 6. Select beneficial uses of the main stem of the Los Angeles River. Note that * denote reaches where access is prohibited by LA County Department of Public Works. Only limited contact activities, such as fishing and kayaking, are allowed in the Recreation Zone (Reach 3 and 5).[1]

Reach	Reach Segment	IND	GWR	NAV	COMM	WARM	EST	MAR	WILD	RARE	MIGR	SPWN	WET	REC1	REC2
LA River Estuary	Queensway Bay														
LA River Reach 1	Estuary to Carson St.													*	
LA River Reach 2	Carson to Figueroa St.													*	
LA River Reach 3	Figueroa St. to Riverside Dr.														
LA River Reach 4	Sepulveda Dr. to Sepulveda Basin														
LA River Reach 5	Sepulveda Basin														
LA River Reach 6	Above Sepulveda Basin														

[1] Beneficial uses include: IND = Inland ; GWR = Groundwater ; NAV = Navigation ; COMM = Commercial and Sport Fishing; WARM = Warm Freshwater Habitat, EST = Estuarine Habitat, MAR = Marine Habitat; WILD = Wildlife Habitat , RARE = Rare, Threatened, and Endangered, MIGR = Migration, SPWN = Spawn, Reproduction, and Early Development, WET = Wetland Habitat , REC1 = Water Contact Recreation, REC2 = Non-Contact Recreation

Question 1. What is the condition of streams in the Los Angeles River Watershed?

1. Background

To determine the condition of streams in the Los Angeles River watershed, data were collected at 88 random sites during 12 annual surveys from 2009 through 2020 (Figure 2). Sites are selected randomly to facilitate drawing statistically valid inferences about an area as a whole, rather than about just the site itself. Spatially, these sites are representative of three major sub-regions: natural streams in the upper reaches of both the mainstem and tributaries (i.e., natural sites); effluent-dominated reaches in the mainstem and the lower portions of the estuary (i.e., effluent dominated sites); and urban runoff-dominated reaches of tributaries flowing through developed portions of the watershed (i.e., urban sites).

Ambient surveys, which include both physical habitat assessments and bioassessments, can help identify and prioritize sites for protection or rehabilitation based on how sites compare to other regional sites. This type of data provides a measure of ecological health to help better understand whether streams support aquatic life and assigned beneficial uses. Biological communities at stream sites respond to, and integrate, multiple stressors across both space and time, which improves our understanding of the impact of stressors on stream communities (Mazor 2015).

In 2014, the Technical Stakeholder Group (TSG) agreed to modify the LARWMP sampling design based on design changes made by the Southern California Stormwater Monitoring Coalitions (SMC) Regional Monitoring Program. This design modification was made to help improve our ability to detect changing conditions not only in the Los Angeles watershed, but in the Southern California region as a whole. The design incorporates site revisits at random sites previously sampled by the SMC program. In addition, the program began to re-visit sites previously sampled through the LARWMP program, contributing more information that can help us detect changing conditions in the Los Angeles watershed. One random site known to be a non-perennial stream was also added to the program to help address a regional gap in assessment of non-perennial streams, which make up 25% of stream miles in the watershed (SMC, 2015).

Figure 2. Location of random sites sampled from 2009 to 2020.

2. *Methods*

LARWMP employed benthic macroinvertebrates (BMIs), California Stream Condition Index (CSCI), Southern California Algae Index (So Ca Algal IBI), and California Rapid Assessment Methods (CRAM) to assess biotic condition. A complete list of biotic condition indicators and water chemistry analytes collected for this program, including methods, units, and detection limits can be found in Appendix C, Table C1.

a. *Benthic Macroinvertebrates and Attached Algae*

The field protocols and assessment procedures for BMIs and attached algae followed the protocols described by Ode *et al.* (2016). Briefly, BMIs were collected using a D kick-net from eleven equidistant transects along a 150-m reach and were identified to Level 2 (generally genus) as specified by the Southwest Association of Freshwater Invertebrate Taxonomists, Standard Taxonomic Effort List (SAFIT; Richards and Rogers 2006). Algal samples were collected one meter upstream of where BMI samples were collected.

b. *California Stream Condition Index*

The California Stream Condition Index (CSCI) was used to assess the BMI community condition. The CSCI is a statewide biological scoring tool that translates complex data about benthic macroinvertebrates (BMIs) found living in a stream into an overall measure of stream health (Mazor *et al*. 2015). The CSCI incorporates two indices, the multi-metric index, helpful in understanding ecological structure and function, and the observed-to-expected (O/E) index, which measures taxonomic completeness (Rehn *et al.* 2015). The CSCI was developed with a large data set spanning a wide range of environmental settings. Scores from nearly 2,000 study reaches sampled across California range from about 0.1 to 1.4 (Mazor *et al.,* 2015). For the purposes of making statewide assessments, three thresholds were established based on 30th, 10th, and 1st percentile of CSCI scoring range at reference sites according to Rhen (2015) (Figure 3). These three thresholds divide the CSCI scoring range into 4 categories of biological condition as follows: ≥0.92 = likely intact condition; 0.91 to 0.80 = possibly altered condition; 0.79 to 0.63 = likely altered condition; ≤0.62 = very likely altered condition. While these ranges do not represent regulatory thresholds, they provide a useful framework for interpreting CSCI results.

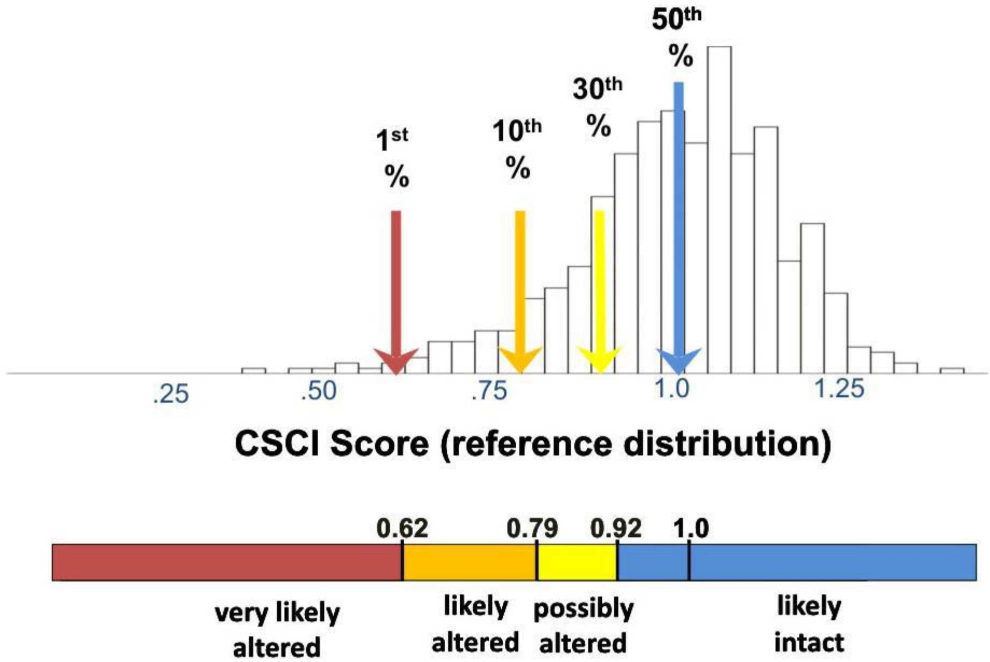

Figure 3. Distribution of CSCI scores at CA reference sites with thresholds and condition categories (Rhen et al., 2015).

c. The Algal Stream Condition Index

The Algal Stream Condition Index (ASCI) uses a multiple line of evidence approach to understand stream condition. Unlike the SoCal Algal IBI, previously reported on by the LARWMP program, the ASCI can be applied statewide. The metric is a compliment to the CSCI multi-metric index for BMI. Algae are useful indicators of stream condition because they are sensitive to water quality conditions, particularly nutrients, and can respond to management actions in locations where BMI are less useful (e.g. engineered channels) (Theroux et al., 2020). Like the CSCI, the ASCI captures the likelihood of biological degradation by comparing scores to the 1st, 10th, and 30th percentile of scores at reference sites located throughout the state. The performance of indices based on soft algae, diatoms, and hybrid of both assemblages have been tested for responsiveness, accuracy, and precision. Multi-metric indices based on diatoms and a hybrid assemblage have been found to be the best performing (Theroux et al., 2020).

d. California Rapid Assessment

Riparian wetland condition was assessed using the California Rapid Assessment Method (CRAM; Collins et al. 2008), a method developed by the USEPA and modified by SWAMP for use in California (Fetscher and McLaughlin 2008). The method was developed to allow evaluation of statewide investments in restoring, protecting, and managing wetlands. Briefly, the CRAM method assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. Each of these attributes is comprised of several metrics and sub-metrics that are evaluated in the field for a prescribed assessment area. The CRAM metrics are ecologically meaningful and reflect the relationship between stress and the high priority functions and ecological services of wetlands. The greater the CRAM score, the better the biotic, physical, hydrologic, and buffer zone condition of the habitat. Streams in reference condition are expected to have a CRAM score ≥72 (Mazor 2015). In addition, since CRAM scores provide insight into a stream's physical condition, they are often used as a surrogate for abiotic stress.

e. Physical Habitat

Physical habitat assessments were completed in conjunction with algal and benthic macroinvertebrate assessments to aid in the interpretation of biological data. Human alteration and the instream and topographical features that result in adverse impacts to habitat quality and structure are important factors that shape aquatic communities (Barbour *et al*., 1999). Briefly, the same 11 equidistant transects that were used for the collection of BMI and algal samples were used in the assessment of wetted width, bank stability, discharge, substrate, canopy cover, flow habitats, bank dimensions, human influence, depth, algal cover, and cobble embeddedness. Ten inter-transects, at the mid-point of the 11 transects used for sample collection, were also used to collect information related to wetted width, flow habitats, and pebble counts. All physical habitat assessments were completed as specified by Ode *et al.* (2016).

f. Aquatic Chemistry

Nutrients, total metals, major ions, and general chemistry analytes (pH, dissolved oxygen, suspended solids, alkalinity, and hardness) were monitored at each site. Data was collected in-situ through the use of digital field probes that were deployed by field crews or via grab sample and lab analysis. Measured analytes and methods are described in Appendix C – Analyte List, Detection Limits and Methods.

g. Trash Assessments

Trash assessments began in 2018 at random sites using the SMC developed riverine quantitative tally method as reviewed in the trash monitoring playbook (Moore et al., 2020). Trash items are tallied under broad categories of trash types (e.g. paper, plastic, cloth and fabric) into more detailed trash types (e.g. foam pieces, plastic bag pieces). A 30 meter stretch of each random site was visually assessed. The assessment area spans the thalweg to the bankfull width. The assessment also makes note of storm drain and homeless encampments within the assessment area (Moore *et al.,* 2020).

h. Data Analysis

The R statistical software (version 4.0.5, R Core Team, 2020) and excel were used for the majority of graphing and data analysis.

- Correlation analysis were completed to detect statistically significant positive or negative trends ($p<0.05$) at individual revisit sites based on CSCI and CRAM scores.
- To better understand changes in ambient stream condition across each sub-region, we aggregated random sites into 3 time periods, 2009-2012, 2013-2016, 2017-2020. Aggregation of sites helped increase the sample size within each sub-region. Scores were averaged for each time period and within each sub-region and graphed with error bars that denote 95% confidence intervals. Revisit and annual revisit sites were removed from regional analysis because these sites would be over-represented in the averages for each sub-region, since they were measured more frequently than other sites.

3. Results

a. Biotic Condition

A pattern of better biotic conditions is consistently seen in CSCI, ASCI, and CRAM, as demonstrated by higher scores, in the natural regions of the watershed compared to the effluent dominated and urban reaches (Figure 4,

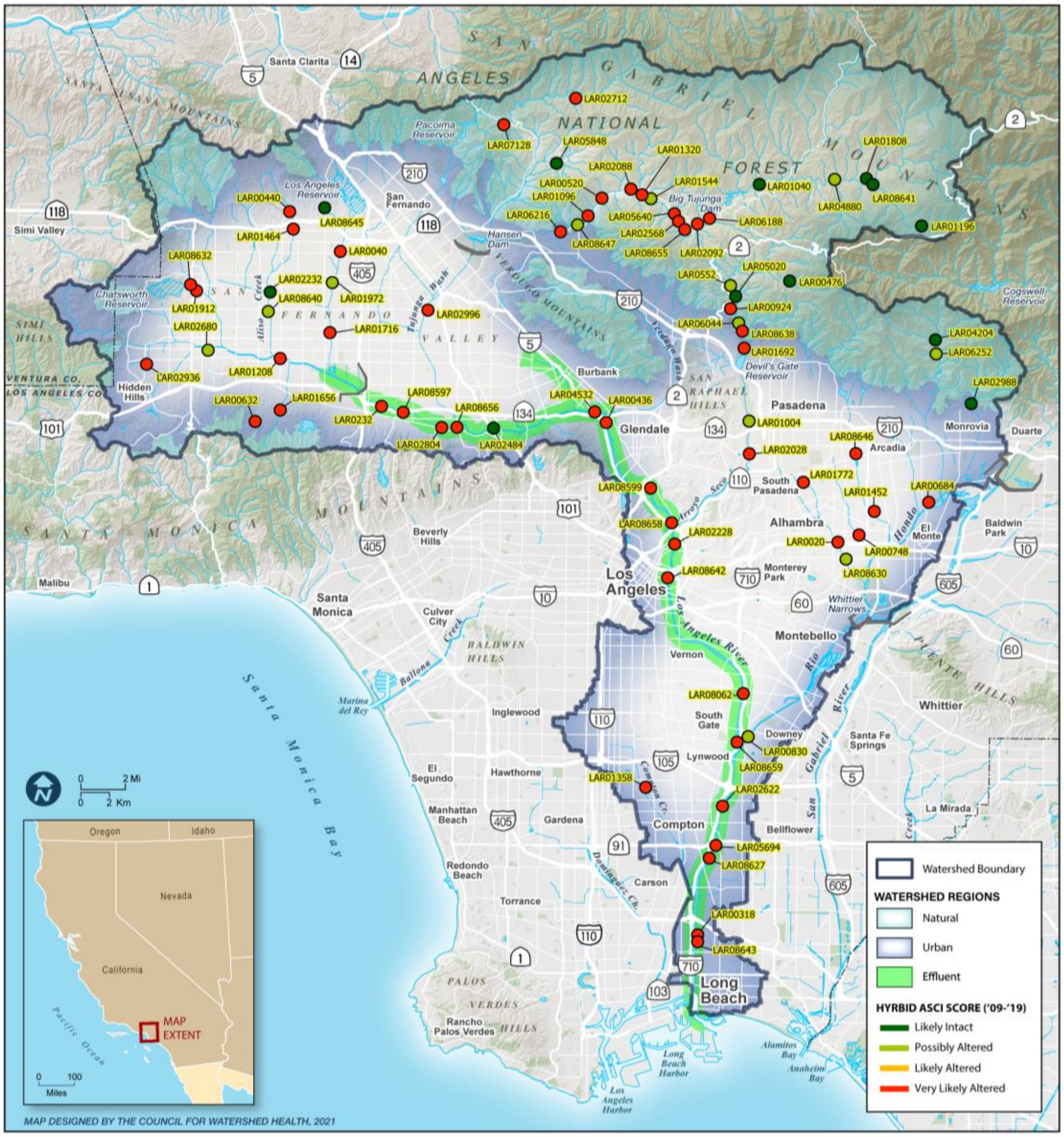

Figure 5, Figure 6, Figure 7). The differences in stream condition categorization between the ASCI hybrid and diatom scores are small across the watershed but can be seen in a handful of urban (LAR02232, LAR08640) and several natural sites (LAR02712, among others) (Figure 5, Figure 6). Compared to CSCI, less of the streams in the upper watershed are in the higher scoring "possibly altered" or "likely intact" categories based on ASCI (Figure 4, Figure 5, Figure 6).

The cumulative frequency distribution for the biotic condition index scores provides insight into the percentage of streams that are in reference and non-reference condition according to three different indicators of ecological health (Figure 8). In the Los Angeles River watershed, the majority of sites are not in reference condition and have altered biological condition. Over the 2009-2020 monitoring period, approximately 60% of all random sites were altered or were below reference condition for benthic macroinvertebrate communities (CSCI scores). In addition, riparian zone habitat condition (CRAM) were altered or were below reference thresholds at roughly 65% of sites, while for algal communities (ASCI - Hybrid) approximately 80% of sites were altered or below reference thresholds.

Summary results for all biotic condition measurements and water quality analytes by watershed sub-region are presented in Table 7. The CSCI scores across sites ranged from 0.21 to 1.35, with greater average and median CSCI scores found at the natural sites compared to the urban and effluent-dominated sites (Table 7, Figure 9). The CSCI scores from 2009-2020 range from 0.65 to 1.35 at natural sites, 0.35 to 0.74 at effluent dominated sites, and 0.21 to 0.80 for urban sites, showing the wide variability in benthic macroinvertebrate community condition within natural and urban regions (Table 7).

The CSCI incorporates two indices, the multi-metric index, which is helpful in understanding ecological structure and function, and the observed-to-expected (O/E) index, which measures taxonomic completeness. For the O/E index, site degradation is reflected by a loss of expected taxa resulting in a lower O/E score. Effluent-dominated and urban sites had lower O/E scores, on average, than natural sites, reflecting the poor condition of benthic macroinvertebrates and taxa loss at sites in areas that are heavily urbanized (Figure 9).

ASCI scores mirrored other biotic indicators, showing higher median scores for the natural sites than effluent-dominated and urban sites (Figure 9). The soft algae based ASCI scores do not separate effluent, natural, and urban regions into altered or likely altered categories. While diatoms and the hybrid-based approach perform better in separating the subregions. Ultimately, sites within each sub-region cluster together more closely using the diatom-based ASCI scores. Ash free dry mass, a measure of organic matter, was similar across all sub-regions but chlorophyll a was higher at effluent-dominated and urban sites (Figure 10). Algal growth is encouraged by environmental conditions, such as nutrients, warm temperatures, and sunlight. These conditions are found in urban and effluent dominated regions due to reduced canopy cover and increased nutrient inputs (Table 7). However, natural sites generally have more organic material than urban or channelized streams and may be indicative of organic matter export from upstream or lateral sources.

The CRAM results underscore the contrast between the highly urbanized lower watershed and the relatively natural conditions found in the upper watershed (Figure 9). Each CRAM score is composed of four individual attribute scores that define riparian habitat condition. They include buffer zone, hydrology, and physical and biotic structure (Figure 9). Natural sites were characterized by wide, undisturbed buffer zones, good hydrologic connectivity, and a multilayer, interspersed vegetative canopy composed of native species. In contrast, the urban and effluent-dominant sites often had no buffer zones, highly modified concrete-lined channels and lacked vegetative cover. Intermediate to these extremes are the effluent dominated, soft-bottom sites like the Glendale Narrows and Sepulveda Basin. These sites tended to have higher attribute scores for buffer and biotic condition, though overall habitat condition scores were still in the likely altered category.

Development in the lower watershed has virtually eliminated natural streambed habitat and adjacent buffer zones and altered stream hydrology. In most cases, the natural riparian vegetation has either been eliminated or replaced by invasive or exotic species. These conditions have led to lower habitat condition scores.

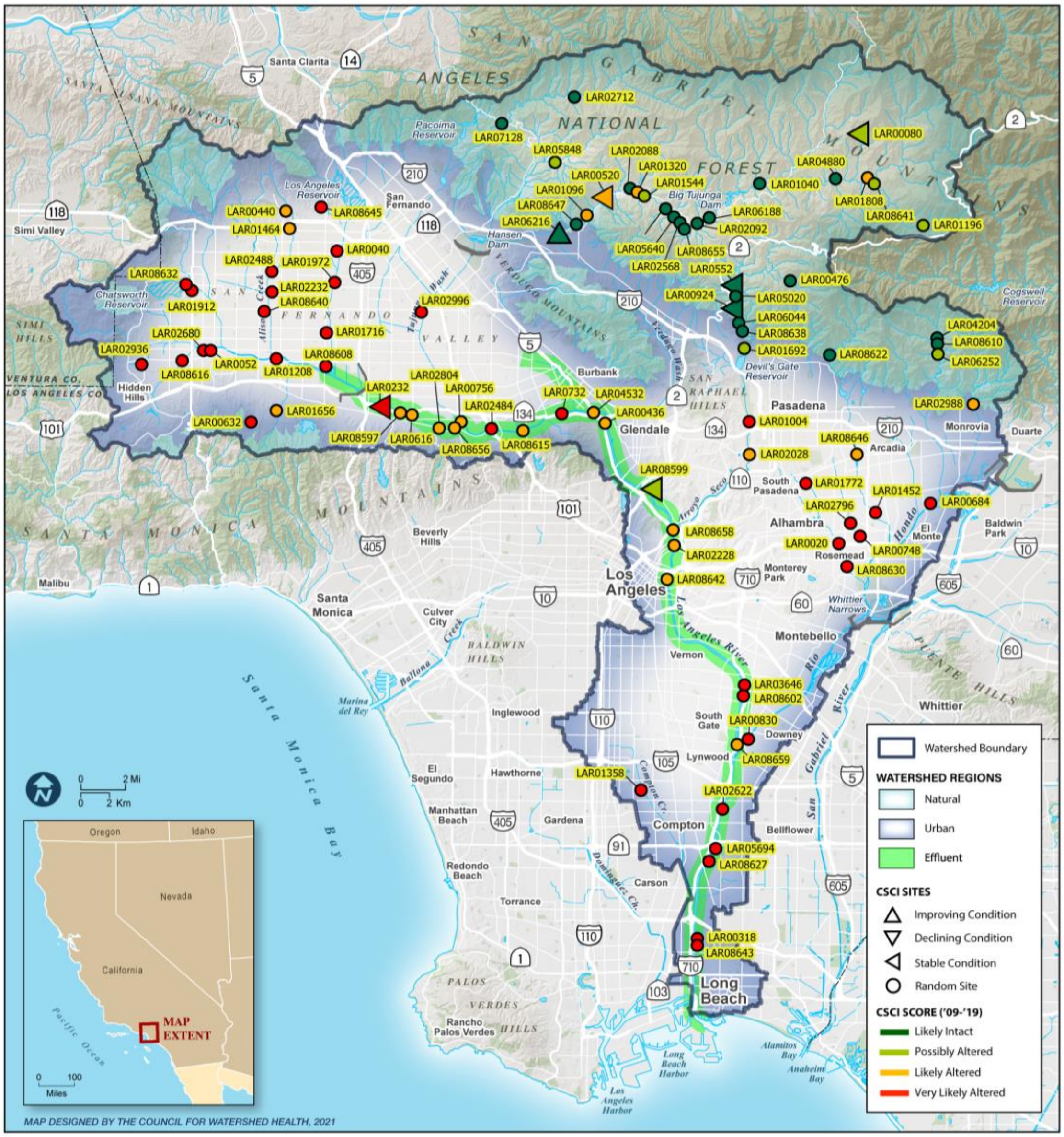

Figure 4. CSCI scores based on probabilistic sites sampled from 2009 to 2020. Likely intact condition = CSCI ≥0.92; possibly altered condition = CSCI 0.91 to 0.80; likely altered condition = CSCI 0.79 to 0.63; very likely altered condition = CSCI ≤0.62. The trend at sites with 3 or more revisits are also symbolized with the direction of each triangle depicting positive, negative, or stable trends.

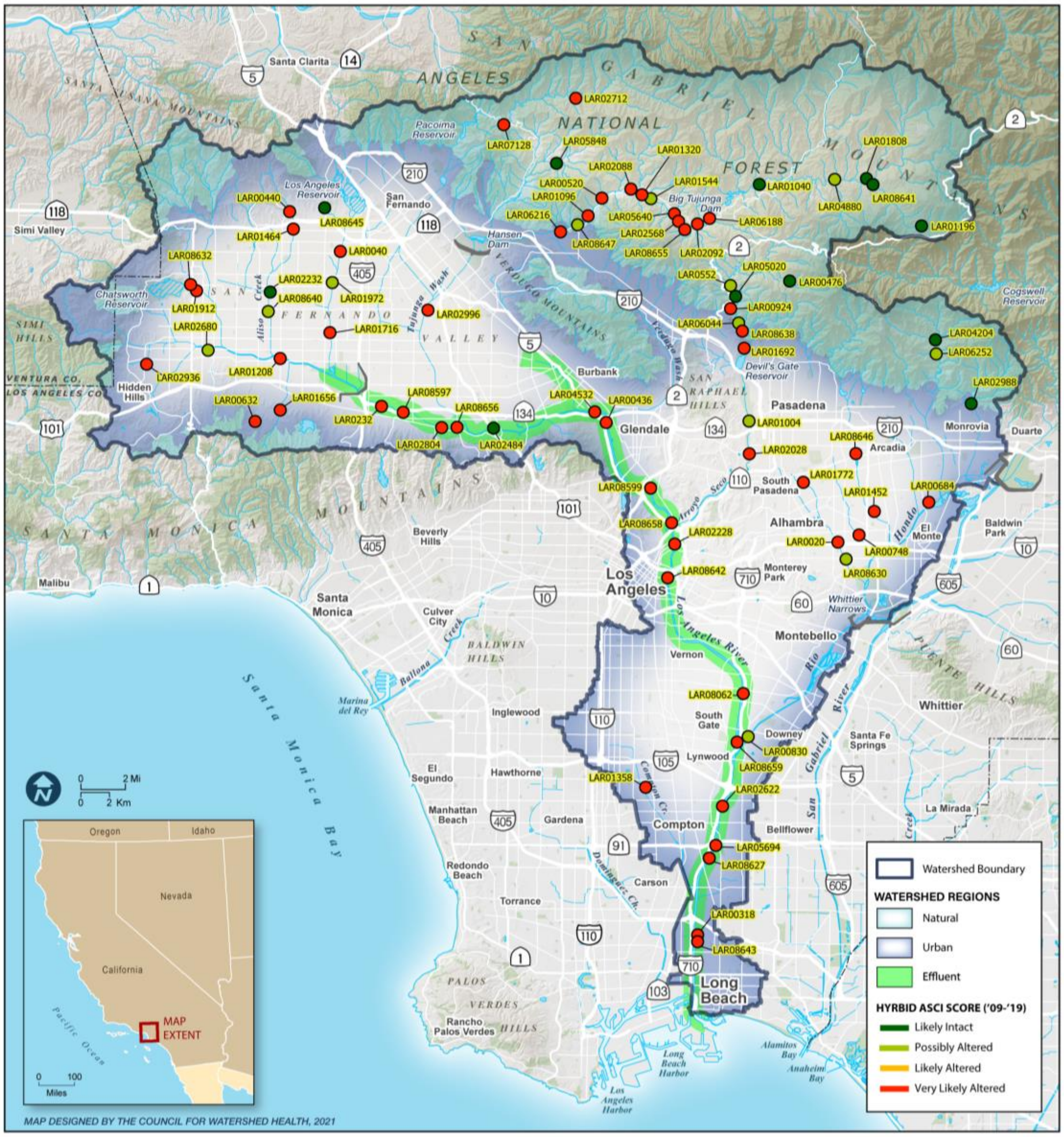

Figure 5. ASCI hybrid scores for LARWMP probabilistic sites sampled from 2009 to 2020. Likely intact condition = ASCI ≥0.94; possibly altered condition = ASCI 0.93 to 0.86; likely altered condition = ASCI 0.86 to 0.75; very likely altered condition = ASCI ≤0.74.

