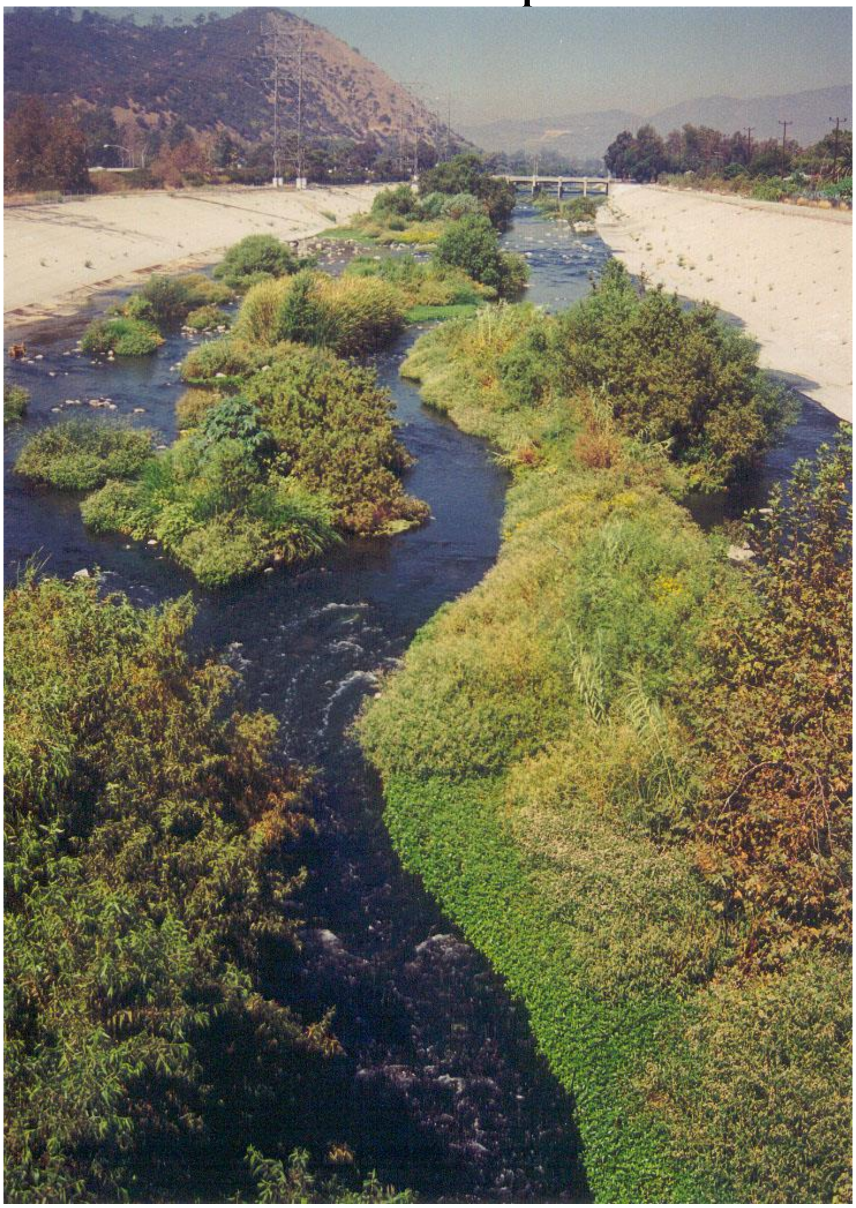
Los Angeles River Watershed Monitoring Program
2021 Annual Report



Prepared by:

The Council for Watershed Health

177 E. Colorado Blvd., Suite 200

Pasadena, CA 91105

Aquatic Bioassay & Consulting Laboratories, Inc.

29 N Olive St

Ventura, CA 9300

Suggested Citation:

CWH. 2021. Los Angeles River Watershed Monitoring Program 2021 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

Acknowledgements

The Los Angeles River Watershed Monitoring Program (LARWMP) was funded and conducted by a number of public agencies and private nonprofit entities working in the watershed. These participants contributed staff time, laboratory analyses, and funding in a collaborative effort and included representatives from regulated, regulatory, environmental, and research organizations. A majority of the funding was provided by the Cities of Los Angeles and Burbank and the Los Angeles County Flood Control District.

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

Table of Contents

List of Tables

List of Figures

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
GN	Glendale Narrows
IBI	Index of Biological Integrity
LAGWRP	Los Angeles Glendale Water Reclamation Plant
LARWMP	Los Angeles River Watershed Monitoring Program
LMP	Lewis MacAdams Park
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	Principal 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
UEV	Upper Elysian Valley
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WER	Water-Effect Ratio
WQO	Water Quality Objective
WRP	Water Reclamation Plan

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 2021 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, IPI and CRAM). Water quality and physical habitat assessments mirror these 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 60% of sites, while for algal communities (ASCI - Hybrid) approximately 80% of sites were altered.
- Trend analysis using revisit sites showed that biological conditions at stream sites is stable through time. A subset of sites downstream of recent fires (2009 Station Fire and the 2017 Creek Fire) show improving trends over time for riparian habitat condition (CRAM scores improved at LAR00080, LAR01544) and for CSCI scores (LAR00080).
- Plastic was the most common trash category across effluent, urban and natural sub-regions.

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. In the past this included confluence sites, which were discontinued entirely in 2021 and replaced with soft bottom sites along the main-channel, 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.

- A total of 55 samples and assessments have been completed at target sites.
- In 2021, the Lewis MacAdams Park (LMP) (LAR08599) and Glendale Narrows (GN) (LAR10210) were monitored.
- LMP site had nitrate-N and total nitrogen concentrations that are among the highest sampled in recent years but have shown steady decline since 2019. The GN site had nitrate-N and total nitrogen similar to the LMP site.
- Orthophosphate and total phosphorus concentrations broke a decreasing trend and were higher in 2021 at the LMP than in the past three to five years.
- 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.
- LMP 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 generally increased.

- There are no trends for the GN site to report since the site was first sampled in 2021. However, the site scores are similarly to the LMP site for all assessments and constituents, except canopy cover which is lower at the GN site.
- The best riparian zone conditions have been consistently found at sites located in the upper watershed (prefix LAUT). Some sites in the lower watershed, particularly those downstream of recent fires and undergoing restoration, also have good riparian zone conditions.
- CRAM scores at Upper Arroyo Seco (LAUT402) and Haines Creek (LAUT407) showed significant improvements since the sites were last assessed (scores improved by 6 points or more). These sites have hovered near reference condition and were in reference condition in 2021. Scores at Eaton Wash were stable (LALT406).

Are receiving waters near discharges meeting water quality objectives?

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 95% of upstream samples and 75% of the downstream samples during the 2021 sampling year.
- There were five exceedances upstream of DCTWRP effluent and three exceedances of the NH_3-nitrogen WQO downstream.
- Downstream concentrations of arsenic, zinc, lead, copper, and cadmium were below both chronic and acute CTR criteria.

Los Angeles Glendale Water Reclamation Plant (LAGWRP)

- Approximately 10% of the *E. coli* samples met the WQO at the upstream site, while approximately 55% of the samples met the WQO at the downstream site.
- There were no exceedances of the NH_3-nitrogen WQO upstream and one exceedance downstream of LAGWRP.
- All metal concentrations were below the Water-Effect Ratio (WER) adjusted CTR thresholds both upstream and downstream of the LAGWRP outfall.

Burbank Water Reclamation Plant (BWRP)

- Approximately 20% of upstream and downstream samples met the WQO.
- Metal concentrations were below the CTR chronic and acute standards for all metals, on all occasions.
- There was one Burbank Channel downstream sample that exceeded the established NH_3-nitrogen WQO for the Burbank Channel

Is it safe to recreate?

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

- During the summer of 2021, a total of 339 water samples were successfully collected from fourteen recreational swim sites popular with visitors and residents of the LA River watershed.
- We found that the Tujunga Wash site at Hansen Dam (LALT 214) and the Bull Creek site (LALT 200) exceeded the STV two of the three months of sampling. The 6-week rolling geometric mean similarly showed Hansen Dam (LALT 214) and, to a lesser extent, Bull Creek (LALT 200) have consistently high *E. coli* concentrations compared to other informal recreation sites.
- Kayak sites were compared to the single sample LREC standard of 526 CFU/100 mL and were found that exceedances were generally low and infrequent across sites and is not part of LARWMP. The highest percentage of exceedances was 15% at the Upper Elysian Valley (UEV) site (LALT218) followed by the Lower Sepulveda Basin site (LALT217) exceedance rate of 5%. Using the 30-day geometric mean based LREC WQO of 126 MPN, UEV site exceeded the WQO every month of sampling (LALT 218) and the Middle Sepulveda Basin (LALT 216) Kayak Zone exceeded the 30-day geomean 2 of the 5 months that were monitored.
- We found that plastic, miscellaneous items, and metals were the most common categories of trash types across all sites. When analyzing more detailed trash sub-types across all recreation sites, we found that aluminum foil pieces, small plastic pieces, and miscellaneous trash sub-categories were the most prevalent.
- Vogel Flats (LAUT 220) had higher total trash counts than any other swim site and counts at this site were significantly higher than Tujunga Wash at Hansen Dam (LAUT 214) and Delta Day Use (LAUT 206).