Figure 6. ASCI diatom scores for LARWMP probabilistic sites sampled from 2009 to 2020. Likely intact condition = ASCI ≥0.94; possibly altered condition = ASCI 0.93 to 0.86; likely altered condition = ASCI 0.86 to 0.75; very likely altered condition = ASCI ≤ 0.74.

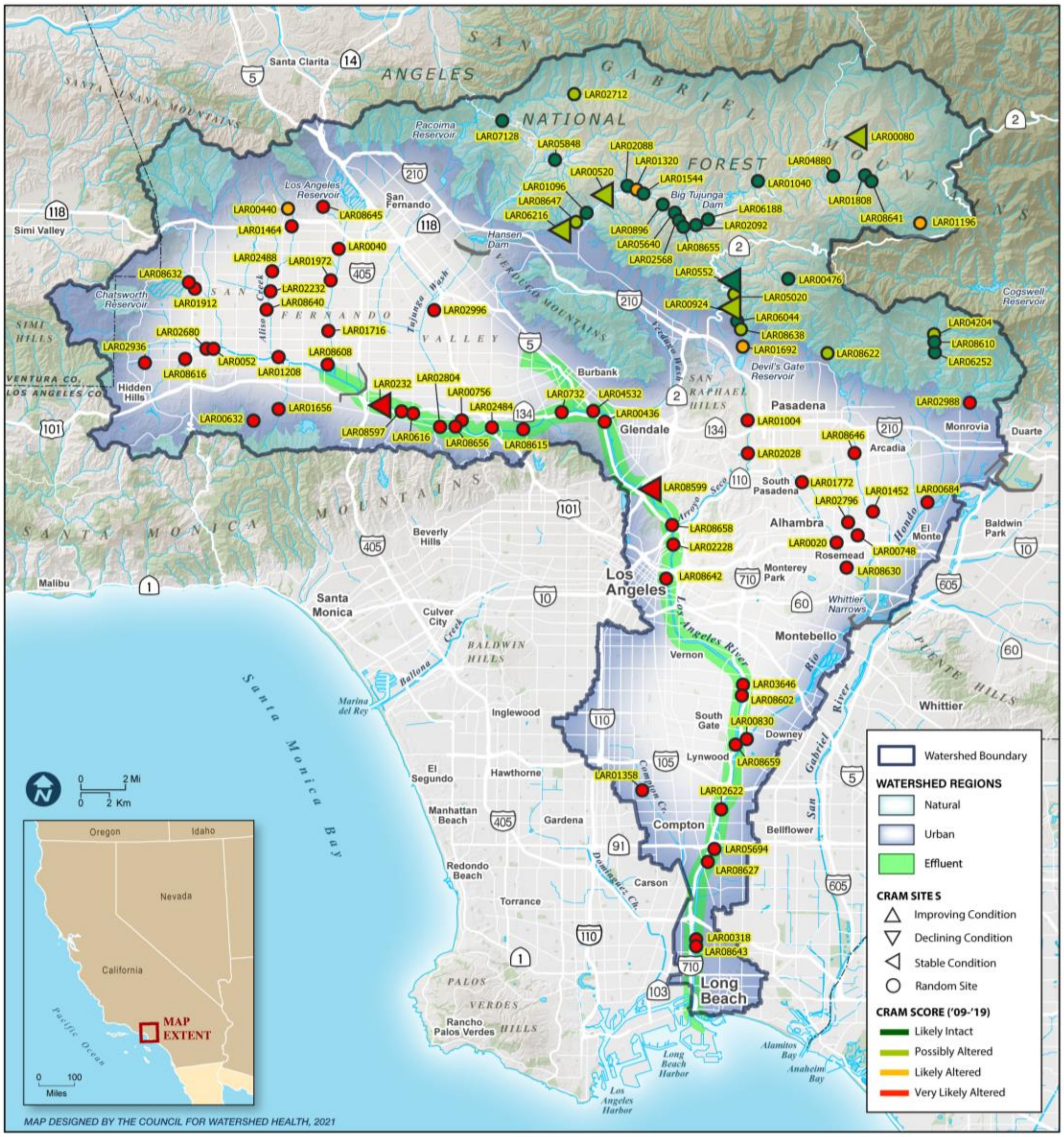

Figure 7. CRAM scores based on probabilistic sites sampled from 2009 to 2019. Likely intact condition = CRAM ≥79; possibly altered condition = CRAM 79 to 72; likely altered condition = CRAM 72 to 63; very likely altered condition = CRAM ≤63. Sites with 3 visits or more were examined for trends and are symbolized using triangles.

Table 7. Summary statistics for biotic conditions and water quality analytes at all random sites combined, collected from 2009 to 2020.

	Watershed				Urban				Effluent				Natural			
Analyte	n=	Mean ± Stdev	min	max	n=	Mean ± Stdev	min	max	n=	Mean ± Stdev	min	max	n=	Mean ± Stdev	min	max
Biological Condition																
Benthic Macroinvertebrates (CSCI)	125	0.73 ± 0.26	0.21	1.35	40	0.50 ± 0.15	0.21	0.80	28	0.60 ± 0.13	0.35	0.74	57	0.96 ± 0.14	0.65	1.35
MMI	125	0.66 ± 0.26	0.18	1.43	40	0.45 ± 0.12	0.23	0.69	28	0.49 ± 0.13	0.19	0.65	57	0.89 ± 0.17	0.58	1.43
O/E	125	0.80 ± 0.28	0.12	1.32	40	0.54 ± 0.22	0.12	0.99	28	0.71 ± 0.15	0.45	0.89	57	1.04 ± 0.16	0.71	1.32
Attached Algae																
ASCI Hybrid	105	0.67 ± 0.19	0.29	1.14	32	0.67 ± 0.18	0.35	1.14	23	0.47 ± 0.11	0.29	0.71	50	0.76 ± 0.17	0.41	1.14
ASCI Diatom	105	0.64 ± 0.20	0.25	1.08	32	0.64 ± 0.16	0.35	0.97	23	0.43 ± 0.10	0.25	0.68	50	0.75 ± 0.17	0.38	1.08
ASCI Soft Algae	106	0.82 ± 0.19	0.00	1.26	33	0.80 ± 0.15	0.31	1.07	23	0.74 ± 0.10	0.43	0.86	50	0.88 ± 0.23	0.00	1.26
So CA D18	105	49 ± 25	4	100	32	39 ± 22	6	92	23	28 ± 19	4	62	50	66 ± 17	26	100
So CA H20	104	44 ± 21	8	95	32	35 ± 16	11	80	23	25 ± 14	9	54	49	60 ± 14	32	95
So CA S2	105	43 ± 20	7	100	33	36 ± 16	7	75	23	28 ± 10	17	48	49	54 ± 19	17	100
Riparian Habitat (CRAM)	123	56 ± 21	27	99	40	39 ± 9	27	67	28	38 ± 5	27	53	55	79 ± 7	63	99
BioticStructure	123	48 ± 24	22	97	40	30 ± 12	22	69	28	28 ± 6	22	50	55	71 ± 15	39	97
BufferLandscape	123	74 ± 19	25	100	40	59 ± 14	25	88	28	62 ± 11	25	68	55	92 ± 5	75	100
Hydrology	123	57 ± 25	25	100	40	37 ± 10	25	58	28	35 ± 8	25	58	55	83 ± 10	58	100
PhysicalStructure	123	46 ± 24	25	100	40	28 ± 10	25	75	28	25 ± 2	25	38	55	69 ± 15	38	100
InSitu Measurements																
Temperature (C°)	124	21.22 ± 5.61	10.97	36.69	40	24.58 ± 6.23	13.84	36.69	28	23.68 ± 4.33	16.30	32.80	56	17.59 ± 3.00	10.97	25.03
Dissolved Oxygen (mg/L)	125	9.25 ± 2.36	3.72	17.45	40	10.23 ± 2.84	5.30	16.81	28	10.02 ± 2.75	3.72	17.45	57	8.19 ± 0.99	5.46	10.48
pH	125	8.31 ± 0.68	6.99	10.80	40	8.76 ± 0.86	7.34	10.80	28	8.41 ± 0.44	7.42	9.15	57	7.94 ± 0.35	6.99	8.51
Salinity (ppt)	124	0.45 ± 0.34	0.13	1.93	40	0.71 ± 0.47	0.14	1.93	27	0.51 ± 0.07	0.32	0.60	57	0.24 ± 0.06	0.13	0.37
SpecificConductivity (us/cm)	125	886 ± 630	8	3681	40	1367 ± 863	8	3681	28	1026 ± 107	736	1154	57	480 ± 116	245	762
General Chemistry																
Alkalinity as CaCO3 (mg/L)	125	221 ± 392	40	4520	40	289 ± 690	40	4520	28	137 ± 25	93	206	57	214 ± 38	119	276
Hardness as CaCO3 (mg/L)	119	301 ± 295	94	2540	38	480 ± 474	94	2540	28	235 ± 50	166	368	53	208 ± 45	96	370
Chloride (mg/L)	120	90 ± 97	5	554	39	165 ± 114	11	554	28	138 ± 17	109	163	53	10 ± 3	5	18
Sulfate (mg/L)	120	163 ± 298	3	2360	39	344 ± 465	17	2360	28	168 ± 36	123	302	53	28 ± 24	3	135
TSS (mg/L)	108	39 ± 148	0	1330	33	98 ± 257	2	1330	26	30 ± 42	6	218	49	4 ± 5	0	26
Nurtients																
Ammonia as N (mg/L)	125	0.17 ± 0.89	0.03	9.95	40	0.34 ± 1.57	0.03	9.95	28	0.16 ± 0.15	0.03	0.63	57	0.05 ± 0.06	0.03	0.40
Nitrate as N (mg/L)	125	1.29 ± 1.83	0.01	6.48	40	1.33 ± 1.70	0.01	6.48	28	3.72 ± 1.41	0.98	5.87	57	0.07 ± 0.10	0.01	0.53
Nitrite as N (mg/L)	125	0.03 ± 0.06	0.01	0.41	40	0.02 ± 0.04	0.01	0.20	28	0.07 ± 0.11	0.01	0.41	57	0.01 ± 0.00	0.01	0.01
NitrogenTotal (mg/L)	125	3.29 ± 4.71	0.00	38.84	40	5.44 ± 6.82	0.23	38.84	28	5.93 ± 1.50	2.71	8.41	57	0.49 ± 0.93	0.00	6.46
OrthoPhosphate as P (mg/L)	125	0.10 ± 0.14	0.01	1.06	40	0.13 ± 0.15	0.01	0.77	28	0.11 ± 0.11	0.02	0.48	57	0.07 ± 0.14	0.03	1.06
Phosphorus as P (mg/L)	125	0.22 ± 0.30	0.01	2.19	40	0.37 ± 0.43	0.01	2.19	28	0.24 ± 0.16	0.10	0.77	57	0.10 ± 0.17	0.01	1.33
Dissolved Organic Carbon (mg/L)	123	6.58 ± 6.14	1.20	37.62	40	11.03 ± 8.81	1.49	37.62	28	7.07 ± 0.76	5.55	9.08	55	3.10 ± 1.36	1.20	6.87
Total Organic Carbon (mg/L)	123	8.16 ± 11.19	0.18	102.22	40	12.40 ± 10.39	1.63	42.00	28	7.89 ± 1.22	6.48	11.20	55	5.21 ± 13.49	0.18	102.22
Algal Biomass																
AFDM (mg/cm ^{2})	106	5.4 ± 12.8	0.1	113.4	33	6.4 ± 11.4	0.2	48.2	23	7.9 ± 23.2	0.1	113.4	50	3.5 ± 4.5	0.2	26.6
Chl-a (ug/cm 2)	106	6.2 ± 6.7	0.4	37.0	33	6.9 ± 6.9	0.4	34.0	23	10.0 ± 8.8	0.5	37.0	50	3.9 ± 4.3	0.4	25.0
Dissolved Metals																
Arsenic (ug/L)	87	1.7 ± 1.3	0.0	6.5	31	2.3 ± 1.3	0.1	6.5	17	1.7 ± 0.8	0.3	3.5	39	1.3 ± 1.3	0.0	5.4
Cadmium (ug/L)	91	0.1 ± 0.1	0.0	0.4	33	0.1 ± 0.1	0.0	0.3	17	0.2 ± 0.1	0.0	0.4	41	0.0 ± 0.1	0.0	0.4
Chromium (ug/L)	89	1.3 ± 1.4	0.1	7.5	31	1.7 ± 1.6	0.2	7.5	17	1.0 ± 0.6	0.4	2.5	41	1.1 ± 1.3	0.1	7.3
Copper (ug/L)	91	5.8 ± 6.6	0.0	30.6	33	10.8 ± 8.2	0.6	30.6	17	6.9 ± 2.7	1.5	13.1	41	1.4 ± 0.7	0.0	3.1
Iron (ug/L)	91	149 ± 959	3	9180	33	57 ± 63	3	253	17	32 ± 35	10	156	41	271 ± 1427	3	9180
Lead (ug/L)	91	0.2 ± 0.2	0.0	1.3	33	0.3 ± 0.3	0.0	1.3	17	0.3 ± 0.1	0.1	0.5	41	0.1 ± 0.0	0.0	0.2
Mercury (ug/L)	91	0.0 ± 0.0	0.0	0.0	33	0.0 ± 0.0	0.0	0.0	17	0.0 ± 0.0	0.0	0.0	41	0.0 ± 0.0	0.0	0.0
Nickel (ug/L)	91	4.3 ± 9.6	0.4	78.0	33	7.7 ± 15.3	0.7	78.0	17	4.6 ± 1.6	1.7	7.8	41	1.3 ± 0.9	0.4	4.2
Selenium (ug/L)	91	1.0 ± 1.8	0.1	11.5	33	2.0 ± 2.7	0.1	11.5	17	1.2 ± 0.4	0.2	1.8	41	0.2 ± 0.1	0.1	0.7
Zinc (ug/L)	91	10.0 ± 11.6	0.5	47.6	33	8.0 ± 5.8	1.5	21.5	17	30.4 ± 10.2	8.4	47.6	41	3.1 ± 2.5	0.5	13.2

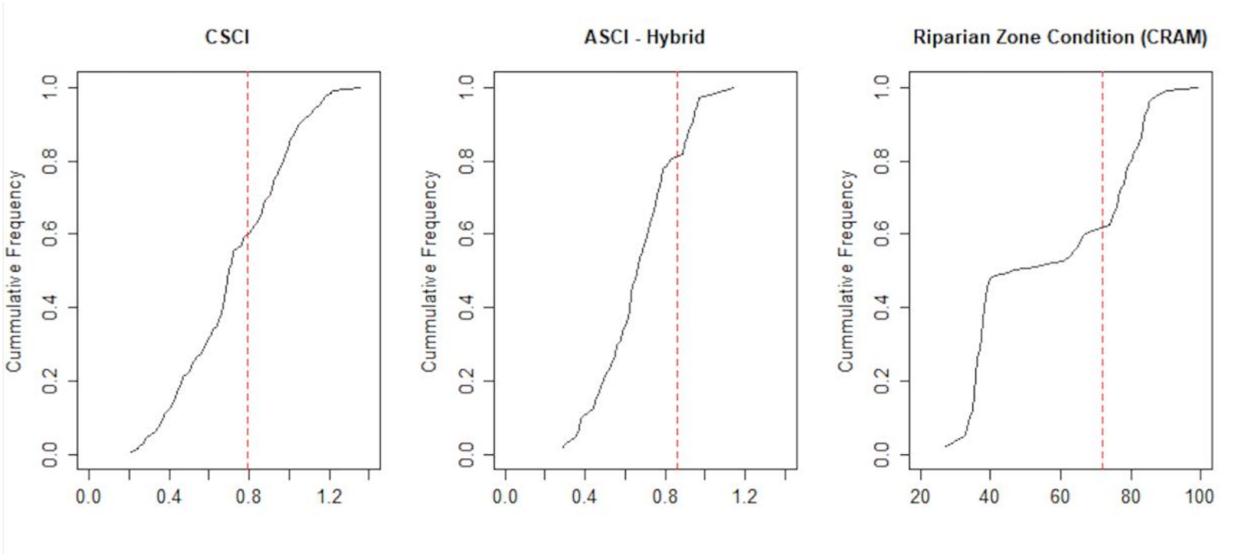

Figure 8. Cumulative frequency distribution of CSCI, ASCI hybrid, and CRAM scores at random sites from 2009-2020. Vertical dashed bar represents the 10th percentile of the reference distribution for each index.

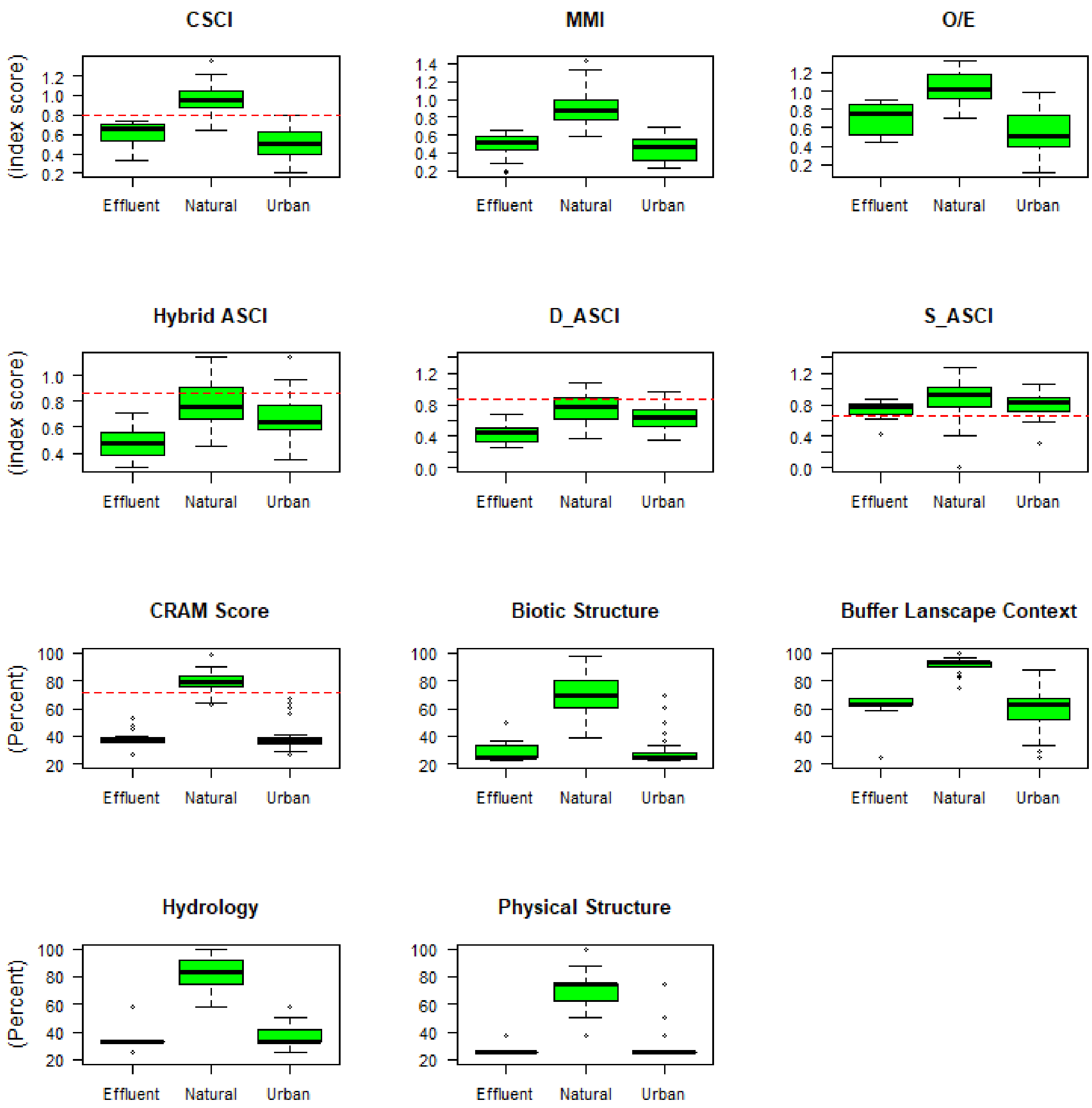

Figure 9. CSCI, ASCI (hybrid, diatom, and soft algae), and CRAM scores and attribute scores for effluent, natural, and urban random sites from 2009-2020. CRAM attribute scores include measures of biotic structure, buffer landscape context, hydrology, and physical structure.

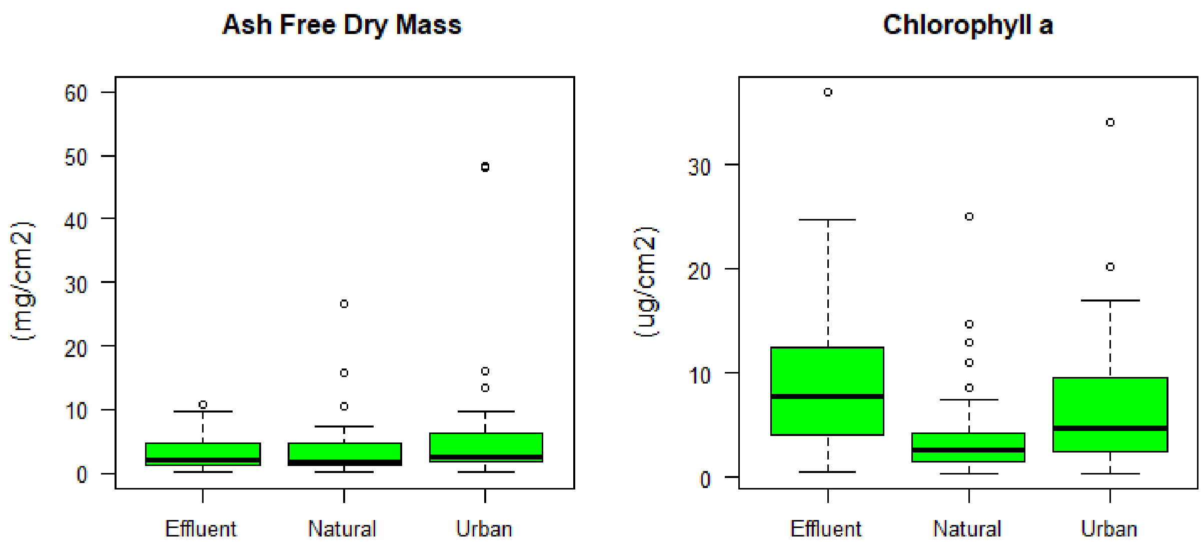

Figure 10. Ash free dry mass and chlorophyll A concentrations in effluent, natural, and urban regions in the watershed.

Figure 11 shows the proportion of BMI feeding groups represented in each of the three watershed sub-regions for all random sites from 2008 to 2020. Collectors, a feeding assemblage that feeds on fine particulate organic matter in the stream bottom, were the dominant group in each sub-region. Collectors make up a larger proportion of the total in the effluent-dominated and urban regions of the watershed. Effluent dominated and urban sites are mostly concrete-lined with little or no canopy cover and substrate complexity, and hence have a smaller relative abundance of other feeding groups compared to natural sites. Natural sites in the upper watershed had a more balanced community assemblage represented by nine feeding groups, although still dominated by collectors. Filterers were also more prevalent in this sub-region, generally indicating better water quality conditions (Vannote et al. 1980).

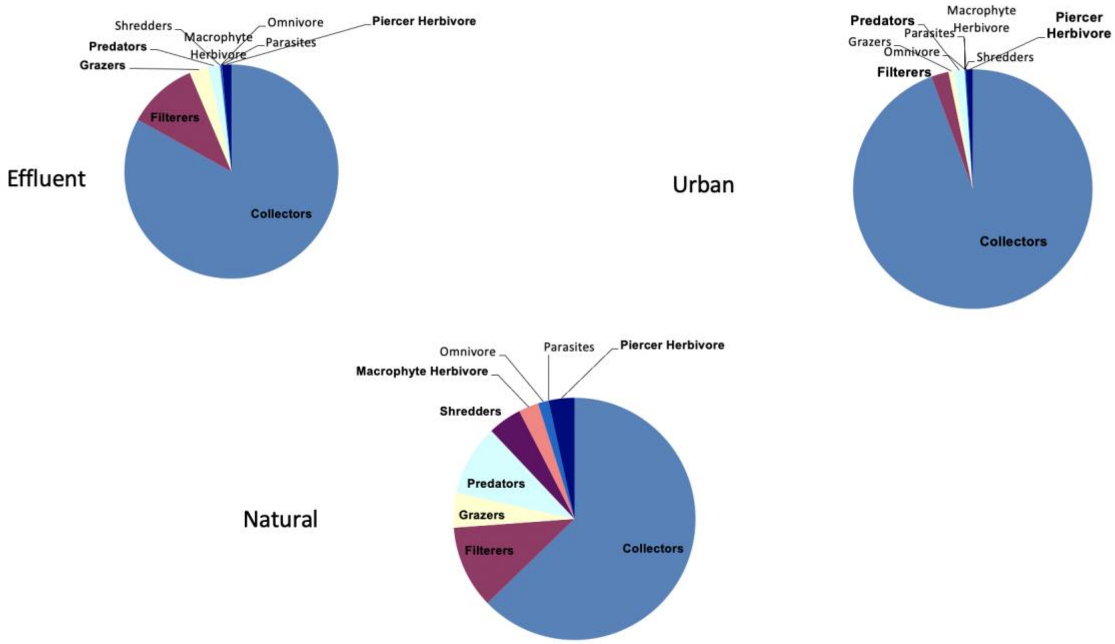

Figure 11. Relative proportion of benthic macroinvertebrate functional feeding groups in each watershed sub-region for 2008-2020 random sites.

b. Random Site Trend Analysis

We examined trends both at a site level and across each sub-region using both CSCI and CRAM scores from 2008 to 2020. Years were binned at 4 year time intervals to increase the sample size within each region, otherwise there can be as few as 2 sites from a particular sub-region during a given monitoring year. We found that CRAM scores are generally stable for each sub-region when comparing the three time intervals (Figure 12), with the exception of natural sites. CRAM scores at natural sites are significantly higher during time 2 (2013-2016) than during time 1 (2009-2012) and are not significantly different than time 3 (2017-2020). CSCI scores within each sub-region are stable and, on average, neither improved nor worsened when comparing the three time periods (Figure 13).