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 2021 took place at Legg Lake.
- Sample analysis showed that bluegill, common carp, and redear sunfish are safe to eat at a consumption to three 8-oz servings a week.
- White catfish should be consumed at lower levels and recommended consumption is for one serving per week.
- Largemouth bass fish tissue has different concentrations of mercury between samples with recommended serving sizes ranging from one to two servings a week based on OEHHA recommendations.

Introduction

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.

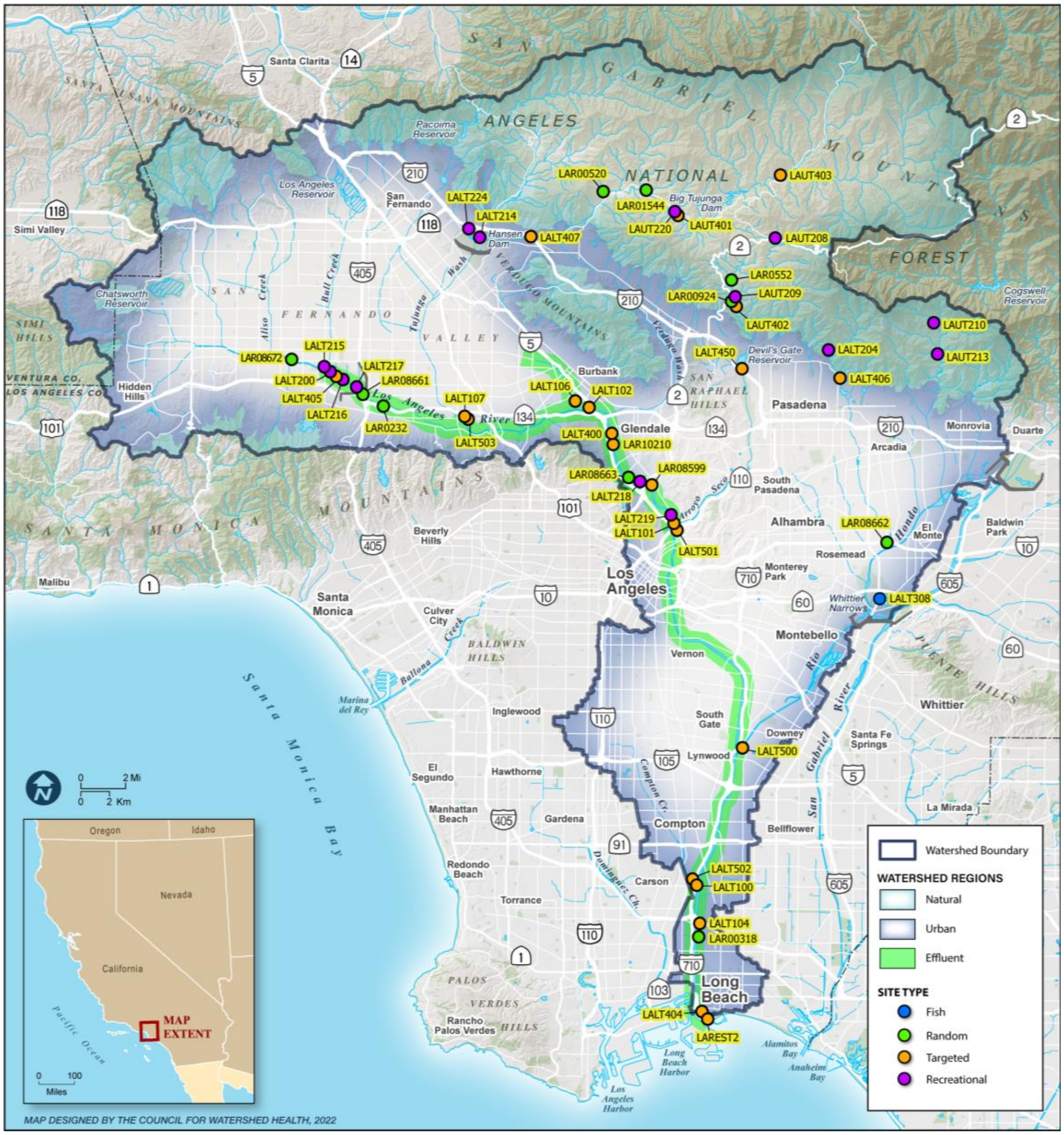


Figure 1. 2021 sampling sites in the Los Angeles River Watershed. Map includes fish, random, targeted, recreational, and high-value sites. Note that targeted sites are sampled on a rotating basis. Not all targeted sites are sampled within a single year.

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

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 2021. 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 2021.

Spring/Summer 2021 Sampling	Site ID	Chemistry			Benthic Macroinvertebrates			Algae			CRAM	
		sampling	lab analysis	funding	sampling	lab analysis	funding	sampling	lab analysis	funding	assessment	funding
Targeted Sample												
Los Angeles River at Marsh Park	LAR08599	Weston	EMD	Cities	Weston	Weston	LACFCD	Weston	Weston	LACFCD	Weston	Cities
Los Angeles River, Glendale Narrows	LAR10210	Weston	EMD	Cities	Weston	Weston	LACFCD	Weston	Weston	LACFCD	Weston	Cities
Random Samples												
Effluent (Los Angeles River)	LAR08661	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Urban (Rio Hondo)	LAR08662	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Effluent (Los Angeles River)	LAR08663	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Urban (Los Angeles River)	LAR08672	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Trend Revisit Sites												
Los Angeles River (Effluent)	LAR00318	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												
Revisit Site (Big Tujunga Creek)	LAR01544	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Revisit Site (Arroyo Seco)	LAR00924	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Revisit Site (Los Angeles River)	LAR0232	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities
Revisit Site (Big Tujunga Creek)	LAR00520	ABC	EMD	Cities	ABC	ABC	Cities	ABC	Rhithron	Cities	ABC	Cities

Table 2. Sampling and laboratory analysis responsibilities for bacteria monitoring in 2021.

Spring/Summer Sampling	Site ID	Microbiology		
		sampling	lab analysis	funding
Swimming Sites				
LA River/Bull Creek Confluence, Sepulveda Basin	LALT200	ABC	EMD	Cities
Eaton Canyon Natural Area Park	LALT204	CWH	EMD	Cities
Tujunga Wash, Hansen Dam	LALT214	ABC	EMD	Cities
Hansen Dam	LALT224	ABC	EMD	Cities
Arroyo Seco, Oakwilde Campground or Switzer Falls	LAUT208	ABC	EMD	Cities
Arroyo Seco, Gould Mesa Campground	LAUT209	ABC	EMD	Cities
Tujunga Creek, Hidden Springs	LAUT211	ABC	EMD	Cities
Tujunga Creek, Delta Flat Day Use	LAUT206	CWH	EMD	Cities
Tujunga Creek, Vogel Flats	LAUT220	CWH	EMD	Cities
LA River Sepulveda Basin at Balboa Blvd	LALT215	EMD	EMD	Cities
LA River Sepulveda Basin	LALT216	EMD	EMD	Cities
LA River Sepulveda Basin at Sepulveda Dam	LALT217	EMD	EMD	Cities
Los Angeles River at Fletcher Dr	LALT218	EMD	EMD	Cities
Los Angeles River at Steelhead Park	LALT219	EMD	EMD	Cities
Los Angeles River Middle Elysian Valley	LALT221	EMD	EMD	Cities

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

Fish Tissue Bioaccumulation Sites	Site ID	Year	Bioaccumulation		
			sampling	lab analysis	funding
Echo Park (Lake)	LALT300	2018	ABC/DFW	EMD	Cities
Balboa Lake	LALT301	2020	ABC/DFW	EMD	Cities
Peck Road Park (Lake)	LALT302	2016	ABC/DFW	EMD	Cities
Legg Lake	LALT308	2021	ABC/DFW	EMD	Cities
Belvedere Lake	LALT310	2014	ABC/DFW	EMD	Cities
Debs Lake	LALT312	2015	ABC/DFW	EMD	Cities
Reseda Lake	LALT313	2015	ABC/DFW	EMD	Cities
Sepulveda Basin (River)	LALT314	2019	ABC/DFW	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, trash	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
		2 Los Angeles River soft-bottom sites	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	16 sites located in ponds, reservoirs, streams and LA River	*E. coli* , trash	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). Grey boxes indicate impairment.