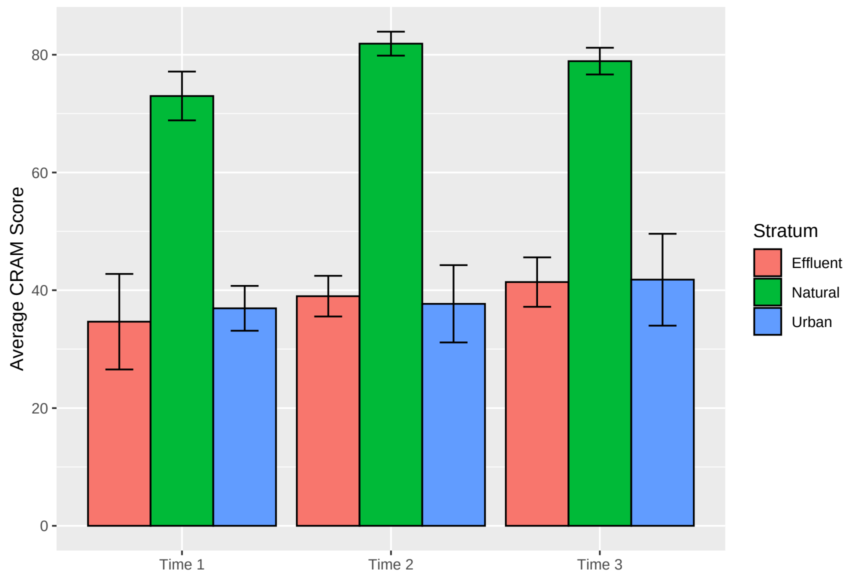

Figure 12 CRAM scores averaged for each subregion for 3 different time periods. Time 1 is 2009-2012; time 2 is 2013-2016, time 3 is 2017-2020. Y error bars represent 95% confidence intervals.

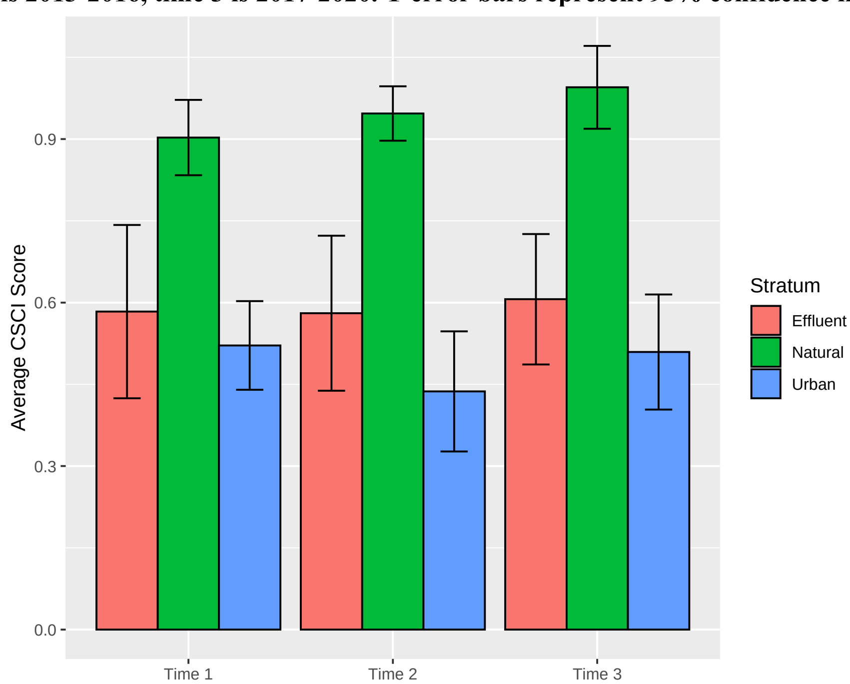

Figure 13 CSCI scores averaged for each subregion for 3 different time periods. Time 1 is 2009-2012; time 2 is 2013-2016, time 3 is 2017-2020. Y error bars represent 95% confidence intervals.

We then examined individual revisit sites, random sites that had been revisited at least 3 times, for trends in CRAM and CSCI scores using correlation analysis. We found that with respect to habitat condition, scores are stable and do not show any significant increasing or decreasing trend. We should note, however, that only 8 random sites have been revisited 3 or more times. In terms of CSCI score, the majority of sites have been stable with the exception of LAR06216, which has significantly improved over time (p=0.02)(Figure 4). The site is located in the natural sub-region along Big Tujunga Creek and is just downstream of recent fire areas, the 2009 Station Fire and the 2017 Creek Fire. Improvement in stream condition, based on CSCI score, may be due to habitat recovery post fire. Our ability to detect trends across a larger extent will be strengthened as the LARWMP program begins to prioritize revisiting undersampled sites.

c. Aquatic Chemistry and Physical Habitat

The differences in nutrient concentrations between watershed subregions is shown in Figure 14. Effluent-dominated and urban sites had greater median concentrations of nutrients compared to natural sites. Average nitrate and total nitrogen concentrations were highest in the effluent-dominated stream segments, though nitrate-nitrogen concentrations were below the Basin Plan objective of 10 mg/L. Other select water quality parameters that showed large differences between natural and effluent/urban sub-regions included temperature, sulfate, and chloride—all were lowest at natural sites (Table 7).

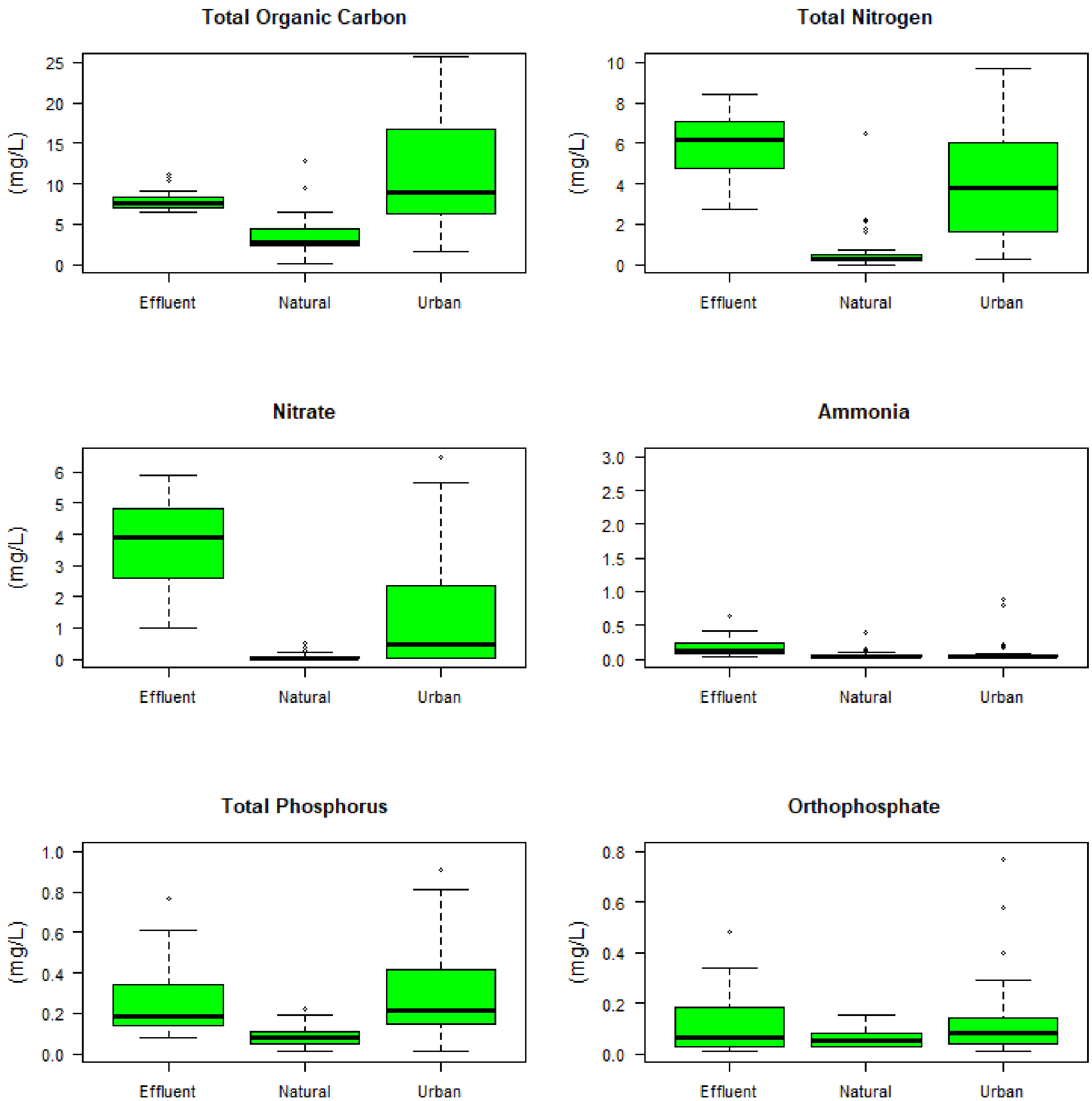

Figure 14. Box-and-whisker plots showing the median and range of representative nutrients measures in each of the three Los Angeles River watershed regions from 2009-2020.

d. Physical Habitat Assessments

Physical habitat was assessed using SWAMP protocols (Ode *et al.* 2016), which focus on streambed quality and the condition of the surrounding riparian zone out to 50 meters. Physical habitat conditions were best in the upper watershed compared to the lower watershed (Figure 15), specifically in terms of percent canopy, channel alteration, level of cobble and gravel, and epifaunal substrate cover. The epifaunal substrate, which was markedly higher in natural sub-regions, is a measure of the amount of natural streambed complexity due to the presence of cobble, fallen trees, undercut stream banks, etc. This complexity is important for healthy benthic macroinvertebrate and fish communities. Channel alteration was limited at natural sites, resulting in high scores. In contrast, effluent-dominated and urban sites are mostly channelized and concrete-lined which resulted in their poor scores. It is important to note that percent bank erosion and sediment deposition scores, where low sediment deposition is represented by high scores, should be interpreted cautiously in urban and effluent-dominated reaches due to the high degree of channelization and channel alteration limiting erosional processes.

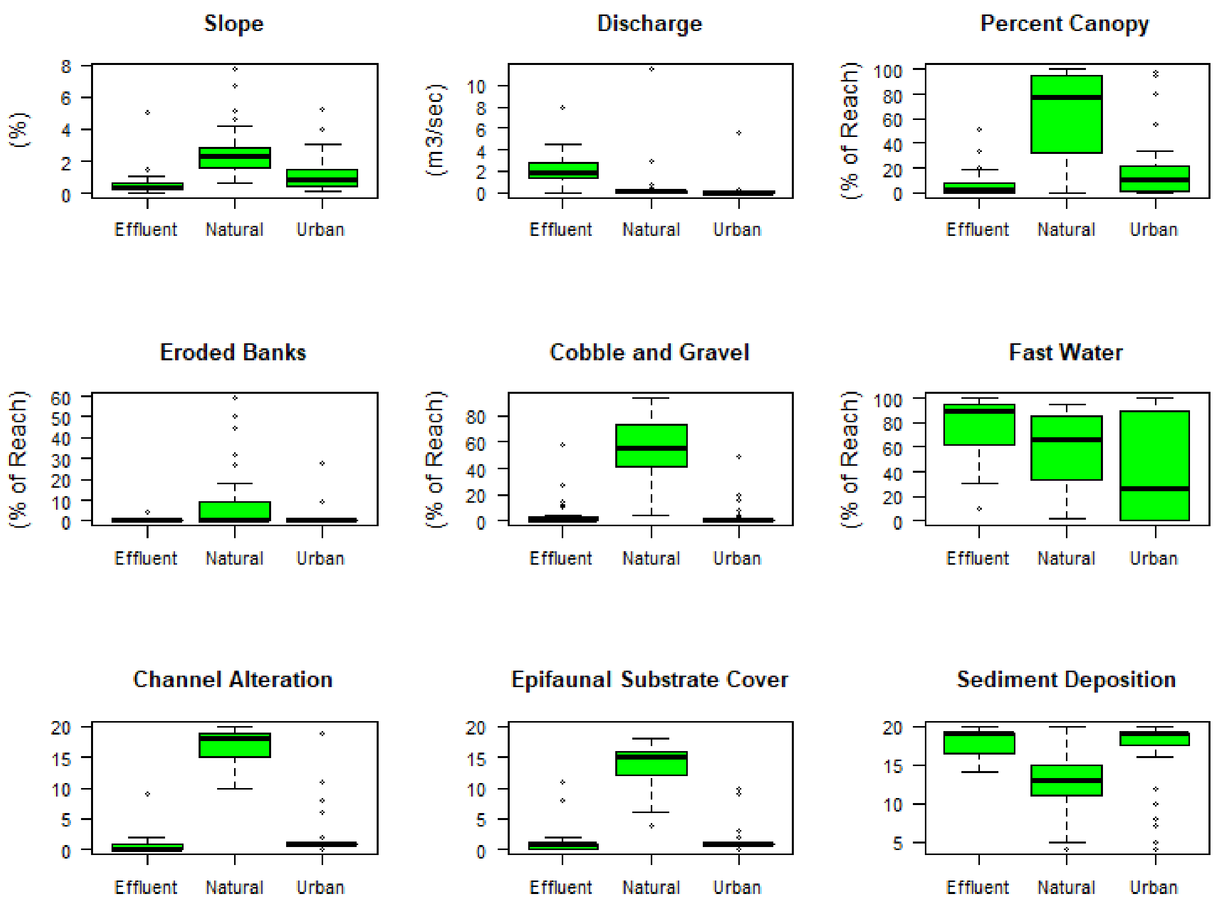

Figure 15. Box-and-whisker plots showing the median and range of representative physical habitat parameters measured in each of the three Los Angeles River watershed regions from 2009-2020. Channel alteration, epifaunal substrate cover, and sediment deposition are scored assessments, higher scores denote better conditions. Channelized streams are an exception. Channelization of streams decreases sedimentation, which results in higher sediment deposition scores. This does not indicate that these sites have better physical habitat.

e. Trash Assessments

Plastic was the most common trash type in effluent, urban and natural sites (Figure 16). Biodegradable items, fabric/cloth items, and metal items were also common across the three sub-regions. More specifically, when analyzing specific trash types within each sub-region, paper/cardboard was the most prevalent trash type at natural sites, wrappers/wrapper pieces at effluent sites, and cigarette butts at urban sites (Figure 17). Figure shows the sites assessed for trash between 2018-2020 and the corresponding trash counts for a subset of trash sub-categories. These sub-categories had the highest total trash counts.

The sites with the highest counts of plastic pieces, foam, and paper cardboard were generally located along the effluent dominated sub-region (Figure 18).

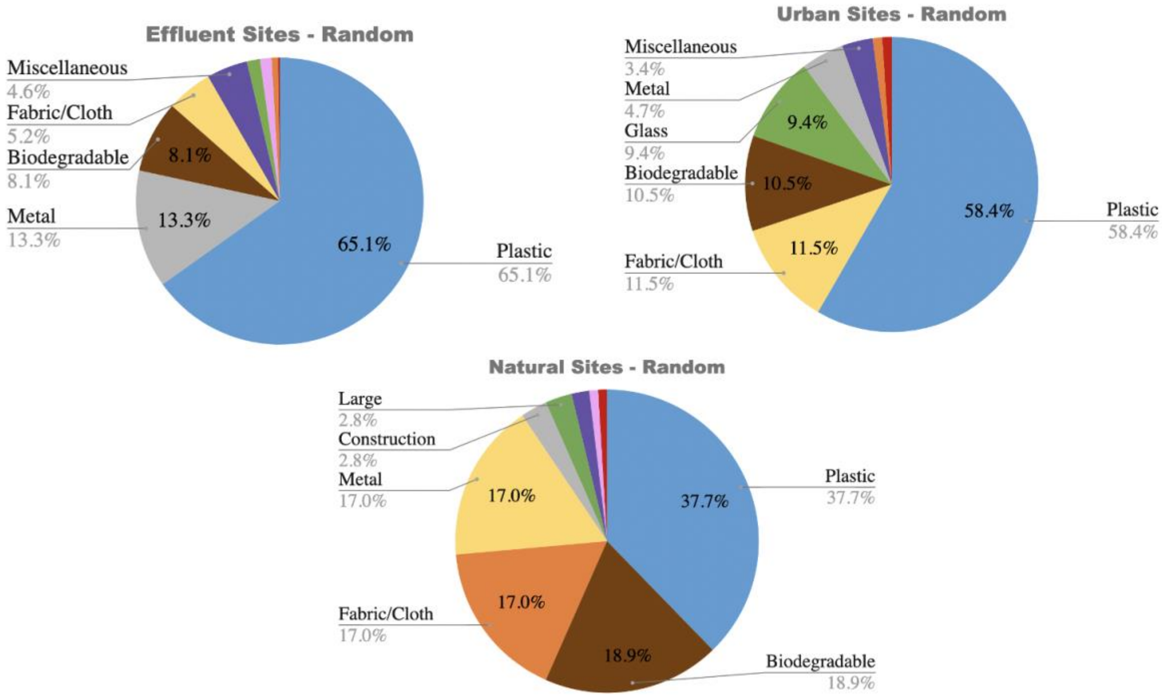

Figure 16 Most common trash types in each sub-region of the watershed for LARWMP sites sampled from 2018-2020.

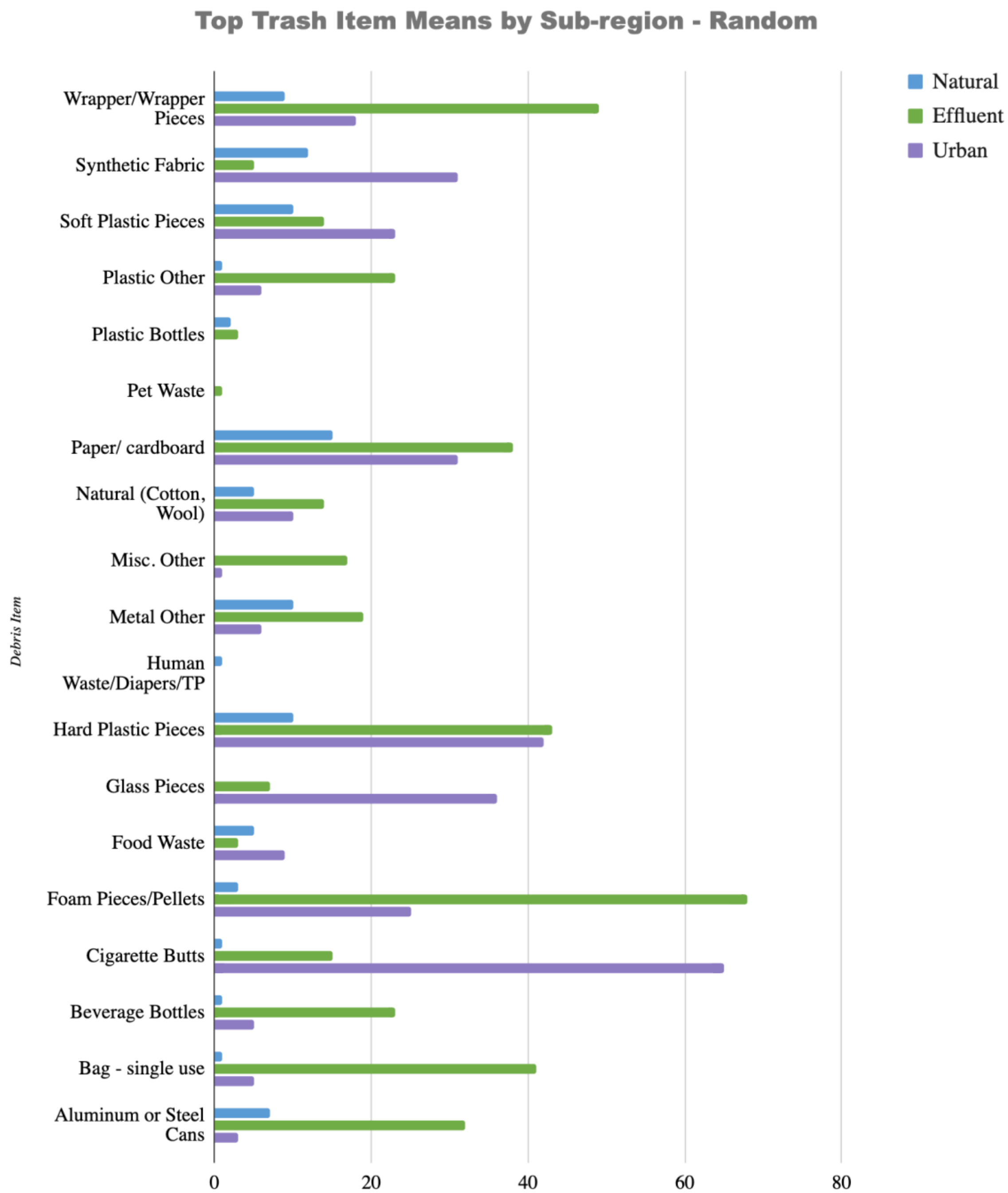

Figure 17 Mean trash sub-types by sub-region for LARWMP random sites sampled from 2018-2020.

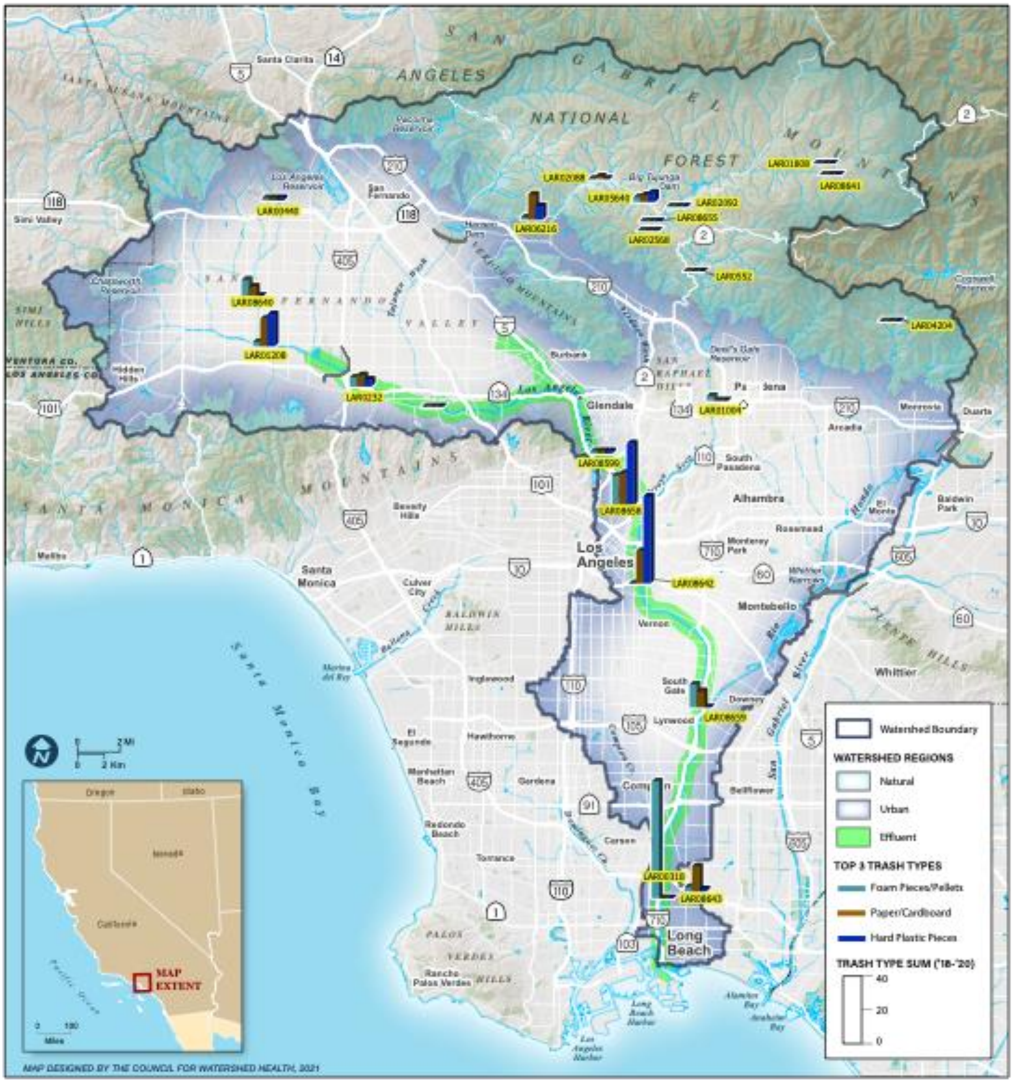

Figure 18 Map of sites assessed for trash between 2018 and 2020. The top 3 trash types graphed at each site are the trash sub-categories with the highest counts of trash across all regions.

Question 2. Are conditions at areas of unique interest getting better or worse?

1. Background

Question 2 monitoring efforts focus on specific locations in the watershed that represent unique areas of special concern to the workgroup. These sites are monitored annually to help better understand how conditions in the watershed are changing over time and when protection or restoration is needed. For this purpose, four separate programs were created:

- Trends at freshwater target sites: Four target sites were established on lower watershed tributaries upstream of their confluence points with the Los Angeles River to monitor water chemistry and assess biological, riparian, and physical habitat condition (Figure 19). These sites differ from the random sites used to assess ambient watershed condition in that their locations are fixed and sites are sampled regularly. Over time these data are being used to assess trends and to determine if changes in these trends can be attributed to natural, anthropogenic, or watershed management changes. Due to the amount of data that has been collected from confluence sites, in 2018 the TSG included another site of interest. This site will be semi-regularly sampled along with other confluence sites on an alternating basis. The 2020 monitoring program included the Arroyo Seco Confluence Site (LALT501) and Lewis McAdams Park, a random site that was sampled in 2015, dredged in 2018, and a revisit site in 2019.

- The Los Angeles River Estuary: is located at the terminus of the Los Angeles River main stem, where it discharges to the Harbor. This monitoring was designed to determine if Estuary sediments are meeting the sediment quality objectives (SQOs) developed by SWAMP, using a multiple lines of evidence approach (Bay et al. 2014). This site was dropped by the LARWMP program since the Lower Los Angeles River CIMP began monitoring the site's sediment quality objectives.

- High-value habitat sites: nine locations were chosen to assess trends in riparian zone condition at sites deemed by the workgroup to be unique. The emphasis of these assessments is on riparian habitat conditions using CRAM. Riparian zone conditions at these sites provide trend data and valuable baseline data for potential habitat restoration or protection efforts.

The methods that were used to better understand the condition of sites that are unique areas of interest are consistent with those described in the previous chapter.

2. Trends at Freshwater Target Sites

A total of 53 samples have been collected from the four confluence locations during the twelve annual surveys from 2008 to 2020 (Figure 19 and Table 8). In 2018, the TSG agreed to begin monitoring near Lewis MacAdams Park, a site that would aid the TSG in understanding the impact of sediment removal to stream health. Samples were collected and analyzed for aquatic chemistry, and biological and riparian habitat condition. The goal of repeated annual sampling at these locations is to monitor changing conditions related to water quality and riparian, physical habitat, and biological condition at the three sub-regions of the watershed.

Figure 19. Location of bioassessment, CRAM, and estuary sites.

Table 8. Location of targeted confluence sites sampled from 2009 through 2020

Targeted Confluence Locations	Channel Type	Site ID	Latitude	Longitude
Confluence of Rio Hondo and mainstem of LA River	Lined	LALT500	33.93642	-118.17147
Confluence of Arroyo Seco and mainstem of LA River	Lined	LALT501	34.08059	-118.22475
Confluence of Compton Creek and mainstem of LA River	Unlined	LALT502	34.84529	-118.20784
Confluence of Tujunga Wash and mainstem of LA River	Lined	LALT503	34.14833	-118.38916
Lewis MacAdams Park	Unlined	LAR08599	34.10603	-118.24338

a. Aquatic Chemistry

In 2020, the Lewis MacAdams Park (LAR08599) and Arroyo Seco confluence (LALT 501) were monitored. Aquatic chemistry results have been highly variable for most constituents during the ten-year monitoring period. Concentrations of general chemistry analytes can oscillate considerably from year to year with no consistent increasing or decreasing patterns (Figure 20). For example, in 2014 the Rio Hondo (LALT500) had a six fold increase in suspended solids but returned to previous concentrations in 2015. The Tujunga Wash site (LALT503) had sharp increases in hardness, specific conductivity, chloride and sulfate in either 2015 or 2016. Similarly, the Arroyo Seco site (LALT501) had elevated hardness in 2015, 2019, and 2020 and sulfate in 2019 and 2020. Conductivity and chloride at the Arroyo Seco site, however, were steady compared to previous years. Compton Creek (LALT502) and the Lewis MacAdams Park site (LAR08599) are notable in the general stability of constituent concentrations from year to year.

Nutrient concentrations have also been variable from year to year (Figure 21). Total organic carbon concentrations were similar and low at each site over time, with the exception of the Tujunga Wash (LALT503) which was up to four times higher than other sites in 2010, 2016 and 2017. Ammonia was low across all sites, except in 2010 and 2015 when concentrations spiked to over 1.0 mg/L at Tujunga Wash. The Arroyo Seco (LALT 501) and Lewis MacAdams Park (LAR08599) had nitrate and total nitrogen concentrations that were between 4 to 11 times greater than concentrations observed at other sites. In contrast, the Tujunga Wash (LALT503) which had low concentrations of nitrate, had elevated total nitrogen concentrations over time indicating that nitrogen at the Tujunga Wash was partitioned into its organic form. Nitrate concentrations at all sites have been below the water quality thresholds specified in the Los Angeles Basin Plan (<10 mg/L; LARWQCB 2019) since 2009. In 2019, the concentrations of orthophosphate and total phosphorus at the Compton Creek site (LALT502) were 3.9 to 2.2 higher, respectively, compared to the other confluence sites. Both have declined slightly since 2014. Orthophospate and total phosphorus spiked at Tujunga Wash in 2010, but both have dereased to low concentrations in 2019. Similarily, total phosphorus spiked in 2009 at the Rio Hondo and then declined.

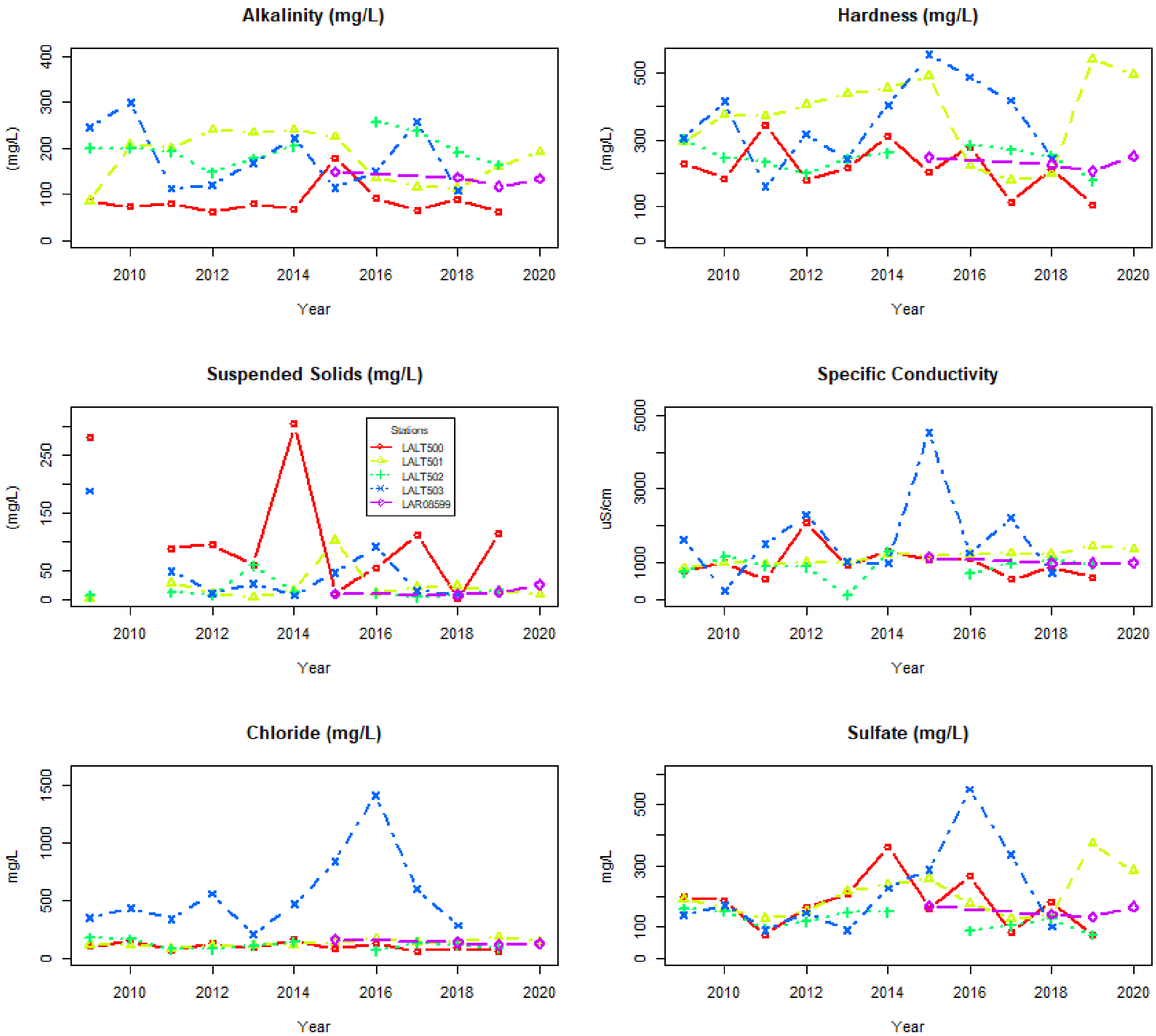

Figure 20. General chemistry at confluence sites sampled annually from 2009 to 2020 (Red = LALT500; Yellow= LALT501; Green = LAL502; Blue = LALT503; Purple = LAR08599).

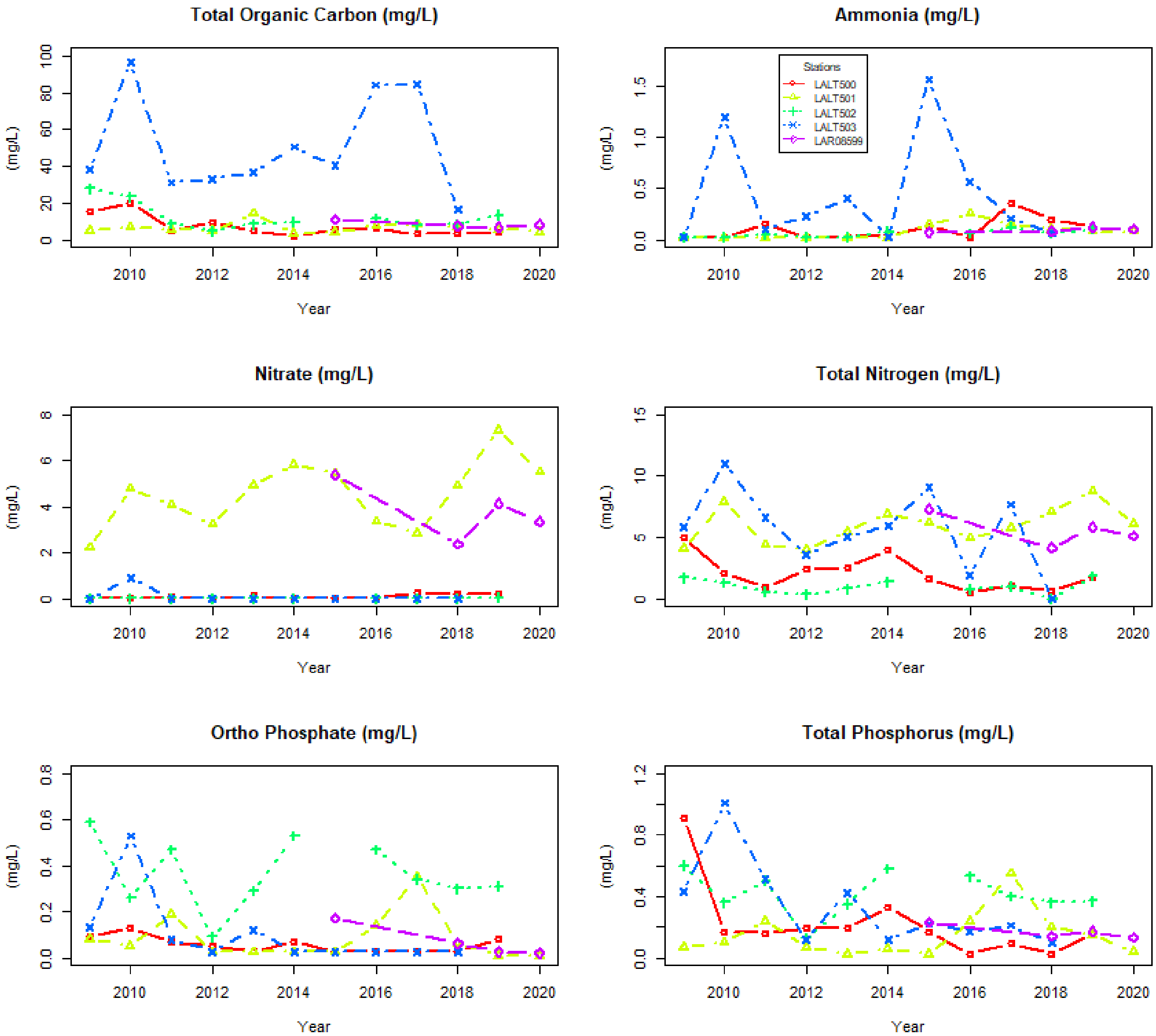

Figure 21. Nutrient concentrations at confluence sites sampled annually from 2009 to 2020 (Red = LALT500; Yellow= LALT501; Green = LAL502; Blue = LALT503; Purple = LAR08599).

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b. Biological and Riparian Habitat (CRAM) Condition

Figure 22 presents the biotic condition index scores for BMI (CSCI) and riparian habitat scores (CRAM; overall and attribute) for the targeted sites sampled from 2009 to 2020. Though CSCI scores at all confluence sites vary from year to year, some by as much as 230% (a 0.429 jump in CSCI score was observed at Tujunga Wash (LALT 503) from 2015 to 2016), most targeted sites scored in one of the altered categories (CSCI <0.79) and continued to be altered/very likely altered condition in 2020. The Arroyo Seco and Lewis MacAdams park sites normally scores higher than the other confluence sites and are consistently within the improved 'likely altered' category. In 2020, the Lewis MacAdams Park site (LAR08599), which was just 0.03 points above the "likely altered" score threshold, was categorized as a "possibly altered" site. Dredging at the Lewis MacAdams site in 2018 has not resulted in markedly negative impacts to biotic condition, as captured by improving CSCI scores and stable CRAM scores.

Low CSCI scores across confluence sites are not surprising given that these sites are in highly modified channels in the urbanized portion of the watershed. In addition to good water quality conditions, healthy biological communities require complex instream and riparian cover, natural flow regimes, and a wide and undisturbed riparian and buffer zone. These types of conditions are rare at confluence sites along the L.A. River, as indicated by the CRAM scores (Figure 22).

CRAM scores at confluence sites are less variable than CSCI scores and all sites are well below the 10^{th} percentile of reference sites (10^{th} percentile threshold is 72). Overall CRAM scores at the Lewis MacAdams park site, a soft-bottom portion of the river, are stable. In 2020 the overall CRAM dropped by 5 points at the site but only changes of greater than 7 points are considered significant. The hydrology attribute score, however, did decrease significantly, drop of 25 points compared to 2019 (CWMW, 2019). The CRAM score at the Arroyo Seco confluence (LALT501) improved significantly, an increase of 12 points since last assessed 2014 due to better buffer landscape context and hydrology attribute scores.

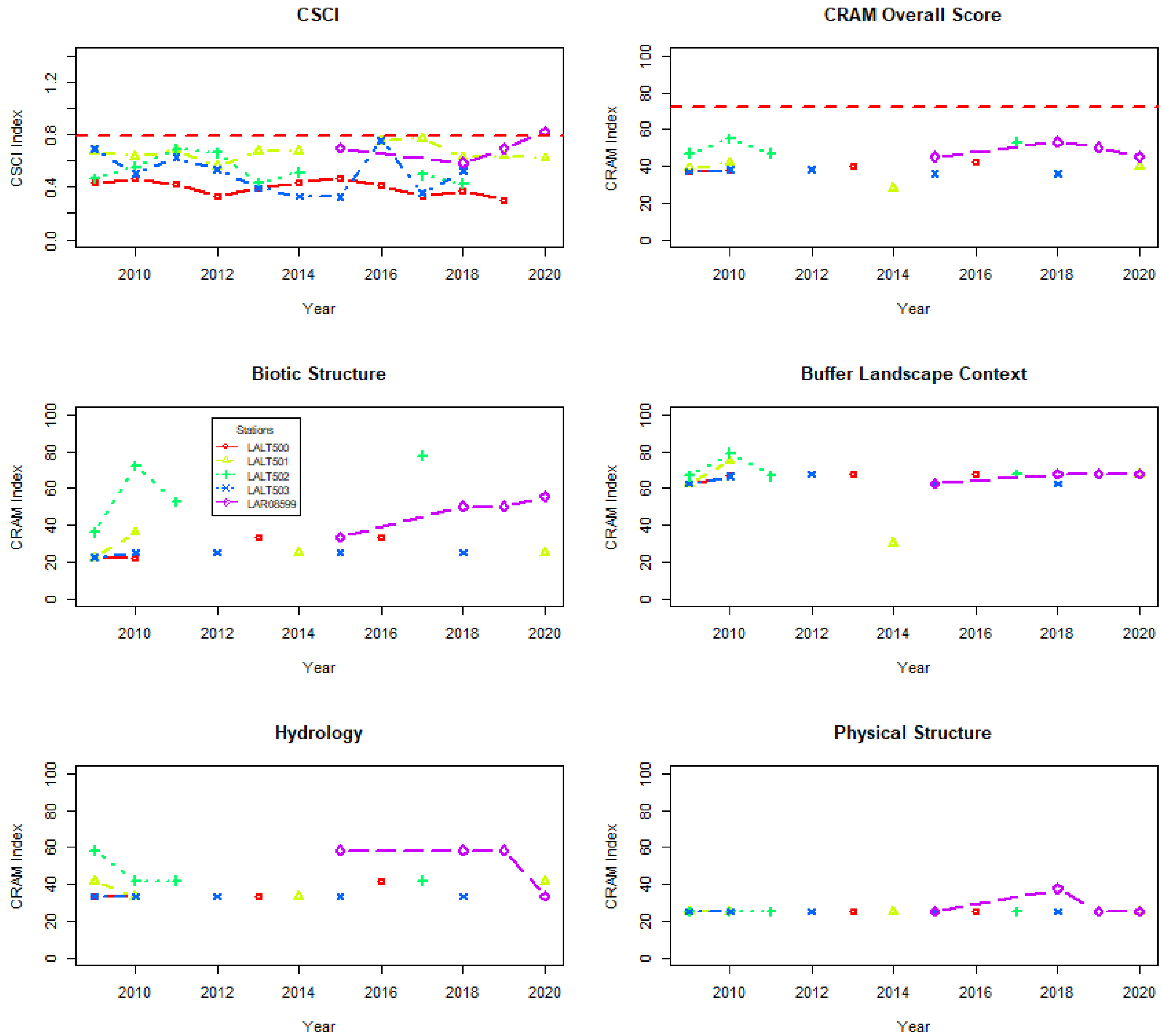

Figure 22. CSCI and CRAM scores (overall and attribute) at confluence sites sampled annually from 2009 to 2020. The red dashed horizontal lines on the CSCI and CRAM Overall Score graphs indicate the threshold, below which the site is in non-reference condition (0.79 for CSCI and 72 for overall CRAM score) (Red = LALT500; Yellow= LALT501; Green = LAL502; Blue = LALT503; Purple = LAR08599).

Correlation analysis of trend sites for overall CRAM scores showed some significant trends. Overall CRAM showed significant improvement through time at the LALT 500 site (or Rio Hondo site). The overall CRAM score at the site was 36 in 2009 and has steadily increased to 42 in 2016 (p=0.03, r=-0.97). This is due to an improvements in every attribue score except physical structure. All other confluence sites have stable CRAM and CSCI scores over time.

c. Physical Habitat

Figure 23 shows selected metrics of physical habitat condition. The three top plots show transect-based measurements recorded in conjunction with bioassessment sampling, while the three bottom plots show three visual physical habitat assessment scores. It is important to note that though visual physical habitat assessments are standardized as much as possible, they still may vary between users. As a result, only large changes in these assessments should be considered as reflecting changing conditions at a site.

The physical habitat conditions at confluence sites, with the exception of percent concrete and asphalt, are surprisingly variable from year to year. Rio Hondo (LALT 500) and Tujunga Wash (LALT 503), compared to other confluence sites, are generally stable over time. The Arroyo Seco confluence has performed similarly to these hardened sites with the exception of a higher, but very variable, canopy cover and reduced, but consistent, levels of sediment deposition. Conditions at Compton Creek (LALT 502) vary widely from year to year. For example, percent canopy, sand fines, epifaunal substrate, and sediment deposition all declined at the Compton Creek Site in 2019, potentially due to dredging and other maintenance activities. In contrast and despite dredging activities at the Lewis MacAdams park site (LAR08599), some physical habitat metrics post dredging suggested negligible changes or improved physical habitat conditions. For example, epifaunal substrate was more prevalent at the site after dredging and percent canopy cover increased. Percent concrete increased when the site was initially dredged, as dredging likely uncovered more of the site's concrete bottom, and has steadily decreased in subsequent assessments. Channel alteration has remained stable since the site was dredged in 2018.

For each of the physical habitat metrics presented, Compton Creek confluence (LALT502) has differed substantially from the other three confluence sites across years. Specifically, it had more canopy cover (or similar canopy cover to LALT501 for three of the eight years), smaller particle sizes, no concrete or asphalt substrate (the channel is unlined at the sampling site), less channel alteration, and more epifaunal substrate cover and sediment deposition. The scores for biotic structure and the overall riparian habitat condition are higher at Compton Creek compared to other confluence sites (Figure 22). Higher physical habitat and CRAM scores at Compton Creek, albeit CRAM scores are still below reference condition, have not translated to the site having better biological condition.

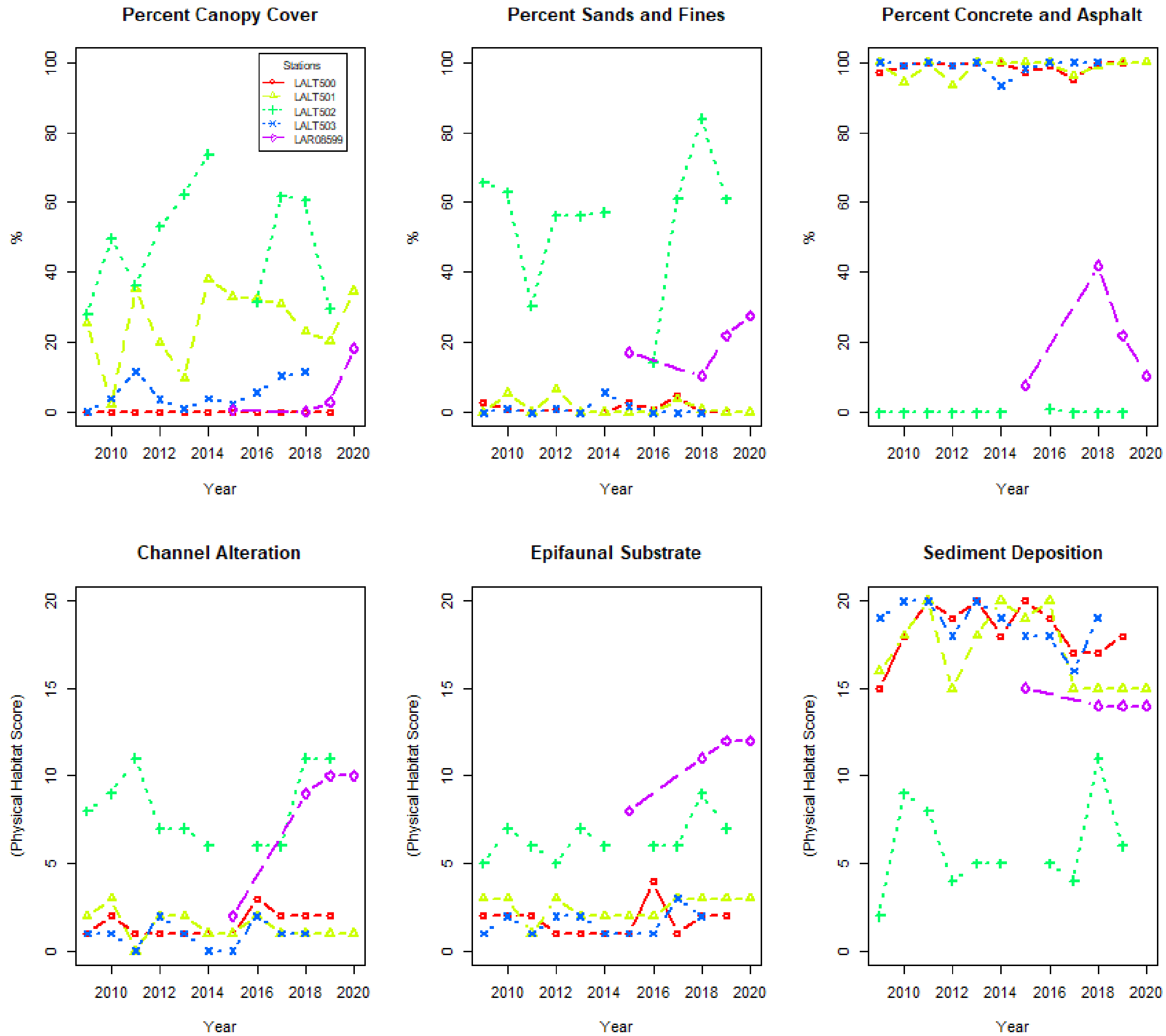

Figure 23. Physical habitat at confluence sites sampled annually from 2009 to 2020 (Red = LALT500; Yellow= LALT501; Green = LAL502; Blue = LALT503; Purple = LAR08599).

d. Los Angeles River Estuary

LARWMP monitored sediment at the LA River estuary to ensure sediment quality was suitable for aquatic life and was protective of human health (for seafood consumption). Sediment samples were collected from 2009 through 2016 at the mouth of the Los Angeles River Estuary near Queensway Bridge (LAREST2). Sediment chemistry testing included the suite of metals and organic constituents specified in the Sediment Quality Objectives (SQO) program (Bay *et al*., 2014) and toxicity testing. From 2009 to 2016, component scores varied from year to year as storms, scouring, and sediment deposition altered sediment quality. For the years when integrated scores could be calculated, EST2 ranked from 'unimpacted' to 'clearly impacted'.

The LARWMP program discontinued monitoring activities at the Los Angeles River Estuary in 2018. However, these data are collected and reported by the Long Beach Nearshore Watershed WMP/EWMP group and are publicly available. Reporting from the Long Beach Nearshore Watershed Group notes that the Los Angeles River Estuary is meeting protective conditions as described in compliance frameworks for the Harbor Toxics TMDL.

e. High-Value Habitat Sites

The condition of the riparian zone was assessed at nine sites deemed by members of the Workgroup to be minimally impacted, high-value, or sites at high risk of impact/loss in the watershed (Table 9). The goal of measuring the condition of these sites over time is to ensure that conditions are not degrading. The riparian zone was assessed using the California Rapid Assessment Method. CRAM assessments at these sites commenced in 2009. After two to four years of annual visits, the Workgroup determined that subsequent visits would occur every two to three years since conditions at these locations were not changing rapidly.

CRAM scores at lower watershed sites (prefix LALT) have usually fallen below the 10th percentile of the reference distribution of sites throughout California, indicating they are 'likely altered'(Question 1. What is the condition of streams in the Los Angeles River Watershed?). Some high value sites in the Lower Watershed have been an exception to this general trend of poorer condition at lower watershed sites. This may be because many urban high value sites are downstream of areas that were recently burned and/or are undergoing restoration activities. These sites include the Arroyo Seco USGS Gage site (LALT450) and Haines Creek Pools and Stream (LALT407). However, the Glendale Narrows (LALT400), Sepulveda Basin (LALT405), Eaton Wash (LALT406) and Golden Shore Wetlands (LALT404) have consistently been below reference condition.

The best riparian zone conditions have been found consistently at sites located in the upper watershed (prefix LAUT). However, the 2009 Station Fire created the opportunity for the LARWMP program to better understand the impact of fire to riparian habitats and recovery. Upper watershed sites that burned included LAUT401, LAUT402, and LAUT403—located in the Tujunga Sensitive Habitat, Upper Arroyo Seco, and Alder Creek.

Sites assessed for riparian habitat condition in 2020 included the Glendale Narrows (LALT400), Golden Shore Wetlands (LALT404), and Sepulveda Basin (LALT405). Figure 24 shows the individual CRAM scores from these sites for the period of 2009 to 2020. CRAM scores at the sites are more or less stable, they have varied by less than 7 points since they were previously sampled, and are below the 10th percentile of the reference distribution. The Golden Shore Wetlands site (LALT404) is nearly in reference condition and habitat condition at this site have shown significant improvement over time ($p=0.03$, $r^2= 0.97$) (Figure 19).

Table 9. Location of high value habitat sites

Site Name	Channel Type	Site ID	Latitude	Longitude
Arroyo Seco USGS Gage	Unlined	LALT450	34.18157	-118.17297
Glendale Narrows	Unlined	LALT400	34.139368	-118.2752
Golden Shores Wetlands	Unlined	LALT404	33.76442	-118.2039
Sepulveda Basin	Unlined	LALT405	34.17666	-118.49335
Eaton Wash	Unlined	LALT406	34.17463	-118.0953
Haines Creek Pools and Stream	Unlined	LALT407	34.2679	-118.3434
Tujunga Sensitive Habitat	Unlined	LAUT401	34.28220	-118.22160
Upper Arroyo Seco	Unlined	LAUT402	34.22121	-118.17715
Alder Creek	Unlined	LAUT403	34.30973	-118.14190

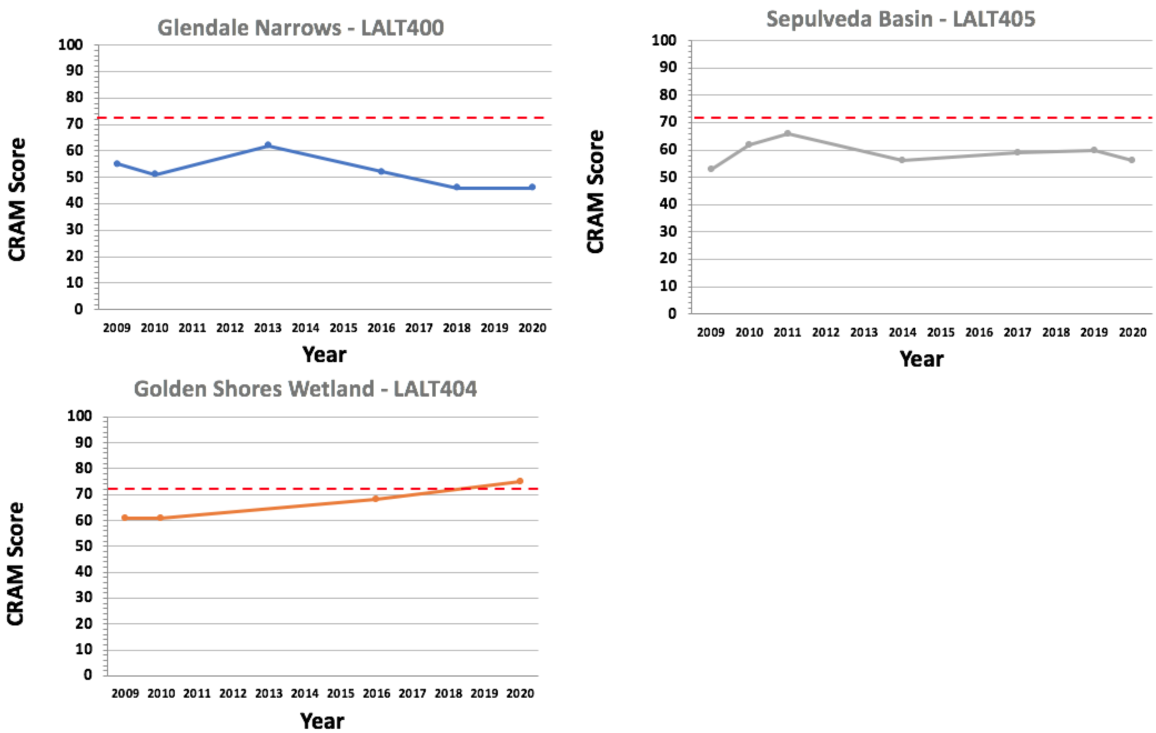

Figure 24. Riparian zone condition (CRAM scores) at select high-value sites from 2009-2020. The red horizontal line represents the 10th percentile of the reference distribution of sites in California. Scores below this line represent 'likely altered' habitat.

Question 3. Are permitted discharges meeting WQOs in receiving waters?

a. Background.

Question 3 addresses the potential impacts of permitted point-source discharges on the Los Angeles River, its tributaries, and receiving waters' ability to meet the Water Quality Objectives (WQOs) set forth in the Los Angeles Basin Plan (LARWQCB, 2019). The data compiled by LARWMP include metals, bacteria (*E. coli*), nutrients, and trihalomethanes. These parameters are measured to provide a basic assessment of water quality and include the contaminants potentially introduced into a stream system via effluent from Publicly Owned Treatment Works (POTWs).

This chapter summarizes NPDES monitoring data for the period from January through December 2020 for three major POTWs that discharge into the Los Angeles River: The City of Los Angeles' Tillman Water Reclamation Plant (DCTWRP), the City of Los Angeles' Glendale Water Reclamation Plant (LAGWRP), and the City of Burbank's Water Reclamation Plant (BWRP). Site codes for the receiving water stations upstream and downstream of each POTW's discharge and their locations are shown in Table 10 and Figure 25, respectively. These receiving water stations are monitored by the permittees as a requirement of their NPDES permits and were chosen to best represent locations upstream and downstream of the discharge locations. Values were compared to LARWQCB Basin Plan Water Quality objectives (Table 11).

Table 10. Station designations for NPDES monitoring sites

POTW	Upstream Site	Downstream Site
City of Los Angeles- Tillman	LATT612	LATT630
City of Los Angeles-Glendale	LAGT650	LAGT654
City of Burbank- Burbank	RSW-002U	RSW-002D

Table 11. Water Quality Objectives for nutrients in the Los Angeles Regional Water Quality Control Board Basin Plan and plan amendments, updated in May 2019.

N species	NO3-N+NO2-N (mg/L)	NO3-N (mg/L)	NO2-N (mg/L)
WQO	8 mg/L	10	1

Figure 25. **Locations of NPDES receiving water sites monitored by the City of Los Angeles and the City of Burbank.**

b. City of Los Angeles - DCTWRP

The cumulative frequency distributions for *E. coli* above and below the City of Los Angeles' DCTWRP discharge location are shown in Figure 26. The statistical threshold value (STV) water quality objective of 320 MPN/100mL for REC-1 beneficial use was attained for approximately 90% of upstream samples and 95% of the downstream samples during the 2020 sampling year.

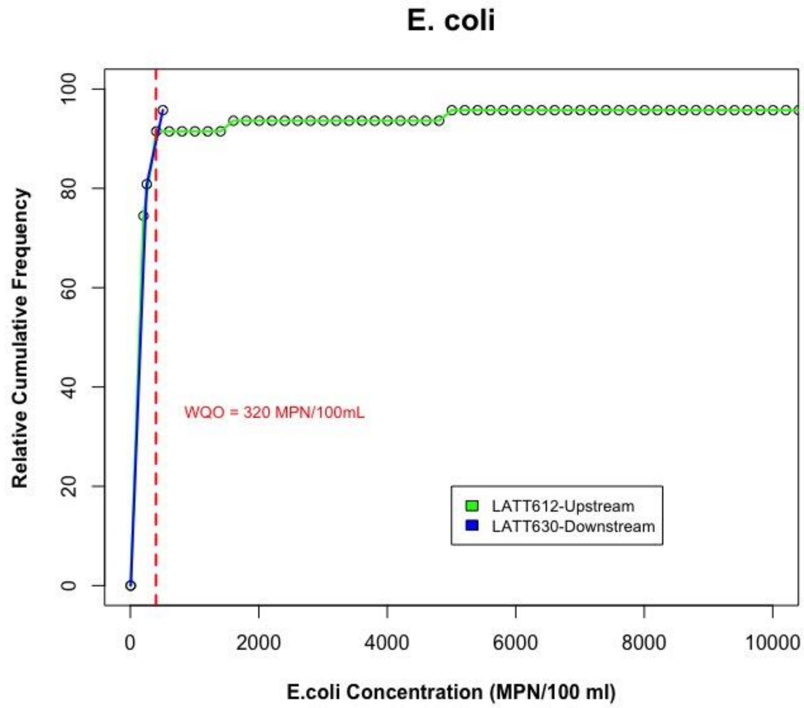

Figure 26. Cumulative frequency distributions of *E. coli* concentrations above and below the DCTWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Table 12 shows the average concentrations of several nitrogen species observed at a site upstream and downstream of DCTWRP discharge. Nitrate-nitrogen, nitrite-nitrogen, and ammonia nitrogen were tested weekly. Average downstream concentrations of nitrate and nitrite were below water quality objectives (Table 11)and max values for nitrogen species show that downstream samples did not exceed WQO in 2020.

Ammonia is toxic to aquatic life and the proportion of toxic ammonia (NH_3) to total ammonium (NH_4) depend on pH and temperature. The monthly average WQO for reach 5 of the Los Angeles River was graphed alongside ammonia samples collected upstream and downstream of DCTWRP effluent (Figure 27). There were no exceedances of established ammonia WQO upstream or downstream of DCTWRP.

Table 12. Range of nutrient concentrations upstream and downstream of DCTWRP discharge in 2020.

Position	N.Species	Mean	Med	Max	SD
Upstream	NH3-N	0.18	0.17	0.51	0.14
	NO2-N	0.44	0.03	17.40	2.53
	NO3-N	2.71	1.94	31.20	4.29
Downstream	NH3-N	0.64	0.68	1.59	0.36
	NO2-N	0.16	0.15	0.42	0.09
	NO3-N	4.66	4.58	6.71	0.67

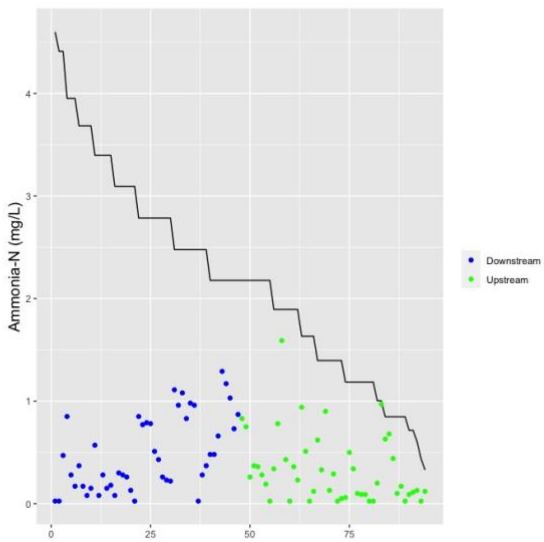

Figure 27 Ammonia concentrations upstream and downstream of DCTWRP in 2020. The line represents the reach specific WQO, a function of pH and temperature at time of sampling.

Total trihalomethanes, which are common disinfection by-products, were detected above and below the discharge location. Disinfection byproducts are, as expected, higher downstream of DCTWRP but are well below the EPA water quality objective of 80 ug/L (Table 13).

Table 13. Trihalomethane concentrations below the DCTWRP discharge (LATT630). Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. "ND" indicates the analyte was not detected or the detected value was below the MDL. The EPA water quality objective for total trihalomethanes is 80 ug/L (U.S. EPA 2002).

Location	Trihalomethanes (ug/L)	2/4/20	8/11/20	Sum T1	Sum T2
Upstream	BROMODICHLOROMETHANE	0.1	0.1	0.38	0.495
	BROMOFORM	0.07	0.07		
	CHLOROFORM	0.085	0.2		
	DIBROMOCHLOROMETHANE	0.125	0.125		
Downstream	BROMODICHLOROMETHANE	1.79	4.25	10.99	15.64
	BROMOFORM	0.07	0.07		
	CHLOROFORM	8.75	10.5		
	DIBROMOCHLOROMETHANE	0.38	0.82		

The metals concentrations shown in Figure 28 are compared to the California Toxics Rule (CTR) chronic and acute standards. The Water Effects Ratio (WER) for copper at Tillman was equal to 1. It is important to note that total recoverable metals, rather than dissolved metals, were measured by the City of Los Angeles as a requirement of their NPDES permit. Total recoverable concentrations from DCTWRP and LAGWRP were converted to dissolved concentrations, which represent the biologically active fraction of the total metal concentration, using a Metals Translator Guidance document written by the EPA (USEPA 1996).

Figure 28 shows the concentration of select metals upstream and downstream of the DCTWRP discharge location. Downstream concentrations of arsenic, zinc, lead, copper, zinc and cadmium were below both chronic and acute CTR criteria. Selenium concentrations upstream of the discharge exceeded the CTR chronic threshold during all four sampling events but were likely diluted by wastewater effluent at the downstream sampling location. Effluent from the DCTWRP does not contribute to metal exceedances downstream of the DCTWRP discharge.

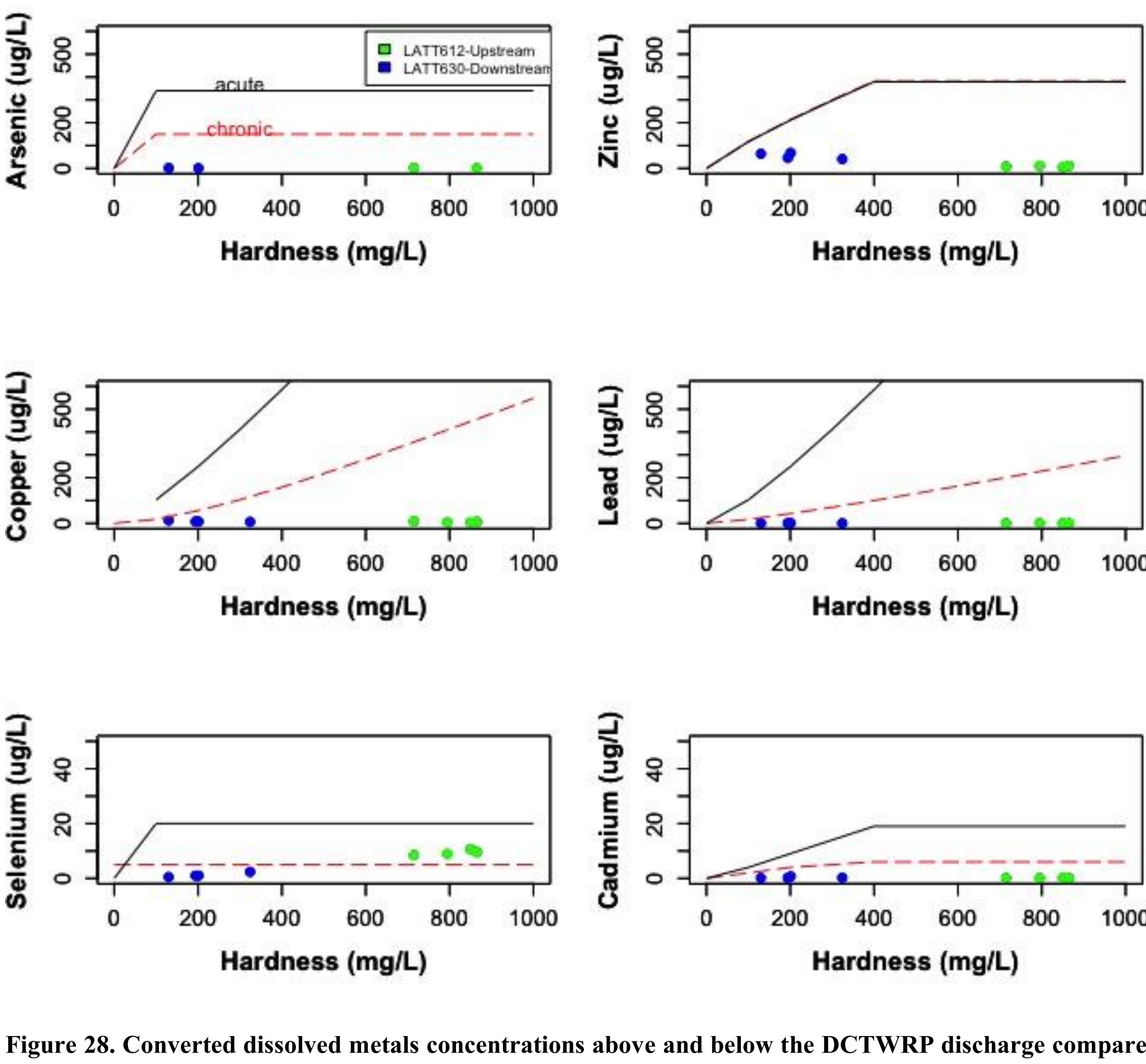

Figure 28. Converted dissolved metals concentrations above and below the DCTWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Black lines indicate acute CTR thresholds and red line indicates chronic CTR thresholds. Values are estimated in instances where there were non-detects that did not meet the laboratory's reporting limit.

c. City of Los Angeles – LAGWRP

Figure 29 shows the cumulative frequency distributions for *E. coli* at sites above and below the discharge point for the LAGWRP. Approximately 35% of the *E. coli* samples met the WQO at the upstream site, while approximately 80% of the samples met the WQO at the downstream site. *E. coli* concentrations are generally lower downstream of LAGWRP, compared to samples from the upstream site, indicating a dilution effect as a result of the LAGWRP effluent.

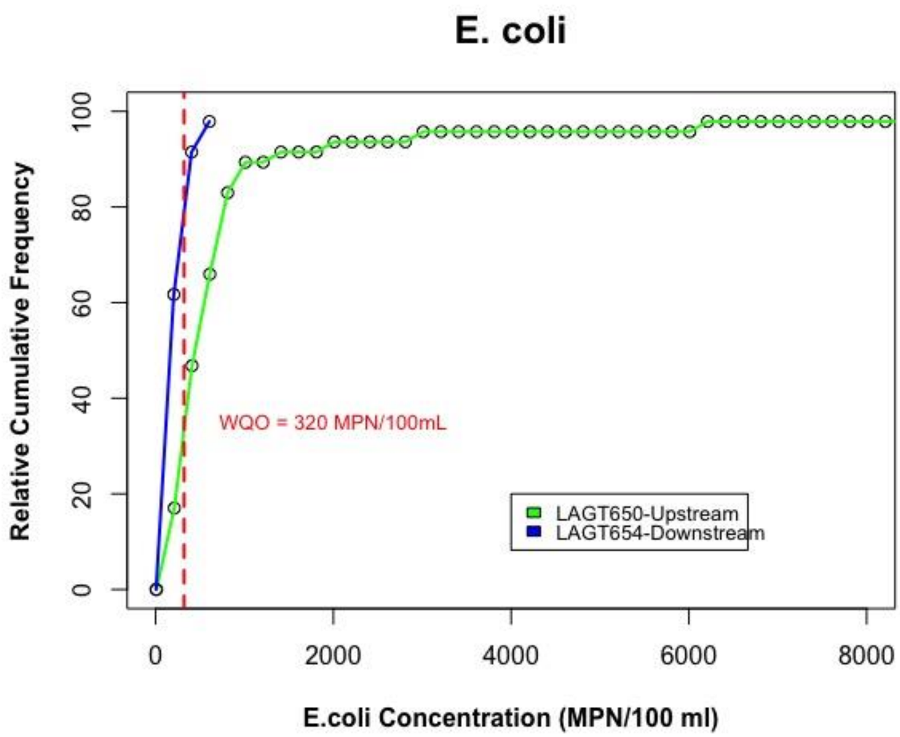

Figure 29. Cumulative frequency distribution of *E. coli* above and below the LAGWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Table 14 shows average concentration of regulated nitrogen species above and below the LAGWRP discharge. Nitrate-nitrogen, nitrite-nitrogen, and ammonia-nitrogen were tested weekly. Most of the nitrogen downstream and upstream of the POTW was in the form of nitrate-nitrogen. Nitrate-nitrogen and nitrite-nitrogen concentrations downstream of the LAGWRP were below regulatory thresholds (Table 11) and, on average, lower than upstream locations.

Table 14. Range of concentrations of ammonia, nitrite, and nitrate at locations upstream and downstream of LAGWRP during 2020.

Position	Nutrient	Mean	Med	Max	SD
Upstream	NH3-N	0.38	0.38	1.26	0.25
	NO2-N	0.26	0.20	0.91	0.23
	NO3-N	5.29	4.91	26.80	3.33
Downstream	NH3-N	0.41	0.41	1.14	0.22
	NO2-N	0.21	0.18	0.82	0.18
	NO3-N	4.71	4.91	6.71	1.11

The monthly average ammonia-nitrogen WQO for reach 3 of the Los Angeles River was graphed alongside ammonia samples collected upstream and downstream of LAGWRP effluent (Figure 30). There were no exceedances of the NH_3-nitrogen WQO upstream or downstream of DCTWRP.

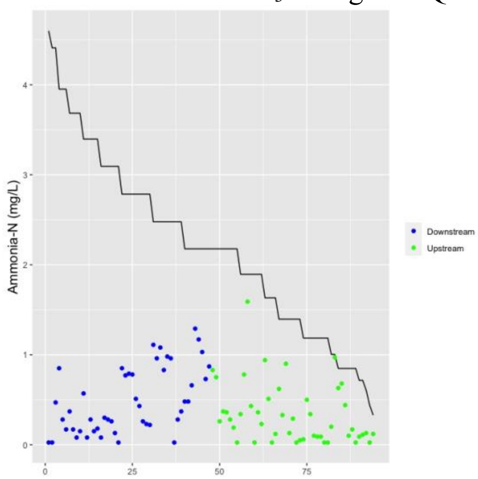

Figure 30 Ammonia concentrations upstream and downstream of LAGWRP during 2020. The line represents the reach specific WQO, a function of pH and temperature at time of sampling.

Total recoverable metals were measured both upstream and downstream of the LAGWRP discharge (Figure 31). The copper WER ratio for reach 3 of the River, where LAGWRP is located, is 3.97 and CTR criteria are adjusted accordingly. All metal concentrations were below the WER adjusted CTR thresholds both upstream and downstream of the LAGWRP outfall. Treated wastewater from LAGWRP is not causing elevated concentrations of metals downstream of discharge locations and metal concentrations are below regulatory objectives.

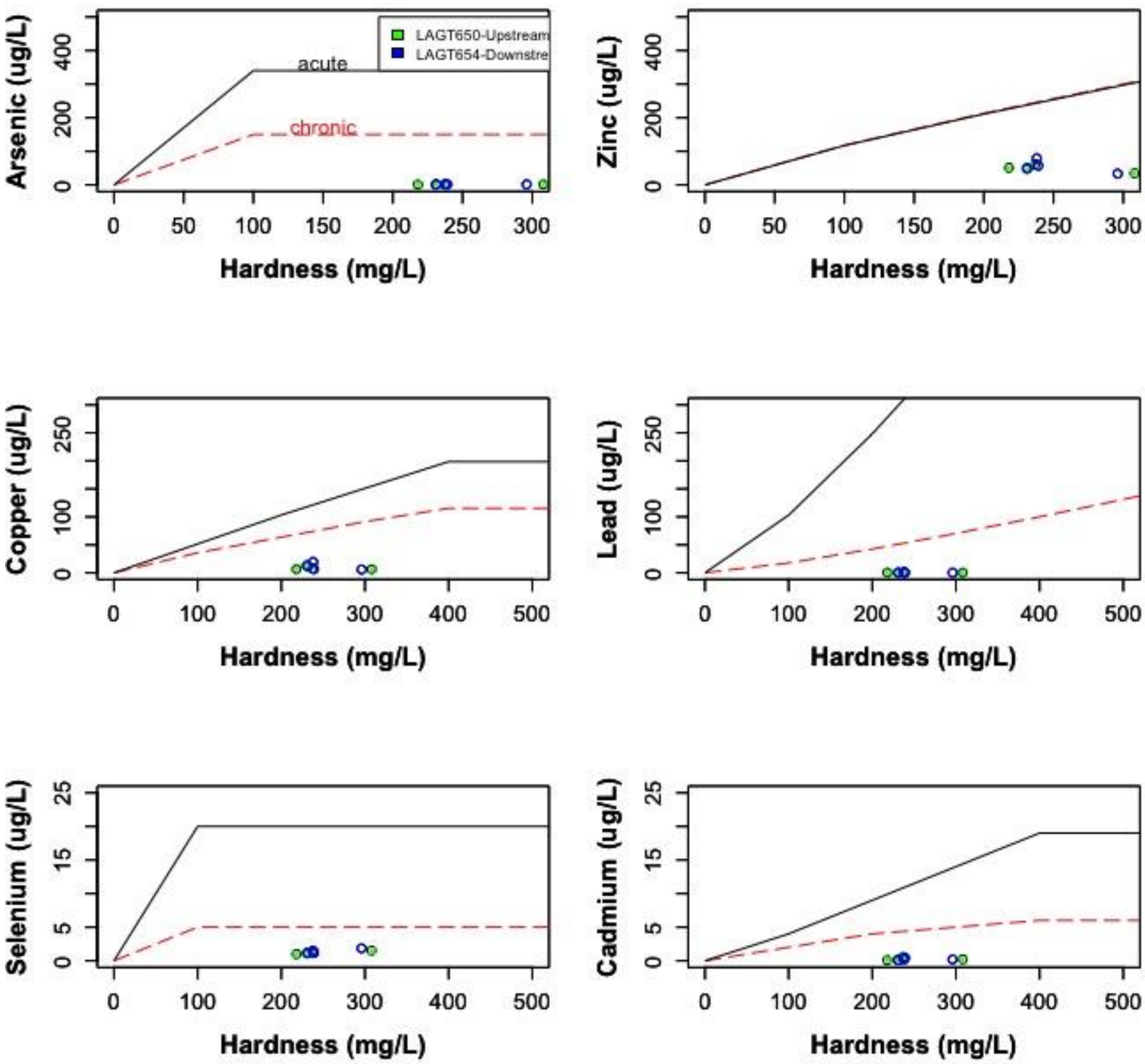

Figure 31. Converted dissolved metals concentrations above and below the LAGWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Black lines indicate acute CTR thresholds and redlines indicate chronic CTR thresholds. CTR criteria is adjusted with the site specific WER. Data includes estimated values for low concentrations that exceeded the method detection limit but that did not meet the laboratory's reporting limit. Note that downstream and upstream concentrations may be close in value, as a result it may be difficult to see overlapping green and blue points on the graph.

Total trihalomethanes were detected below and above the LAGWRP discharge location but the concentrations upstream and downstream of the discharge were well below the EPA water quality objective of 80 ug/L (Table 15).

Table 15. Concentrations of trihalomethanes below and above the LAGWRP discharge. Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. "ND" indicates the analyte was not detected or the detected value was below the MDL. The EPA water quality objective for total trihalomethanes is 80 ug/L (U.S. EPA 2002).

Location	Trihalomethanes (ug/L)	2/4/20	8/11/20	Sum T1	Sum T2
Upstream	BROMODICHLOROMETHANE	0.1	0.1	2.115	1.325
	BROMOFORM	0.07	0.07		
	CHLOROFORM	1.82	1.03		
	DIBROMOCHLOROMETHANE	0.125	0.125		
Downstream	BROMODICHLOROMETHANE	0.46	0.34	3.375	1.805
	BROMOFORM	0.07	0.07		
	CHLOROFORM	2.72	1.27		
	DIBROMOCHLOROMETHANE	0.125	0.125		

d. City of Burbank - BWRP

The cumulative frequency distributions for *E. coli* upstream and downstream of the City of Burbank's BWRP discharge location are shown in Figure 32. Approximately 25% of upstream samples met the WQO, compared to approximately 40% of the downstream samples. *E. coli* concentrations are lower downstream of the BWRP effluent.

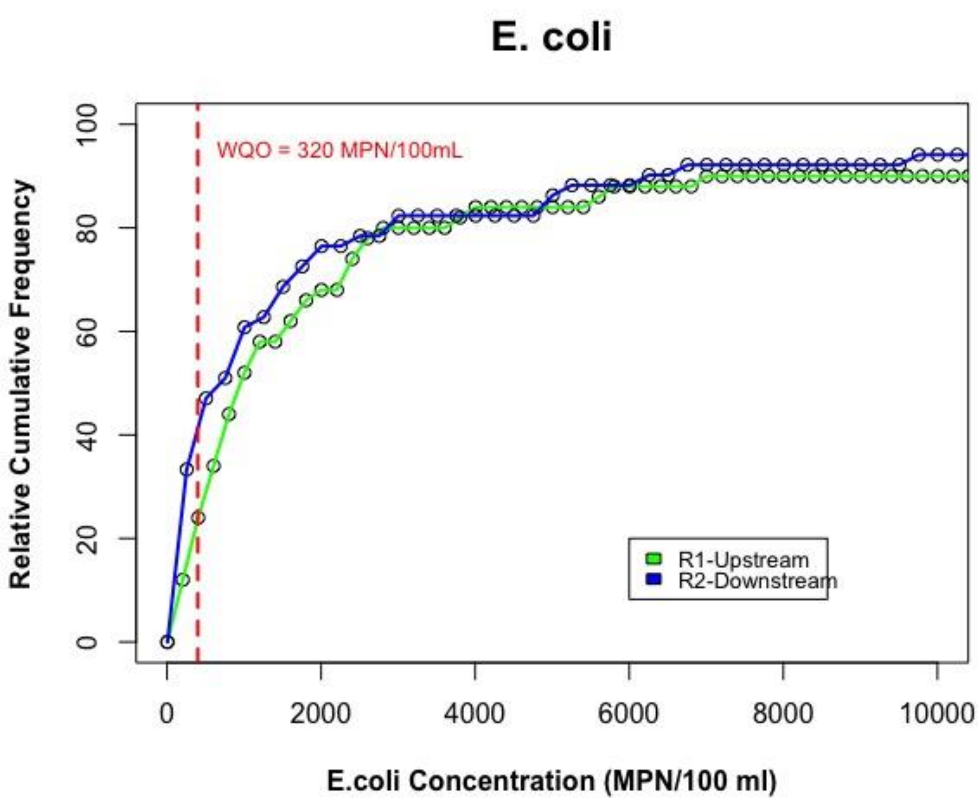

Figure 32. Cumulative frequency distributions for *E. coli* above and below the BWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Table 16 shows the range in nutrient concentration measured above and below the BWRP discharge. Nutrients were measured approximately every week. Average concentrations for nitrate-nitrogen and nitrate-nitrogen plus nitrite-nitrogen were higher downstream. However, all samples of nitrate-nitrogen and nitrate-nitrogen plus nitrite-nitrogen, both upstream and downstream, met established WQO objectives (Table 11). There were 6 downstream (about 12%) samples during the 2020 year that exceeded established ammonia-nitrogen WQO for the Burbank Channel (Figure 33).

Table 16. Range of concentrations of nitrogenous compounds upstream and downstream of BWRP discharge point in 2020.

Position	Nutrient	Mean	Med	Max	SD
Upstream	NO2-N	0.2	0.2	0.6	0.1
	NO2-N+NO3-N	2.9	2.7	6.2	1.4
	NO3-N	2.8	2.7	6.2	1.4
Downstream	NO2-N	0.2	0.1	0.5	0.1
	NO2-N+NO3-N	3.7	3.6	7.6	1.1
	NO3-N	3.5	3.5	7.4	1.1

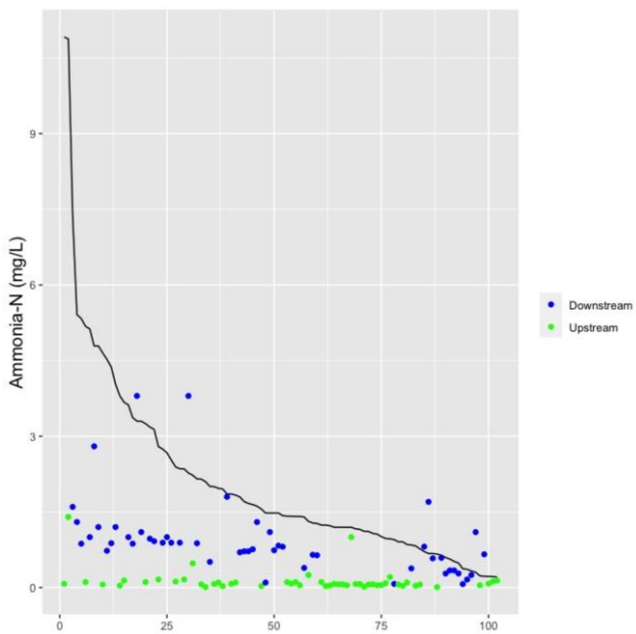

Figure 33 Ammonia nitrogen concentrations of samples collected upstream and downstream of the BWRP graphed with the Burbank Channel pH and temperature dependent WQO for ammonia-nitrogen.

Figure 34 shows the hardness adjusted dissolved metal concentrations compared to their CTR chronic and acute standards. The copper WER for this reach of the Burbank Channel is 4.75 and CTR criteria were adjusted accordingly. Metal concentrations were below the CTR chronic and acute standards for all metals, on all occasions. Wastewater discharge from BWRP is not causing downstream metal exceedances.

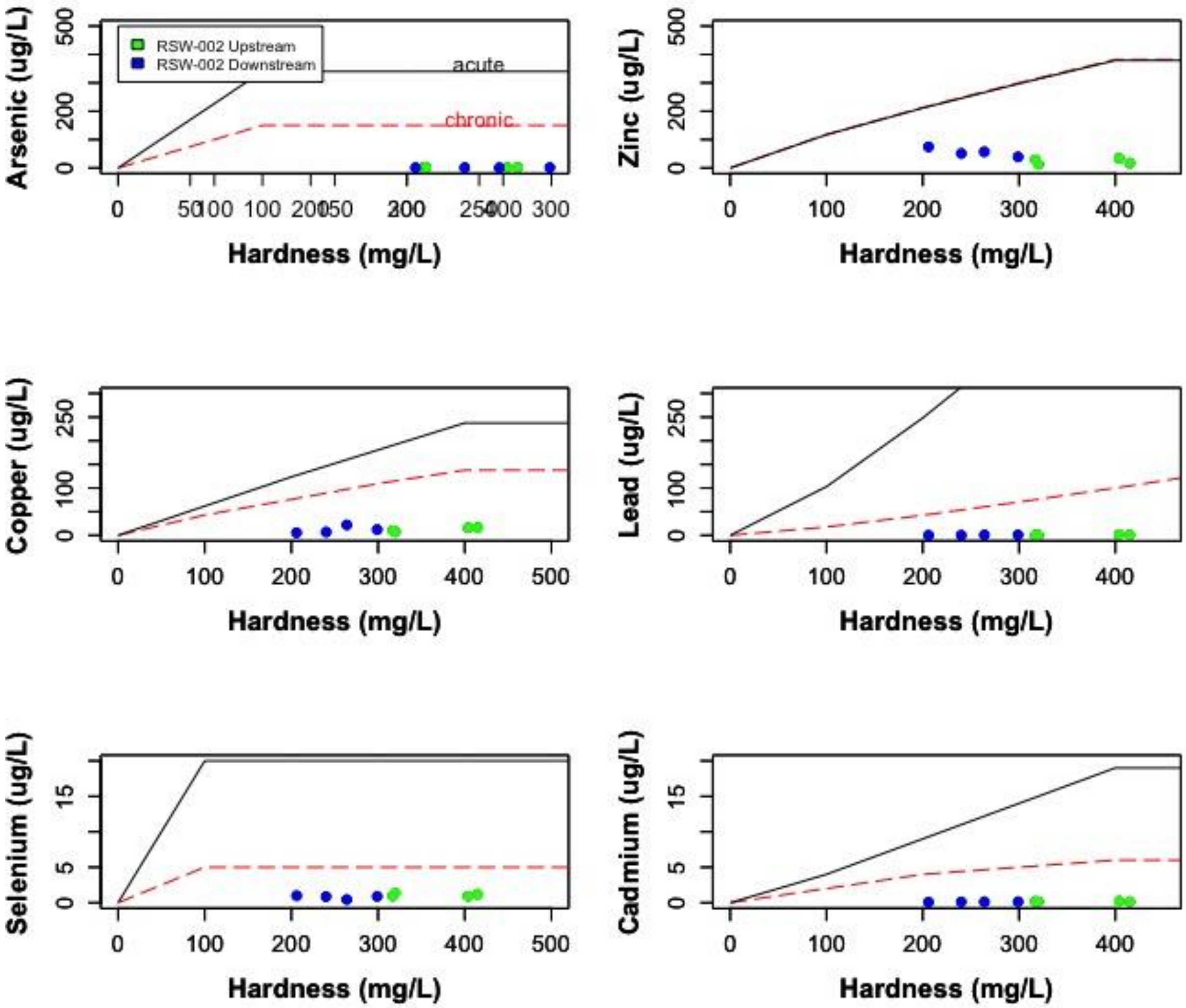

Figure 34. Dissolved metals concentrations above and below the BWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Only copper has a reach specific WER and CTR criteria are adjusted. Black lines indicate acute thresholds and red lines indicate chronic thresholds. Values are estimated in instances where there were non-detects that did not meet the laboratory's reporting limit.

Trihalomethanes were detected above and below the BWRP discharge locations. Concentration upstream and downstream were well below the EPA water quality objective 80 ug/L (Table 17).

Table 17. Trihalomethane concentrations above (RSW-002U) and below (RSW-002D) the BWRP discharge. Total trihalomethanes was precalculated and reported by the City of Burbank. "ND" indicates the analyte was not detected or the detected value was below the MDL. The EPA water quality objective for total trihalomethanes is 80 ug/L (U.S. EPA 2002).

Site	Parameter	2/4/20	8/3/20	Sum T1	Sum T2
RSW-002U (R1)	Bromodichloromethane	0.22	0.63	0.675	2.64
RSW-002U (R1)	Bromoform	0.135	0.135		
RSW-002U (R1)	Chloroform	0.145	1.7		
RSW-002U (R1)	Dibromochloromethane	0.175	0.175		
RSW-002D (R2)	Bromodichloromethane	1.4	0.22	5.69	1
RSW-002D (R2)	Bromoform	0.38	0.135		
RSW-002D (R2)	Chloroform	3.5	0.47		
RSW-002D (R2)	Dibromochloromethane	0.41	0.175		

Question 4: Is it safe to recreate?

1. Background

Thousands of people swim at unpermitted sites within the Los Angeles River Watershed each summer. The fourth element of the monitoring program assesses the beneficial use of informal sites in the Los Angeles River Watershed for Water Contact Recreation (REC-1). Prior to the initiation of LARWMP, the concentrations of potentially harmful fecal pathogens and the bacteria that indicate their presence was not known. Monitoring at both permitted and informal recreational swim sites reflects concerns for the risk of gastrointestinal illness posed by pathogen contamination to recreational swimmers in streams of the Los Angeles River watershed. Depending on the site, sources of indicator bacteria and pathogen contamination could include humans, dogs, wildlife, urban runoff, and refuse from campgrounds and homeless encampments.

Fecal indicator bacteria (FIB) tests are inexpensive and the body of literature shows *E. coli* to be a good predictor for gastrointestinal illness. Standards used by both EPA and LARWQCB are also based on *E. coli* cultivation methodology (EPA, 2010; Wade et al., 2003). However, several studies have found that no single indicator is protective of public health and that in some studies, FIB do not correlate well with pathogens (Hardwood et al., 2005). Studies have also highlighted the need to better understand whether faster and more specific microbial methods can better predict health outcomes (Wade et al., 2003), particularly since human fecal sources have an increased pathogenic risk. Many improved methods are in development but challenges remain related to performance, specificity, and sensitivity remain before they are applied to a regulatory realm (Harwood et al., 2013). Until methods improve and become cost-effective, the safe to recreate effort within the LARWMP will monitor FIB, specifically *E. coli*, at recreational sites in the watershed.

2. Methods

LARWMP's bacteria-monitoring program samples for *E. coli* about five times a month at each recreational swim site during the summer (Memorial Day to Labor Day) (Figure 35 and Table 18). The kayak sites are monitored from Memorial Day through the end of September. Sites sampled for swimming safety are selected based on the collective knowledge of the workgroup related to the most frequently used swimming locations in the watershed. To better understand the relationships between periods of heavy recreational swim use and *E. coli* concentrations, sampling is conducted on weekends and holidays to capture the occasions when the greatest numbers of people are swimming. This is because the San Gabriel River Watershed program, a similar program to LARWMP, found that indicator bacteria levels are higher on weekends and holidays when recreational swim use is greatest (SGRRMP 2009). However, due to COVID-19 and USFS restrictions meant to reduce crowding at recreational sites, we were not able to sample during weekends or holidays during the 2020 program year. Additionally, Hermit Falls, a site with a narrow access trail was dropped due to organizational social distancing requirements.

Field-monitoring teams deploy during the morning and collect grab samples at recreational sites. Observational data are also recorded at each site including information on flow habitats, number of visitors and swimmers, animals present, wind direction, and site refuse. Handheld meters and probes were used to collect data on dissolved oxygen, pH, water conductivity, and water temperature. The bacteria concentrations were compared against State of California REC-1 and LREC-1 standards (LARWQCB 2014) (

Table 19).

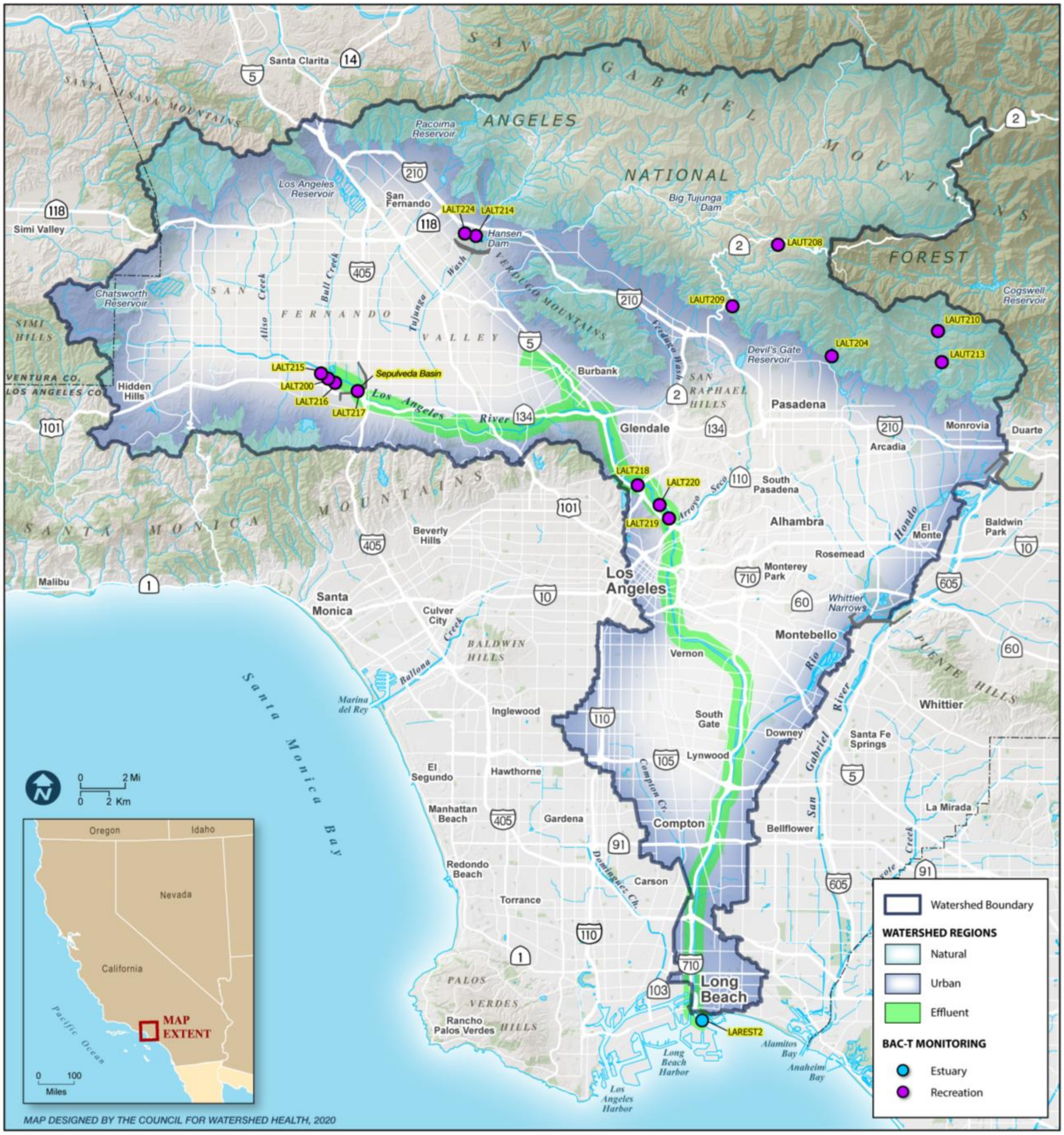

Figure 35. Recreational swim site locations in 2020.

Table 18. Sampling locations and site codes for indicator bacteria.

Program Element	Sampling Sites	Site Code
Recreational Swim Sites	Hansen Dam Recreation Lake	LALT224
	Bull Creek Sepulveda Basin	LALT200
	Eaton Canyon Natural Area Park	LALT204
	Tujunga Wash at Hansen Dam	LALT214
	Switzer Falls	LAUT208
	Gould Mesa Campground	LAUT209
	Sturtevant Falls	LAUT210
	Hermit Falls	LAUT213
	Vogel Flats	LAUT220
Recreational Kayak Sites	Upper Sepulveda Basin Zone	LALT215
	Middle Sepulveda Basin Zone	LALT216
	Lower Sepulveda Basin Zone	LALT217
	Upper Elysian Valley Zone	LALT218
	Middle Elysian Valley Zone	LALT221
	Lower Elysian Valley Zone	LALT219

Table 19. Indicator bacteria REC-1 standards for freshwaters. The statistical threshold value (STV) of 320 is not to be exceeded by more than 10 percent of samples collected in a calendar month. Whereas the geometric mean is calculated weekly using a rolling average to not exceed 100 MPN/100 mL.

Indicator	**Statistical Threshold Value**	**Six Week Rolling Geometric Mean**
E. coli	320 MPN/100 mL	100 MPN/100 mL

Table 20. Indicator bacteria LREC-1 single sample standards for freshwaters.

Indicator	**Single Sample Maximum Value**	**30-day Geometric Mean**
E. coli	576 MPN/100 mL	126 MPN/ 100 mL

The State of California describes REC-1 (LARWQCB 2020) as they apply to recreational activities where ingestion is reasonably possible and LREC-1 standards as they apply to activities where ingestion is infrequent. A standard making use of the geometric mean can be applied to both beneficial uses and provides an indication of how persistent elevated bacterial concentrations are at a site. Recent updates to the basin plan required a 6-week rolling geometric mean be applied at REC-1 sites and statistical threshold value applied to single samples. The REC-1 rolling mean standard and STV was applied to all informal recreation sites. LREC-1 standards were applied to kayak sites since recreators have limited water contact when kayaking as opposed to swim sites, where full submersion in water is more likely to occur. In order to apply the geometric mean, at least 5 samples per month are required. During the summer survey in 2020, there was a goal to collect no fewer than five samples per month at each of the swim sites. However, site closure, fires, and safety considerations prevented the collection of five monthly samples at select sites.

3. *Results*

During the summer of 2020, a total of 220 water samples were successfully collected from fourteen recreational swim sites popular with visitors and residents of the LA River watershed. The concentrations of *E. coli* at swim sites (Table 21) and kayak sites were compared to water quality objectives. The REC-1 STV standard was used at swim sites, a site exceeds the STV standard if more than 10% of samples within a calendar month are above 320 CFU/100 mL. We found that the Tujunga Wash Site at Hansen Dam (LALT 214) exceeded the STV all four months of sampling, including 100% exceedance of samples during the second month of sampling. Bull Creek (LALT200) and Eaton Canyon (LALT204) exceeded the STV during two of the four months of sampling. Kayak sites were compared to the single sample LREC standard of 526 CFU/100 mL and we found that exceedances were generally low and infrequent across sites. The highest percentage of exceedances was 11% at the Upper Elysian Valley site (LALT218) followed by the Lower Sepulveda Basin site (LALT217) exceedance rate of 6% (Table 22).

Table 21. Single sample *E. coli* concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from May through September 2020 (<10 MPN/100 mL = non-detect). NS indicates the site was not sampled on that date. Samples are compared to the statistical threshold value of 320. If more than 10% of samples taken within a calendar month exceed this value, it is considered an exceedance.

Swim Sites	6/3/20	6/11/20	6/18/20	6/23/20	7/1/20	7/9/20	7/17/20	7/24/20	7/27/20	7/30/20	8/3/20	8/7/20	8/11/20	8/14/20	8/21/20	8/24/20	8/28/20	9/1/20	9/4/20	9/16/20	5/21-6/20 STV Exceedances	6/21-7/20 STV Exceedances	7/21-8/20 STV Exceedances	8/21-9/20 STV Exceedances
LALT200	146	216	185	96	292	156	473	146	130	288	110	155	201	134	63	183	122	135	62	417	0%	25%	0%	17%
LALT204	NS	NS	NS	NS	NS	NS	NS	NS	10	20	10	20	20	5	NS	10	323	10	31	NS	NS	NS	0%	25%
LAUT208	NS	NS	NS	NS	NS	NS	NS	20	75	31	20	2490	20	31	10	97	52	504	480	NS	NS	NS	14%	40%
LAUT209	NS	NS	NS	NS	NS	NS	NS	20	74	10	41	41	85	31	109	173	216	84	10	NS	NS	NS	0%	0%
LAUT210	NS	NS	NS	NS	NS	NS	NS	63	10	41	63	31	52	20	NS	NS	148	262	20	NS	NS	NS	0%	0%
LAUT220	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	20	10	5	10	110	86	74	5	NS	NS	NS	0%	0%
LALT214	171	359	203	457	880	1050	336	496	265	408	487	243	279	175	295	855	148	512	420	1480	33%	100%	43%	67%
LALT224	5	5	5	5	41	10	5	5	5	5	5	5	5	5	10	5	31	10	10	5	0%	0%	0%	0%

Table 22. Single sample *E. coli* concentrations (MPN/100 mL) at kayak sites in the Los Angeles River Watershed from May through September 2020 (<10 MPN/100 mL = non-detect). NS indicates the site was not sampled on that date. Samples are compared to the single sample LREC-1 objective of 576 MPN/100 mL. Exceedances of

the LREC-1 standard are in a red box and exceedances of the REC- standard of 320 MPN/100mL are bolded red for comparison with swim recreation sites.

Kayak Sites	5/21/20	5/26/20	6/2/20	6/9/20	6/16/20	6/23/20	7/1/20	7/7/20	7/15/20	7/21/20	7/29/20	8/5/20	8/11/20	8/18/20	8/25/20	9/1/20	9/9/20	9/15/20	% Single Sample Exceedances
LALT215	**323**	41	241	86	52	**341**	30	52	193	20	52	161	52	74	**350**	10	52	145	0%
LALT216	**432**	108	74	86	122	63	75	31	63	86	122	73	122	279	**345**	120	**393**	97	0%
LALT217	**1380**	187	73	122	95	75	63	41	134	85	63	51	52	98	74	121	160	110	6%
LALT218	318	288	96	135	85	134	**624**	85	262	128	213	**571**	**960**	269	**495**	120	160	145	11%
LALT221	233	85	86	63	97	146	75	31	86	10	62	63	20	135	20	31	86	41	0%
LALT219	249	31	20	109	52	110	5	52	5	31	41	86	52	20	41	**364**	86	63	0%

The geometric mean is meant to capture persistently high FIB. Table 23 shows the percentage of swim site samples that exceed the 6-week rolling geometric mean REC-1 standard. We observed persistently high FIB at Bull Creek (LALT200) and Tujunga Wash at Hansen Dam (LALT214), each with 100% exceedance of the 6-week rolling geometric mean. With the exception of Switzer falls, which had a single exceedance of the 6-week geometric mean, all other swim sites did not exceed the REC-1 rolling average WQO. We found persistently high levels of bacteria, when compared to the 30-day geometric mean LREC-1 standard, at the Upper Elysian Valley (LALT218, 100% exceedance). The Middle Sepulveda Basin (LALT216) had 50% of samples exceed the geometric mean and the Lower Sepulveda Basin (LALT217) had 25% exceedance.

Table 23. Six-week rolling geometric mean *E. coli* concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed in 2020. Exceedance of the 100 MPN/ML (REC-1 Standards).

	5/21/20 - 7/2/20	5/28/20 - 7/9/20	6/4/20 - 7/22/20	6/11/20 - 7/29/20	6/18/20 - 8/5/20	7/1/20- 8/10/20	7/8/20 -8/17/20	7/15/20 -8/24/20	7/22/20 -8/31/20	7/29/20 -9/7/20	8/5/20- 9/14/20		
Site Name	**Week 1 - Week 6**	**Week 2- Week 7**	**Week 3 - Week 8**	**Week 4- Week 9**	**Week 5- Week 10**	**Week 6- Week 11**	**Week 7 - Week 12**	**Week 8- Week 13**	**Week 9 - Week 14**	**Week 10- Week 15**	**Week 11- Week 16**	**% Exceedances**	**N**
LALT200	175	172	209	188	183	194	183	162	143	132	122	100%	11
LALT204	NS	NS	NS	10	13	14	14	13	18	20	21	0%	8
LAUT208	NS	NS	NS	39	31	75	75	44	49	81	108	13%	8
LAUT209	NS	NS	NS	39	28	30	30	40	55	52	66	0%	8
LAUT210	NS	NS	NS	25	36	35	35	34	41	53	54	0%	8
LAUT220	NS	NS	NS	NS	NS	20	20	10	21	21	21	0%	6
LALT214	347	417	467	438	450	459	418	315	321	337	314	100%	11
LALT224	8	8	8	7	7	7	6	5	6	7	8	0%	11

Table 24. 30-day geometric mean of *E. coli* concentrations (MPN/100 mL) at kayak zones in the Sepulveda Basin Recreation Zone and Elysian Valley Recreation Zone (LREC-1 Standards).

Kayak Sites	**Month 1 GM**	**Month 2 GM**	**Month 3 GM**	**Month 4 GM**	**% Exceedances**
LALT215	107	101	58	72	0%
LALT216	129	55	121	199	50%
LALT217	185	71	67	112	25%
LALT218	159	208	332	193	100%
LALT221	101	74	40	38	0%
LALT219	61	19	41	95	0%

Table 25 summarizes site observations for the 2020 monitoring year. The most popular sites among the public are Sturtevant Falls (LAUT210) and Hansen Dam Recreation Lake (LALT224), sites that are generally meeting WQO for FIB. Eaton Canyon (LALT214) has been amongst the most popular in previous years but site closures and a timed entry system during COVID-19 likely limited visitors to the site. It is important to note that many sites are sampled in the morning, prior to the arrival of large crowds and bacteria concentrations may reflect usage patterns of the previous day. The monitoring program attempts to account for this by scheduling sampling on holidays and the days after a major holiday. Site visitation has not correlated with E. coli concentrations in previous years and instead pH and turbidity have been significantly correlated with *E. coli* numbers (see 2019 LARWMP Report).

Table 25. Site usage summary for recreational swim sites sampled in 2020.

StationID	# People On-Shore	# Animals	#Bathers	#Fisherman	Refuse	Algae	Foam	Oil	Tar	Sewage	Upstream Stormdrain
LALT200	0.4	0.4	0.0	0.0	Present	Absent	Absent	Absent	Absent	Absent	Absent
LALT204	1.8	0.2	0.2	0.0	Largely present	Absent	Absent	Absent	Absent	Absent	Absent
LALT214	0.8	0.8	0.0	0.0	Present	Absent	Absent	Absent	Absent	Absent	Absent
LALT224	4.8	2.7	0.0	0.0	Absent	Absent	Absent	Absent	Absent	Absent	Absent
LAUT208	0.3	0.2	0.0	0.0	Largely present	Absent	Absent	Absent	Absent	Absent	Absent
LAUT209	0.3	0.1	0.3	0.0	Largely present	Absent	Absent	Absent	Absent	Absent	Absent
LAUT210	18.2	0.8	0.5	0.0	Largely present	Largely absent	Absent	Absent	Absent	Absent	Absent
LAUT220	0.6	0.3	0.0	0.0	Largely present	Absent	Absent	Absent	Absent	Absent	Absent

Trash assessments were also completed at recreation sites, excluding kayak sites, from 2018 to 2020 using the methodology described under Question 1- Methods. We found that plastic, biodegradable items, and biohazardous materials were the most common categories of trash types across all sites (Figure 36). When analyzing more detailed trash sub-types across all recreation sites, we found that wrappers/wrapper pieces and cardboard were the most common (Figure 37). Hansen Dam at the Tujunga Wash (LALT214) and Sturtevant Falls (LAUT210) were the recreation sites with the highest trash counts (Figure 38).

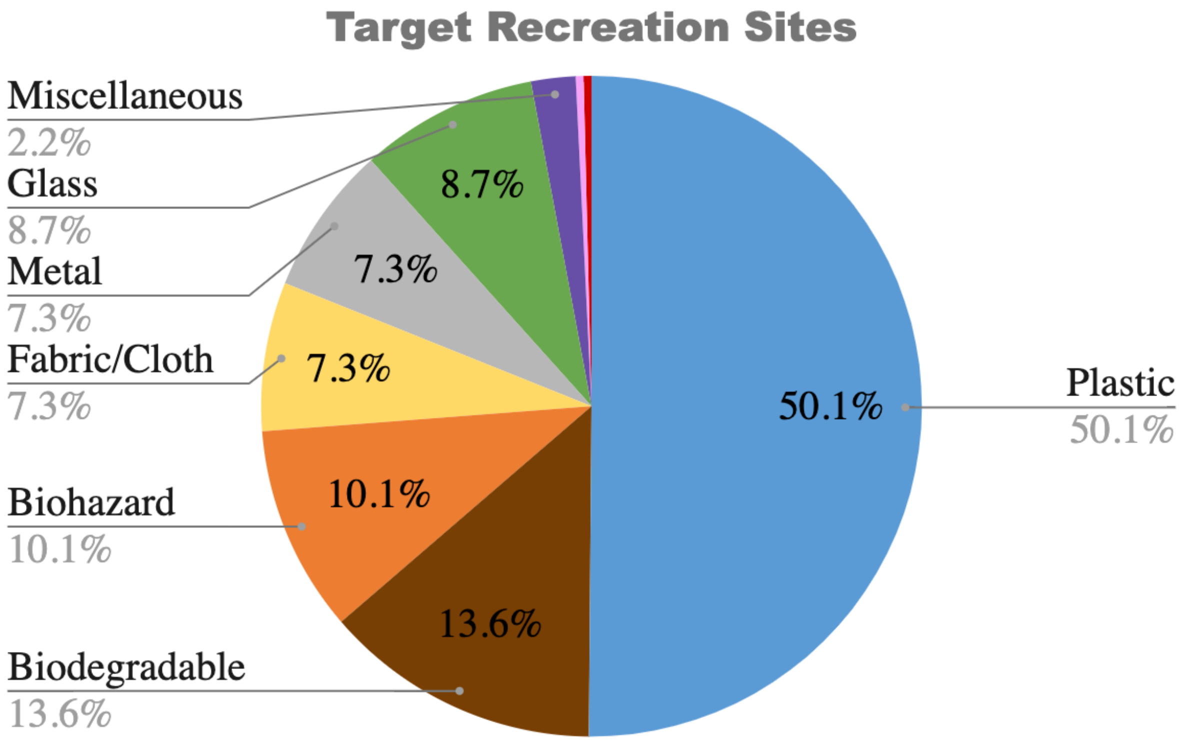

Figure 36 Proportion of trash within each broad trash category at recreation sites surveyed between 2018-2020 by the LARWMP program.

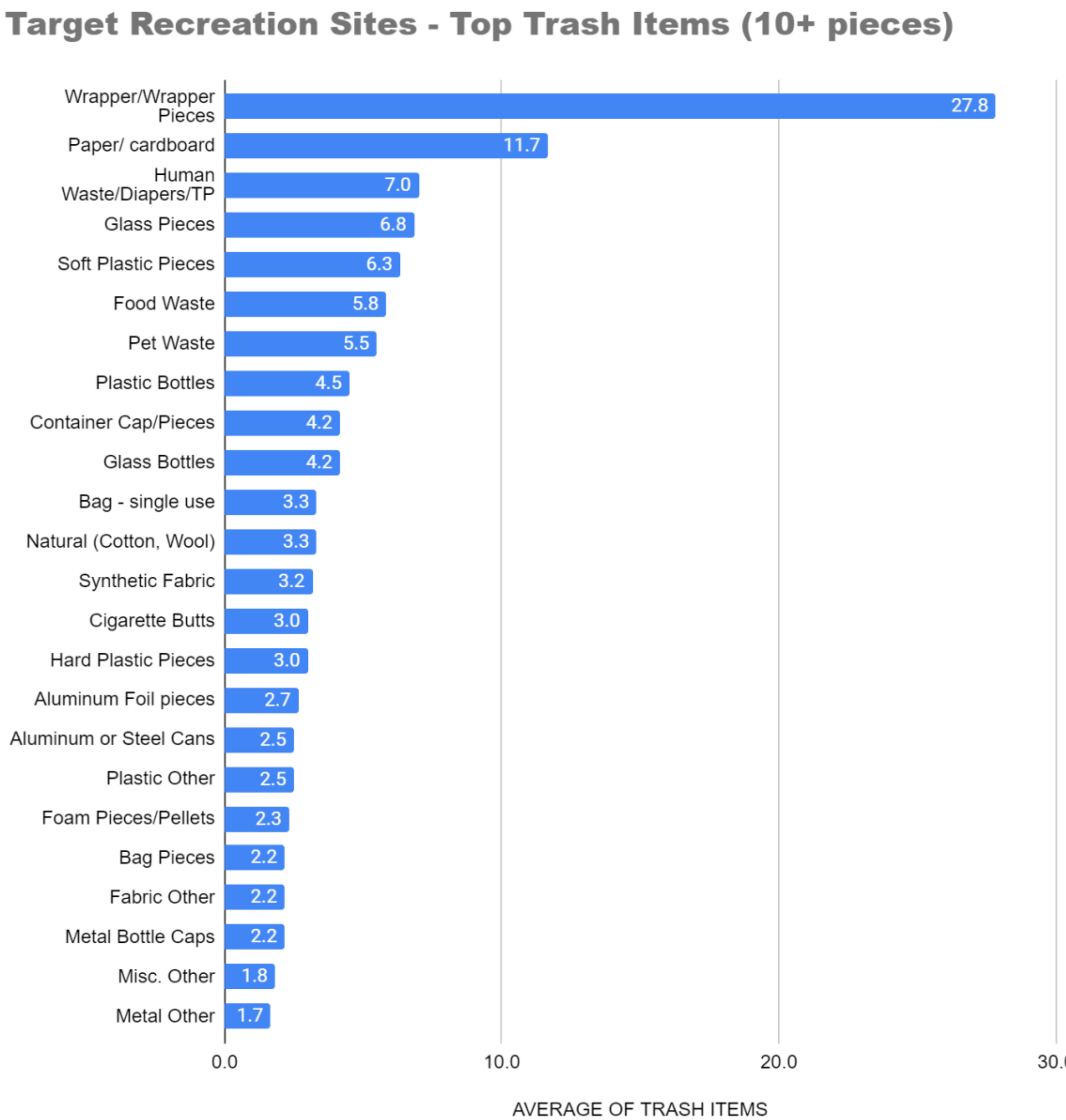

Figure 37 Average count of each trash sub-category across recreation sites sampled between 2018-2020 by the LARWMP program.

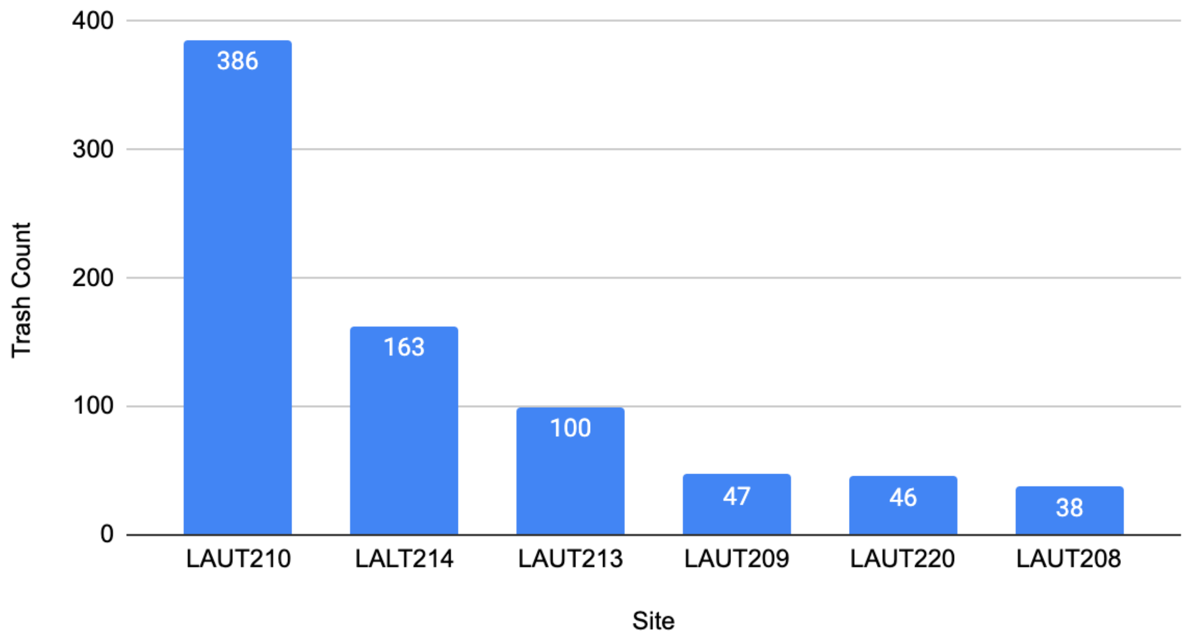

Figure 38 Total counts of trash for a sub-set of recreation sites.

Question 5: Are locally caught fish safe to eat?

1. Background

Question 5 addresses the human health risk associated with consuming contaminated fish caught at popular fishing locations in the watershed. The monitoring program focuses on one or two fishing sites each year with the goal of identifying the fish species and contaminant types that are of concern. Sites are selected based on the technical stakeholder group's input about sites that are popular with the angler community. Data will provide watershed managers with the information necessary to educate the public about the safety of consuming the fish they catch.

2. Methods

Sampling and Tissue Analysis

Sites for contaminant monitoring in fish populations revolve from year to year and have included various lake and river sites throughout the watershed. Lake and river sites are selected based on angler surveys conducted at recreational sites throughout the watershed by Allen et al. (2008) and the recommendations of the Technical Stakeholder Group.

Fish were collected using a boat outfitted with electroshocking equipment, in accordance to the Office of Environmental Health Hazards (OEHHA) sport fish sampling and analysis protocols, which allowed specific species and size classes to be targeted (OEHHA 2005). OEHHA specifies that the muscle fillets from at least five individual fish of the same species and size class be combined to form a composite sample. LARWMP analyzed only the muscle tissue of the fish, which is common practice in regional regulatory programs. Other body parts, such as the skin, eyes, and organs of fish may contain higher levels of contaminants and are not recommended for consumption by the OEHHA. Four contaminants, mercury, selenium, total DDTs, and total PCBs, were selected for analysis based on their contribution to human health risk in California's coastal and estuarine fishes.

Mercury can transform in the environment, effecting its behavior and tendency for biological accumulation. It is widely assumed that nearly all (>95%) of the mercury present in fish is methyl mercury (Wiener et al. 2007). Consequently, monitoring programs usually analyze total mercury as a proxy for methyl mercury, as was done in this study. The U.S. EPA (2000) recommends using the conservative assumption that all mercury that is present is methyl mercury, since it is most protective of human health.

It is also important to note that this program component does not include rainbow trout, a popularly stocked and locally caught fish. Once rainbow trout are released to a waterbody they are caught very quickly and, therefore, have a very short residence time, reducing their potential to accumulate contaminants from that waterbody. There is still the potential for stocked fish to accumulate contaminants from the waterbody where they were raised, but that is not the focus of this study.

Advisory Tissue Levels
Concentrations of contaminants in each fish species were compared to State Fish Contaminant Goals (FCGs) and Advisory Tissue Levels (ATLs) for human consumption developed by the OEHHA (2008). The OEHHA Fish Contaminant Goals (FCGs) are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, and over a lifetime. This guidance assumes a lifetime risk level of 1

in one million for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant.

The OEHHA ATLs, while still conferring no significant health risk to individuals consuming sport fish in the quantities shown over a lifetime, were developed with the recognition that there are unique health benefits associated with fish consumption and that the advisory process should be expanded beyond a simple risk paradigm to best promote the overall health of the fish consumer (Table 26 and Table 27). ATLs protect consumers from being exposed to more than the average daily reference dose for non-carcinogens or to a lifetime cancer risk level of 1 in 10,000 for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant. For specific details regarding the assumptions used to develop the FCGs and ATLs, go to: http://oehha.ca.gov/fish/gtlsv/crnr062708.html (OEHHA, 2008).

Figure 39. Fish tissue sampling location for the 2020 bioaccumulation survey.

Table 26. Fish contaminant goals (FCGs) for selected fish contaminants based on cancerous and noncancerous risk * using an 8-ounce/week (prior to cooking) consumption rate (32 g/day). **

	FCGs (ppb, wet weight)
Contaminant Cancer Slope Factor (mg/kg/day)-1	
DDTs (0.34)	**21**
PCBs (2)	**3.6**
Contaminant Reference Dose (mg/kg-day)	
DDTs (5x10-4)	1600
Methylmercury (1x10-4)[S]	**220**
PCBs (2x10-5)	63
Selenium (5x10-3)	**7400**

*The most health protective Fish Contaminant Goal for each chemical (cancer slope factor-
**g/day represents the average amount of fish consumed daily, distributed over a 7-day
[S]Fish Contaminant Goal for sensitive populations (i.e., women aged 18 to 45 years and children aged 1 to 17 years.)

Table 27. OEHHA (2008) advisory tissue levels (ATLs) for selected fish contaminants based on cancer or non-cancer risk using an 8-ounce serving size (prior to cooking; ppb, wet weight)

Contaminant	Three 8-ounce Servings* a Week	Two 8-ounce Servings* a Week	One 8-ounce Servings* a Week	No Consumption
DDT[snc]**	≤520	>520-1,000	>1,000-2,100	>2,100
Methylmercury (Women aged 18-45 years and children aged 1-17 years)[nc]	≤70	>70-150	>150-440	>440
Methylmercury (Women over 45 years and men)[nc]	≤220	>220-440	>440-1,310	>1,310
PCBs[nc]	≤21	>21-42	>42-120	>120
Seleniumn[c]	≤2500	>2500-4,900	>4,900-15,000	>15,000

[c]ATLs are based on cancer risk
[nc]ATLs are based on non-cancer risk
*Serving sizes are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts (for
**ATLS for DDTs are based on non-cancer risk for two and three servings per week and cancer risk for one serving per week.

3. Results

A total of 3 fish were successfully collected from Lake Balboa including common carp (*Cyprinus carpio*) and channel catfish (*Ictalurus punctatus*) (Figure 32). As a result of delayed sampling due to COVID-19 restrictions, fewer fish were caught in 2020 making composite analysis (as done in normal years) infeasible. Each fish was analyzed individually. On average, the largest fish captured in the lake was common carp (6,900 g), while the smallest fish caught was channel catfish (1,100 g) (Table 28).

The feeding strategies for each of the five species are as follows:

- Common carp adults feed on bottom-dwelling invertebrates and aquatic plants that provide habitat for invertebrates (McGinnis 1984).

- Bluegill populations are bottom feeders, consuming all available food including largemouth bass eggs (McGinnis 2006). Their diet also includes aquatic insects and their larvae; up to 50% of their diet can consist of midge larvae (Page, 1991).
- Green sunfish are opportunistic predators, feeding primarily on invertebrates and small fish. (Regents of University of California)

Table 28. Number, average standard weight, and length of the individual and composite fish samples collected in 2020.

Waterbody	Comp #	n	Species Name	CommonName	Avg. Weight (g)	Standard Length			Total Length		
						Avg. (mm)	Min (mm)	Max (mm)	Avg. (mm)	Min (mm)	Max (mm)
Lake Balboa	1	1	*Cyprinus carpio*	common carp	1600.0	400	400	400	490	490	490
	2	1	*Cyprinus carpio*	common carp	6900.0	690	690	690	800	800	800
	1	1	*Ictalurus punctatus*	channel catfish	1100.0	380	380	380	470	470	470

Of the four contaminants measured in each of the composites of fish tissue, none exceeded the OEHHA ATL thresholds (Table 29).

Common carp and channel catfish from Lake Balboa are safe to eat. Based on OEHHA guidance, one should limit their consumption to three 8-oz servings a week.

Common carp is a trophic level three fish and channel catfish is a trophic level four fish (LARWQCB, 2017). Both trophic level four fish and trophic level three fish are some of the most common fish that recreational anglers catch and consume (Palumbo and Iverson 2017).

The concentrations of harmful contaminants are generally consistent with predictions based on size, trophic position, and feeding ecology. According to the State Water Resources Control Board, methylmercury concentration in fish tissue is often directly related to fish length and trophic position. While all fish in this study were found safe to eat three times a week (8-oz), higher trophic level and feeding ecology may explain why channel catfish had higher concentrations of contaminants than common carp.

Additionally, while it is not uncommon for fish consumers to consume many parts of the fish they catch, it is important to note that the results of this report are based on the concentration of contaminants in fish filet. According to OEHHA, contaminants can be much higher in the eggs, guts, liver, skin, and fatty parts of fish. They do not recommend consuming these parts of the fish because of the increased risk of contaminant exposure. Interestingly, a study by Regine et al. (2006) found that fish who feed on bacteria and small benthic invertebrates had higher organ to muscle ratios of mercury in their liver and kidneys. Fish who fed on other fish had higher ratios of mercury in their muscle tissue.

Table 29. Sport fish consumption chemistry results: concentration of contaminants in fish tissues relative to the OEHHA ATL thresholds.

Fish Consumption Lake Balboa - LALT301					
Common Name	Comp. #	Mercury (ppb)	Selenium (ppb)	DDTs (ppb)	PCBs (ppb)
channel catfish	1	21	ND	167.8	4.7
common carp	1	12	400	20.4	0.31
common carp	2	12	490	25.6	0.36

Three 8-oz servings a week ATL
Two 8-oz servings a week ATL
One 8-oz serving a week ATL
No consumption ATL.

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Appendix A – Quality Assurance/Quality Control

LARWMP includes an emphasis on QA/QC for each phase of the program including the standardization of data formats so that monitoring results can be shared with local, state, and federal agencies. The data quality objectives for the program are outlined in LARWMP's QAPP and were finalized prior to the 2009 survey and it was updated each year thereafter (https://www.watershedhealth.org/resources). Therefore, the data reported herein from the 2020 survey were based on field sampling and laboratory analysis protocols agreed upon by the participants.

Measurement or Data Quality Objectives (MQOs or DQOs) are quantitative or qualitative statements that specify the tolerable levels of potential errors in the data and ensure that the data generated meet the quantity and quality of data required to support the study objectives. The DQOs for LARWMP are detailed in the Program QAPP (CWH 2020). The MQOs for the processing and identification of benthic macroinvertebrate samples are summarized in LARWMP's QAPP and detailed in the Southern California Regional Watershed Monitoring Program: Bioassessment Quality Assurance Project Plan, Version 1.0 (SCCWRP 2009). The DQOs and MQOs focused on five aspects of data quality: completeness, precision, accuracy, representativeness, and sensitivity.

Completeness

Completeness describes the success of sample collection and laboratory analysis (biology, chemistry, and toxicity) which should be sufficient to fulfill the statistical criteria of the project. One lake, 10 randomly selected sites, and 2 targeted sites were sampled in 2020.

Freshwater targeted and random analysis completeness was 100% for general chemistry, nutrients, major ions, and bioassessment (Table A-1).

Percent completeness for bioaccumulation samples analyzing organochlorine pesticides was 100% in 2020. PCB's were 100% complete for 43 congeners. Due to missing standards, 21 PCB congeners were reported 0% (Table A-2-2 and Table A-2-3). The sampling team and laboratories were notified of completeness deficiencies.

Accuracy

Accuracy provides an estimate of how close a laboratory or field measurement of a parameter is to the true value. Field sampling accuracy was assessed by calibration of the water quality probes with standards of known concentration. The accuracy of physical habitat measurements was assessed during a field audit conducted by the Southern California Coastal Water Research Project (SCCWRP) as part of the Stormwater Monitoring Coalitions (SMC) Southern California Regional Monitoring Survey, field calibration exercise. BMI sorting accuracy was assessed by a recount of 10% of sorted materials. The MQO of 95% was met for each lab reporting results for this program. Taxonomic identification accuracy was assessed through the independent re-identification of 10% of samples by the Department of Fish and Games Aquatic Biology Laboratory. MQOs for taxa count, taxonomic identification, and individual identification rates were met.

Analytical chemistry accuracy measures how close measurements are to the true value. For analytical chemistry samples Certified Reference Materials (CRM), matrix spike / matrix spike duplicates and laboratory control standards are used to assess method accuracy and precision. LARWMP followed SWAMP protocols, which allow one of these elements to fail in a batch and still be compliant. If data fails accuracy checks, it is noted in data and an accuracy qualifier is associated with that result.

Precision

Field duplicates were collected for chemistry, toxicity, and benthic macroinvertebrates at 10% of the random sites visited in 2010. The MQO for field duplicates was a relative percent difference (RPDs) <25%, except for benthic macroinvertebrates. At this time, no MQO has been developed for benthic macroinvertebrate duplicate samples. For analytical chemistry results matrix spike (MS), matrix spike

duplicates (MSD), and laboratory duplicates (DUP) were used to assess laboratory precision. RPDs <25% for either the MS/MSD or DUPs were considered acceptable. Of the analytes measured in 2020, 2did not meet the precision criteria (Table A-4).
Taxonomic precision was assessed using three error rates: random errors which are misidentifications that are made inconsistently within a taxon; systemic errors occur when a specific taxon is consistently misidentified; taxonomic resolution errors occur when taxa are not identified to the proper taxonomic level. Error rates of <10% are considered acceptable and all precision requirements were met.

Laboratory Blanks

Laboratory blanks were used to demonstrate that the analytical procedures do not result in sample contamination. The MQO for laboratory blanks were those with values less than the Method Detection Limit (MDL) for the analyte. During the 2020 surveys, laboratory blanks for Total Organic Carbon, nickel, and zinc were above the MDL (Table A-3).

Program Improvements and Standardization

Intercalibration studies will be ongoing as part of the SMC Regional Monitoring Program. This intercalibration included all participating laboratories and covered nutrient and metal analyses. Environmental Monitoring Division (EMD), City of Los Angeles is participating in an interlab calibration study involving nutrients, metals pesticides and PAH analysis methods in 2021. EMD uses all ELAP-approved methods and routinely participates in internal QC and Proficiency Test (PT) studies mandated by the State Water Resources Control Board (SWRCB)/Environmental Laboratory Accreditation Program (ELAP).

Sampling procedures for each field team collecting samples for LARWMP were audited by biologists from the Southern California Coastal Water Research Project during summer surveys. The audit covered the SWAMP bioassessment and physical habitat protocols, including algae and benthic macroinvertebrate collection, and CRAM assessment (Ode, 2007, Fetscher *et al.,* 2009, CWMW 2012, and CWMW 2013). Each team passed their audit.

Table A-1. Percent completeness and non-detects by watershed sub-region for water chemistry samples collected in 2020.

	2020					
			Number of Non-Detects (<MDL)			
Analyte	Number of Sites	Completeness (%)	Effluent (n=3)	Natural (n=5)	Urban (n=6)	Total
Genreal Chemistry						
Alkalinity as CaCO3	12	100	0	0	0	0
Hardness as CaCO3	12	100	0	0	0	0
Total Suspended Solids	12	100	0	2	0	2
Turbidity	12	100	0	0	0	0
Chlorophyll a	10	100	0	0	0	0
Ash-Free Dry Mass	10	100	0	0	0	0
Nutrients						
Ammonia as N	12	100	0	1	1	2
Dissolved Organic Carbon	12	100	0	0	0	0
Nitrate as N	12	100	0	1	0	1
Nitrite as N	12	100	2	5	4	11
OrthoPhosphate as P	12	100	0	4	2	6
Phosphorus as P	12	100	0	0	0	0
Total Nitrogen (calculated)	12	100	0	0	0	0
Total Organic Carbon	12	100	0	0	0	0
Major Ions						
Chloride	12	100	0	0	0	0
Sulfate	12	100	0	0	0	0
Metals						
Arsenic	12	100	0	0	0	0
Cadmium	12	100	0	1	4	5
Chromium	12	100	0	1	1	2
Copper	12	100	0	0	0	0
Iron	12	100	0	0	2	2
Lead	12	100	0	1	0	1
Mercury	12	100	3	5	5	13
Nickel	12	100	0	0	0	0
Selenium	12	100	0	3	0	3
Zinc	12	100	0	0	0	0
Bioassessment						
Benthic Macroinvertebrate ID	10	100	NA	NA	NA	NA
Algae ID	10	100	NA	NA	NA	NA

Table A-2 1 Percent completeness and non-detects for bioaccumulation samples collected in 2020.

Bioaccumulation	2020		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
General Chemistry			
Lipids	3	100	0
Metals			
Mercury	3	100	0
Selenium	3	100	0
Organochlorine Pesticides			
Aldrin	3	0	NA
Chlordane, cis-	3	0	NA
Chlordane, trans-	3	0	NA
DDD(o,p')	3	100	4
DDD(p,p')	3	100	0
DDE(o,p')	3	100	3
DDE(p,p')	3	100	0
DDT(o,p')	3	100	4
DDT(p,p')	3	100	2
Dieldrin	3	0	NA
Endosulfan I	3	0	NA
Endosulfan II	3	0	NA
Endosulfan Sulfate	3	0	NA
Endrin	3	0	NA
Endrin Aldehyde	3	0	NA
HCH, alpha	3	0	NA
HCH, beta	3	0	NA
HCH, delta	3	0	NA
HCH, gamma	3	0	NA
Heptachlor	3	0	NA
Heptachlor Epoxide	3	0	NA
Methoxychlor	3	0	NA
Mirex	3	0	NA
Nonachlor, cis-	3	0	NA
Nonachlor, trans-	3	0	NA
Oxychlordane	3	0	NA
Toxaphene	3	0	NA

Table A-2 2 Percent completeness and non-detects for bioaccumulation samples collected in 2020 (continued)

Bioaccumulation	2020		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
PCBs			
PCB 003	3	0	NA
PCB 008	3	0	NA
PCB 018	3	100	4
PCB 027	3	0	NA
PCB 028	3	100	4
PCB 029	3	0	NA
PCB 031	3	0	NA
PCB 033	3	0	NA
PCB 037	3	100	4
PCB 044	3	100	4
PCB 049	3	100	4
PCB 052	3	100	4
PCB 056	3	0	NA
PCB 056/060	3	0	NA
PCB 060	3	0	4
PCB 064	3	0	NA
PCB 066	3	100	4
PCB 070	3	100	4
PCB 074	3	100	4
PCB 077	3	100	4
PCB 081	3	100	4
PCB 087	3	100	4
PCB 095	3	0	NA
PCB 097	3	0	NA
PCB 099	3	100	4
PCB 101	3	100	4
PCB 105	3	100	4
PCB 110	3	100	4
PCB 114	3	100	4
PCB 118	3	100	4
PCB 119	3	100	4
PCB 123	3	100	4

Table A-2 3 Percent completeness and non-detects for bioaccumulation samples collected in 2020(continued)

Bioaccumulation	2020		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
PCB 126	4	100	4
PCB 128	4	100	4
PCB 128/167	4	100	4
PCB 137	4	0	NA
PCB 138	4	100	4
PCB 141	4	0	NA
PCB 146	4	0	NA
PCB 149	4	100	4
PCB 151	4	100	4
PCB 153	4	100	4
PCB 156	4	100	4
PCB 157	4	100	4
PCB 158	4	100	4
PCB 167	4	100	4
PCB 168	4	100	4
PCB 168/132	4	0	NA
PCB 169	4	100	4
PCB 170	4	100	4
PCB 174	4	0	NA
PCB 177	4	100	4
PCB 180	4	100	4
PCB 183	4	100	4
PCB 187	4	100	4
PCB 189	4	100	4
PCB 194	4	100	4
PCB 195	4	0	NA
PCB 198/199	4	0	NA
PCB 200	4	100	4
PCB 201	4	100	4
PCB 203	4	0	NA
PCB 206	4	100	4
PCB 209	4	0	NA

Table A-3 Lab Blanks

Analyte	Sampling Year	Sample Type	Batch ID	Result	Unit	Minimum Detection Limit	Reporting Limit
General Chemistry							
Total Organic Carbon	2020	LabBlank	9263	0.06	mg/L	0.05	0.05
Metals							
Nickel	2020	LabBlank	4794	0.53	ug/L	0.31	0.31
Zinc	2020	LabBlank	4547	1	ug/L	0.58	0.58

Table A-4 QA/QC Table. Bold type indicates values that did not meet quality control criteria.

QAQC Table. Matrix spikes, matrix spike duplicates (MS), laboratory control samples, laboratory control sample duplicates (LCS), certified reference material (CRM), Laboratory Duplicates (Lab Dup), percent recovers (% R) and relative percent differences (RPD) that did not meet data quality objectives (DQO). Boldface type indicates values that did not meet quality control criteria.

Analyte	Station ID	Sample Date	Batch ID	Sample Type	Recovery DQO	% Recovery	Dup % Recovery	RPD	RPD DQO
Metals (Samplewater)									
Nitrate as N	LAR08656	14-Jul-20	6212501	Samplewater	80 - 120 %	**138**	**139**	1	< 25 %
Nitrite as N	LAR08656	14-Jul-20	6212501	Samplewater	80 - 120 %	**129**	**129**	0	< 25 %

Appendix B – Biotic Condition Index Scores for the CSCI & CRAM

Table B-1. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2018.

Stratum	Station	Station Description	CSCI	CSCI Percentile	MMI	MMI Percentile	O/E	O/E Percentile	Overall CRAM Score	Biotic Structure	Buffer and Landscape Context	Hydrology	Physical Structure
2009													
Effluent	LAR00436	Los Angeles River	0.62	0.01	0.49	0	0.74	0.09	27	8	6	12	6
	LAR02228	Los Angeles River	0.70	0.03	0.55	0.01	0.84	0.21	27	8	6	12	6
Urban	LAR00440	Aliso Canyon Wash	0.80	0.1	0.60	0.01	0.99	0.48	64	25	21	18	12
	LAR00756	Tujunga Wash	0.68	0.02	0.51	0	0.85	0.21	37	8	15	12	6
	LAR01004	Arroyo Seco	0.67	0.02	0.51	0	0.83	0.19	29	8	8	12	6
Natural	LAR00476	Little Bear Canyon	1.22	0.92	1.16	0.82	1.28	0.93	99	34	24	36	24
	LAR00520	Big Tujunga Creek	1.02	0.55	0.77	0.1	1.27	0.92	80	33	20	21	21
	LAR00924	Arroyo Seco	1.35	0.99	1.43	0.99	1.27	0.93	87	33	20	30	21
	LAR01040	Big Tujunga Creek	1.21	0.91	1.10	0.72	1.32	0.95	89	33	24	27	21
	LAR06216	Big Tujunga Creek	0.85	0.17	0.73	0.07	0.97	0.43	64	23	20	21	12
2010													
Effluent	LAR00318	Los Angeles River	0.35	0	0.19	0	0.51	0.01	36	8	16	9	6
	LAR02622	Los Angeles River	0.44	0	0.37	0	0.52	0.01	36	8	16	9	6
Urban	LAR01208	Los Angeles River	0.54	0	0.58	0.01	0.50	0	38	8	16	12	6
	LAR01452	Eaton Wash	0.37	0	0.30	0	0.44	0	36	10	16	9	6
	LAR01716	Bull Creek	0.43	0	0.48	0	0.39	0	38	8	16	12	6
	LAR01972	Bull Creek	0.42	0	0.44	0	0.40	0	38	8	16	12	6
Natural	LAR00080	Lynx Gulch	0.75	0.06	0.64	0.02	0.86	0.23	55	17	18	21	9
	LAR00520	Big Tujunga Creek	0.75	0.06	0.73	0.07	0.76	0.11	63	15	22	24	12
	LAR00924	Arroyo Seco	0.68	0.02	0.55	0.01	0.81	0.16	70	20	24	27	12
	LAR01096	Big Tujunga Creek	0.65	0.01	0.59	0.01	0.71	0.06	63	15	20	27	12
	LAR01196	Big Tujunga Creek	0.82	0.13	0.79	0.12	0.85	0.21	65	21	22	21	12
	LAR01320	Big Tujunga Creek	0.69	0.03	0.62	0.02	0.77	0.12	66	21	22	27	9
	LAR01544	Big Tujunga Creek	0.84	0.15	0.77	0.1	0.90	0.3	66	18	22	30	9
2011													
Effluent	LAR02804	Los Angeles River	0.72	0.04	0.55	0.01	0.88	0.27	39	13	15	12	6
Urban	LAR00632	Tarzana	0.44	0	0.33	0	0.55	0.01	32	15	7	12	6
	LAR00684	Rio Hondo Spillway	0.44	0	0.43	0	0.44	0	38	8	16	12	6
	LAR00748	Rubio Wash, Rosemead	0.25	0	0.27	0	0.24	0	35	10	15	9	6
	LAR00830	Rio Hondo	0.43	0	0.47	0	0.39	0	38	8	16	12	6
	LAR01358	Compton Creek	0.37	0	0.23	0	0.51	0.01	37	8	15	12	6
Natural	LAR00080	Lynx Gulch	0.89	0.25	0.81	0.14	0.98	0.45	78	20	22	36	15
	LAR00520	Big Tujunga Creek	0.80	0.1	0.75	0.08	0.85	0.21	71	15	20	30	18
	LAR00924	Arroyo Seco	0.79	0.1	0.80	0.13	0.79	0.13	76	19	22	30	18
	LAR01692	Arroyo Seco	0.83	0.15	0.67	0.03	0.99	0.48	63	16	18	30	12
	LAR01808	Alder Creek	0.87	0.21	0.80	0.14	0.93	0.37	86	26	23	36	18
	LAR02088	Big Tujunga Creek	0.86	0.2	0.71	0.05	1.02	0.54	66	14	20	33	12
	LAR02092	Big Tujunga Creek	0.88	0.23	0.72	0.06	1.04	0.58	77	21	22	30	18
2012													
Effluent	LAR04532	Los Angelese River	0.68	0.02	0.51	0	0.85	0.21	47	13	16	21	6
Urban	LAR01464	Aliso Canyon Wash	0.70	0.03	0.60	0.01	0.80	0.14	34	8	7	21	6
	LAR01656	Cabarello Creek	0.69	0.03	0.52	0	0.86	0.22	36	13	12	12	6
	LAR01772	Alhambra Wash	0.60	0.01	0.52	0	0.67	0.04	39	12	15	12	6
	LAR01912	Santa Susana Creek	0.36	0	0.32	0	0.39	0	34	8	13	12	6
	LAR02028	Arroyo Seco	0.68	0.02	0.57	0.01	0.78	0.13	34	10	12	12	6
Natural	LAR00080	Lynx Gulch	0.85	0.17	0.85	0.2	0.85	0.21	79	25	24	30	15
	LAR00520	Big Tujunga Creek	1.01	0.52	1.03	0.57	0.99	0.47	61	16	18	27	12
	LAR00924	Arroyo Seco	0.82	0.13	0.87	0.23	0.77	0.11	74	20	22	30	15
	LAR02568	Big Tujunga Creek	0.97	0.42	0.91	0.31	1.02	0.55	79	23	22	30	18
	LAR02712	Pacoima Canyon	1.04	0.59	0.84	0.18	1.24	0.89	77	21	24	27	18
	LAR04204	Santa Anita Wash	0.99	0.48	0.81	0.14	1.18	0.83	69	25	22	27	9
	LAR04880	Big Tujunga Creek	1.04	0.6	0.83	0.17	1.25	0.91	82	20	23	36	18

Table B-1. continued.

Stratum	Station	Station Description	CSCI	CSCI Percentile	MMI	MMI Percentile	O/E	O/E Percentile	Overall Score	Biotic Structure	Buffer and Landscape Context	Hydrology	Physical Structure
2013													
Effluent	LAR03646	Los Angeles River	0.61	0.01	0.48	0	0.73	0.08	38	25	67.67	33.33	25
Urban	LAR02232	Limekiln Canyon Wash	0.24	0	0.30	0	0.18	0	40	25	50	58.33	25
	LAR02484	Tujunga Wash	0.56	0	0.55	0.01	0.56	0.01	30	36.11	25	33.33	25
	LAR02488	Wilbur Wash	0.21	0	0.30	0	0.12	0	40	25	50	58.33	25
	LAR02796	Rubio Wash	0.28	0	0.28	0	0.29	0	27	25	25	33.33	25
	LAR02936	Bell Creek Tributary	0.46	0	0.46	0	0.46	0	37	27.78	55.17	41.67	25
Natural	LAR05020	Arroyo Seco	0.95	0.37	0.90	0.29	1.00	0.49	84	69.44	93.29	100	75
	LAR05640	Big Tujunga Creek	0.92	0.31	0.95	0.39	0.89	0.29	81	77.78	93.29	91.67	62.5
	LAR05848	Gold Creek	0.91	0.28	0.87	0.23	0.95	0.4	84	77.78	100	83.33	75
	LAR06044	Arroyo Seco	1.13	0.79	1.10	0.72	1.15	0.79	84	75	93.29	91.67	75
2014													
Effluent	LAR05694	Los Angeles River	0.45	0	0.45	0	0.45	0	35	25	58.54	33.33	25
Urban	LAR02680	Los Angeles River	0.41	0	0.34	0	0.48	0	38	25	67.67	33.33	25
	LAR02988	Sawpit Wash	0.70	0.03	0.69	0.04	0.72	0.07	36	25	62.5	33.33	25
	LAR02996	Big Tujunga Wash	0.47	0	0.38	0	0.55	0.01	34	25	62.5	25	25
Natural	LAR00520	Big Tujunga Creek	0.86	0.2	0.81	0.14	0.92	0.34	74	61.11	90.29	83.33	62.5
	LAR00924	Arroyo Seco	1.13	0.79	1.02	0.55	1.24	0.89	81	86.11	93.29	83.33	62.5
	LAR06188	Big Tujunga Wash	1.11	0.75	0.95	0.38	1.27	0.92	83	97.22	93.29	66.67	75
	LAR06216	Big Tujunga Creek	0.92	0.31	0.84	0.18	1.01	0.51	81	88.89	90.29	83.33	62.5
	LAR06252	Santa Anita Wash	0.82	0.13	0.88	0.25	0.76	0.1	83	83.33	85.38	75	87.5
	LAR07128	Pacoima Canyon	1.05	0.63	0.99	0.48	1.11	0.72	90	97.22	96.54	91.67	75
2015													
Effluent	LAR0232	Los Angeles River	0.66	0.02	0.50	0	0.82	0.17	36	25	62.5	33.33	25
	LAR08597	Los Angeles River	0.69	0.03	0.48	0	0.89	0.28	38	25	67.67	33.33	25
	LAR08599	Los Angeles River	0.70	0.03	0.51	0	0.89	0.28	45	33.33	62.5	58.33	25
	LAR08602	Los Angeles River	0.38	0	0.28	0	0.47	0	39	33.33	62.5	33.33	25
	LAR0616	Los Angeles River	0.68	0.02	0.58	0.01	0.77	0.12	36	25	62.5	33.33	25
	LAR0732	Los Angeles River	0.59	0	0.42	0	0.75	0.1	36	25	62.5	33.33	25
Natural	LAR0552	Arroyo Seco	0.98	0.45	0.89	0.27	1.07	0.64	79	75	93.29	83.33	62.5
	LAR00520	Big Tujunga Creek	0.92	0.3	0.83	0.17	1.01	0.51	77	80.56	82.92	83.33	62.5
	LAR0896	Big Tujunga Creek	0.93	0.33	0.87	0.24	0.98	0.47	85	77.78	100	75	87.5
2016													
Effluent	LAR0232	Los Angeles River	0.65	0.01	0.54	0	0.76	0.1	39	33.33	62.5	33.33	25
Natural	LAR0552	Arroyo Seco	0.91	0.28	0.91	0.31	0.91	0.31	75	69.44	93.29	75	62.5
	LAR00520	Big Tujunga Creek	0.94	0.35	0.90	0.28	0.98	0.46	76	63.89	82.92	83.33	75
	LAR00924	Arroyo Seco	1.00	0.51	0.96	0.42	1.05	0.59	84	63.89	93.29	91.67	87.5
	LAR01096	Big Tujunga Creek	0.77	0.08	0.71	0.05	0.84	0.2	84	88.89	90.29	83.33	75
	LAR01544	Big Tujunga Creek	0.87	0.21	0.72	0.06	1.02	0.55	85	77.78	90.29	83.33	87.5
	LAR08610	Santa Anita Wash	0.97	0.43	0.89	0.27	1.05	0.6	84	66.67	93.29	100	75
	LAR08622	Eaton Wash	1.01	0.52	0.90	0.3	1.12	0.73	77	52.78	93.29	75	87.5
Urban	LAR08608	Bull Creek	0.50	0	0.49	0	0.52	0.01	61	61.11	75	58.33	50
	LAR08615	Los Angeles River	0.67	0.02	0.56	0.01	0.77	0.12	39	33.33	62.5	33.33	25
	LAR08616	Arroyo Calabasas	0.53	0	0.63	0.02	0.43	0	34	25	62.5	25	25
	LAR0020	Alhambra Wash	0.29	0	0.30	0	0.28	0	34	25	62.5	25	25
	LAR0040	Bull Creek	0.59	0.01	0.55	0.01	0.62	0.02	39	25	62.5	41.67	25

Table B-1. continued.

Stratum	Station	Station Description	CSCI	CSCI Percentile	MMI	MMI Percentile	O/E	O/E Percentile	Overall Score	Biotic Structure	Buffer and Landscape Context	Hydrology	Physical Structure
2017													
Effluent	LAR0232	Los Angeles River	0.72	0.04	0.60	0.01	0.83	0.19	36	25	62.5	33.33	25
	LAR00436	Los Angeles River	0.68	0.02	0.63	0.02	0.74	0.08	38	25	67.67	33.33	25
	LAR08627	Los Angeles River	0.35	0	0.20	0	0.51	0.01	38	25	67.67	33.33	25
Urban	LAR0052	Los Angeles River	0.51	0	0.43	0	0.58	0.01	39	25	62.5	41.67	25
	LAR08630	Alhambra Wash	0.27	0	0.31	0	0.24	0	33	25	50	33.33	25
	LAR08632	Santa Susana Pass Wash	0.41	0	0.54	0.01	0.27	0	36	25	62.5	33.33	25
Natural	LAR0552	Arroyo Seco	0.97	0.41	1.01	0.51	0.93	0.35	78	61.11	93.29	83.33	75
	LAR00520	Big Tujunga Creek	0.78	0.08	0.69	0.04	0.87	0.24	78	72.22	82.92	83.33	75
	LAR00924	Arroyo Seco	0.95	0.38	1.00	0.5	0.90	0.3	77	66.67	93.29	75	75
	LAR08638	Arryo Seco	0.99	0.48	1.07	0.65	0.91	0.32	77	66.67	93.29	75	75
2018													
Effluent	LAR0232	Los Angeles River	0.71	0.03	0.63	0.02	0.78	0.12	25	62.5	33.33	36	25
	LAR08599	Los Angeles River	0.59	0	0.65	0.02	0.52	0.01	50	67.67	58.33	53	37.5
	LAR08642	Los Angeles River	0.72	0.04	0.58	0.01	0.87	0.24	25	67.67	33.33	38	25
	LAR08643	Los Angeles River	0.33	0	0.18	0	0.48	0	33.33	67.67	33.33	40	25
Urban	LAR08640	Aliso Canyon Wash	0.33	0	0.31	0	0.35	0	25	62.5	33.33	36	25
	LAR00440	Aliso Canyon Wash	0.64	0.01	0.50	0	0.78	0.12	50	82.92	58.33	67	75
	LAR00756	Tujunga Creek	0.52	0	0.52	0	0.52	0.01	25	62.5	33.33	36	25
Natural	LAR0552	Arroyo Seco	0.77	0.07	0.58	0.01	0.96	0.41	66.67	93.29	91.67	79	62.5
	LAR02092	Big Tujunga Creek	1.07	0.67	0.88	0.24	1.27	0.92	72.22	93.29	75	79	75
	LAR02568	Big Tujunga Creek	1.13	0.79	1.03	0.56	1.24	0.89	69.44	93.29	83.33	83	87.5
	LAR02088	Big Tujunga Creek	1.01	0.52	0.89	0.27	1.12	0.74	83.33	93.29	91.67	80	50

Appendix C – Analyte List, Detection Limits and Methods

Table C-1 Analyte list and method for each program element in 2019.

Analyte	Method	Units	Reporting Limit
Conventional Water Chemistry			
Temperature	Probe	ºC	-5
pH	Probe	None	NA
Specific Conductivity	Probe	mS/cm	2.5
Dissolved Oxygen	Probe	mg/L	N/A
Salinity	Probe	ppt	N/A
Water Chemistry: freshwater			
Alkalinity as CaCO3	SM 2320 B	mg/L	10
Hardness as CaCO3	SM 2340 B	mg/L	1.32
Turbidity	SM 2130 B	NTU	0.3
Total Suspended Solids	SM 2540 D	mg/L	2
Nutrients			
Ammonia as N	EPA 350.1	mg/L	0.1
Nitrate as N	EPA 300.0	mg/L	0.1
Nitrite as N	EPA 300.0	mg/L	0.1
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Total Nitrogen	Calculated	NA	NA
Total Organic Carbon	SM 5310 C	mg/L	0.1
Dissolved Organic Carbon	SM 5310 C	mg/L	0.1
OrthoPhosphate as P	SM 4500-P E	mg/L	0.1
Phosphorus as P	SM 4500-P E	mg/L	0.1
Major Ions			
Chloride	EPA 300.0	mg/L	1.0
Sulfate	EPA 300.0	mg/L	1.0
Metals (Dissolved)			
Arsenic	EAP 200.8	ug/L	1
Cadmium	EAP 200.8	ug/L	0.2
Chromium	EAP 200.8	ug/L	0.5
Copper	EAP 200.8	ug/L	0.5
Iron	EPA 200.7	ug/L	20
Lead	EAP 200.8	ug/L	0.5
Mercury	SM 3112 B or EPA 7470 A	ug/L	0.2
Nickel	EAP 200.8	ug/L	1
Selenium	EAP 200.8	ug/L	1

Zinc	EAP 200.8	ug/L	1
Benthic Macroinvertebrate	SWAMP (2007), SAFIT STE	Count	NA
Qualitative Algae	SWAMP, In Development	Count	NA
Quantitative Diatom	SWAMP, In Development	NA	NA
Quantitative Algae	SWAMP, In Development	NA	NA
Habitat Assessments: Freshwater			
Freshwater Bioassessments	SWAMP (2007)	NA	NA
Freshwater Algae (collected in conjunction with bioassessments)	SWAMP (2010)	NA	NA
California Rapid Assessment Method (CRAM)	Collins et al., 2008	NA	NA
Water Chemistry: Estuary Seawater			
Alkalinity as CaCO3	SM 2320 B	mg/L	10
Hardness as CaCO3	SM 2340 B	mg/L	1.32
Suspended Solids	SM 2540 D	mg/L	2
Total Dissolved Solids	SM 2540 C	mg/L	28
Nutrients			
Ammonia	SM 4500-NH3 B&C; EPA 350.1	mg/L	0.1
Nitrate	EPA 300.0 or EPA 353.2	mg/L	0.1
Nitrite	EPA 300.0 or EPA 353.2	mg/L	0.1
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Dissolved Organic Carbon	SM 5310 B	mg/L	0.5
Total Organic Carbon	SM 5310 B	mg/L	0.5
OrthoPhosphate as P	SM 4500-P E	mg/L	0.1
Phosphorus as P	SM 4500-P E	mg/L	0.1
Metals (Total & Dissolved)			
Arsenic	EPA 200.8 or 200.7	mg/L	1
Cadmium	EPA 200.8 or 200.7	mg/L	0.2
Chromium	EPA 200.8 or 200.7	mg/L	0.5
Copper	EPA 200.8 or 200.7	mg/L	0.5
Iron	EPA 200.8 or 200.7	mg/L	50
Lead	EPA 200.8 or 200.7	mg/L	0.5
Mercury	SM 3112 B	mg/L	0.2
Nickel	EPA 200.8 or 200.7	mg/L	1
Selenium	EPA 200.8 or 200.7	mg/L	1
Zinc	EPA 200.8 or 200.7	mg/L	1
Organics			
Pyrethroid Pesticides	EPA 625-NCL	μg/L	0.002-0.005
Sediment Chemistry: Estuary			
Sediment Particle Size (% fines)	SM 2560 D	um	<2000->0.2

Metals			
Arsenic	EPA 6010 B	mg/Kg dw	1
Cadmium	EPA 6010 B	mg/Kg dw	1
Chromium	EPA 6010 B	mg/Kg dw	1
Copper	EPA 6010 B	mg/Kg dw	1
Iron	EPA 6010 B	mg/Kg dw	5
Lead	EPA 6010 B	mg/Kg dw	0.5
Mercury	EPA 7471 A	mg/Kg dw	0.02
Nickel	EPA 6010 B	mg/Kg dw	2
Selenium	EPA 6010 B	mg/Kg dw	1
Zinc	EPA 6010 B	mg/Kg dw	2
Nutrients			
Total Kjeldahl Nitrogen (TKN)	EPA 351.2; SM4500-N ORG B	mg/Kg dw	20
Total Organic Carbon	SM 5310 B	mg/Kg dw	0.05
Phosphorus as P	SM 4500-P E	mg/Kg dw	0.05
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	µg/Kg dw	0.5-20
Polychlorinated Biphenyl (PCBs)	EPA 8082	µg/Kg dw	0.2
Polynuclear Aromatic Hydrocarbons (PAHs)	EPA 8270C	ug/Kg dw	300-3300
Sediment Toxicity: Estuary			
Chronic *Eohaustorius* sp. (sediment) 10 day survival	EPA 600/R-94/025	% survival	N/A
Chronic *Mytilus* Sediment Water Interface	EPA 600/R-95-136m	% development	N/A
Taxonomy: Sediment			
Infauna	SCCWRP (2008)*, SCAMIT STE	N/A	N/A
Habitat Assessments: Estuary			
California Rapid Assessment Method (CRAM)	Collins et al., 2008	NA	NA
Tissue Chemistry: Fish			
Percent Lipids	Bligh, E.G. and Dyer ,W.J. 1959.	%	0.05
Metals			
Mercury	EPA 7471A	mg/kg ww	0.02
Selenium	EPA 6010B	mg/kg ww	1
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	µg/kg ww	0.5
Polychlorinated Biphenyl (PCBs)	EPA 8082	µg/kg ww	0.5-20
Indicator Bacteria			
Total Coliform and E. coli	SM 9223 B	MPN/100mL	10
Enterococcus	SM 9230 D (21st ed. on line)	MPN/100mL	10

* Southern California Regional Monitoring Program, 2008 Field and Laboratory Operating Procedures, SCCWRP.