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. Grey boxes indicate impairment. Note that dots 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 134 random sites during 12 annual surveys from 2009 through 2021 (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 mainstream and tributaries (i.e., natural sites); effluent-dominated reaches in the mainstream 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).

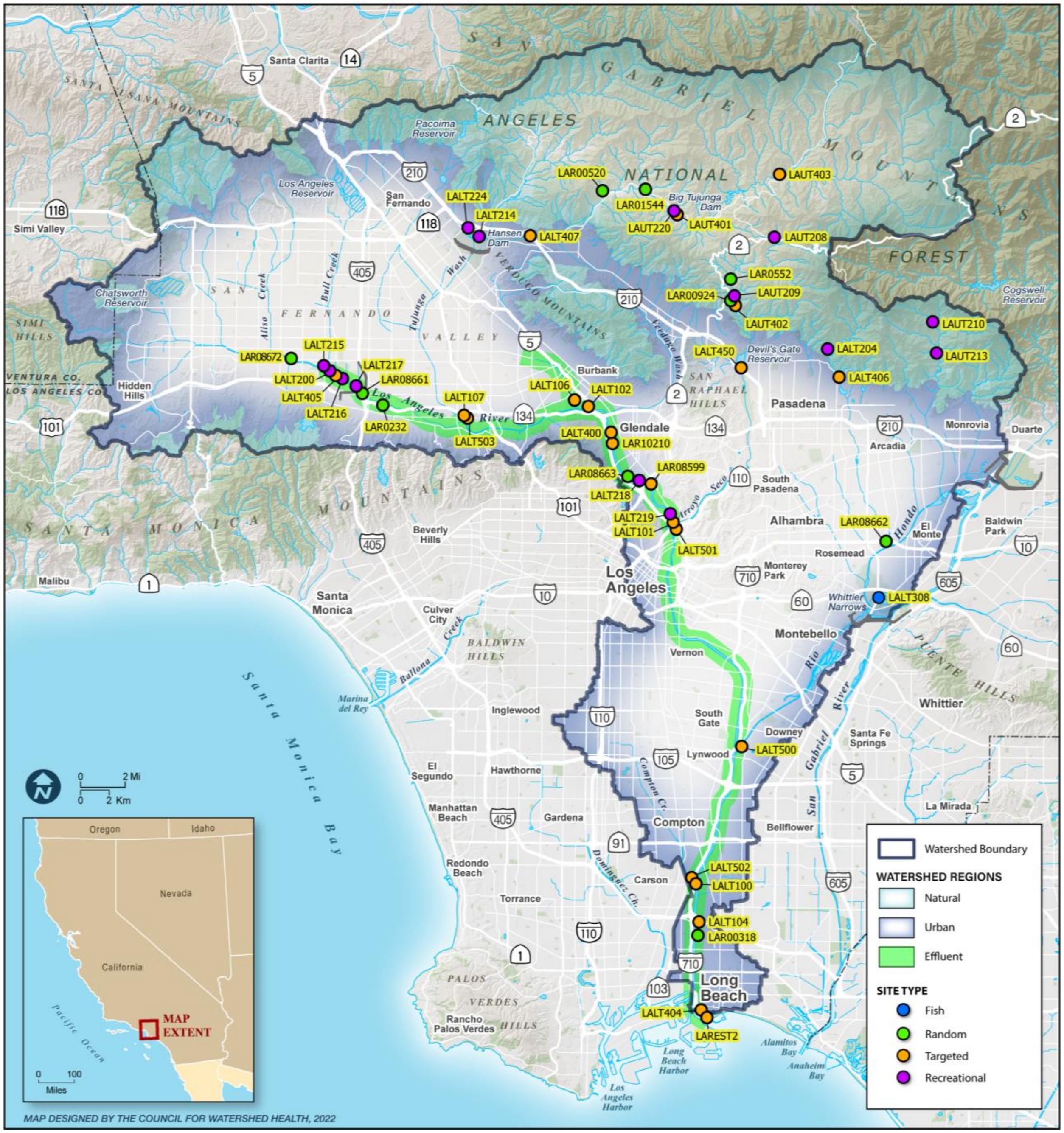


Figure 2. Location of random sites sampled from 2009 to 2021.

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 conditions 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

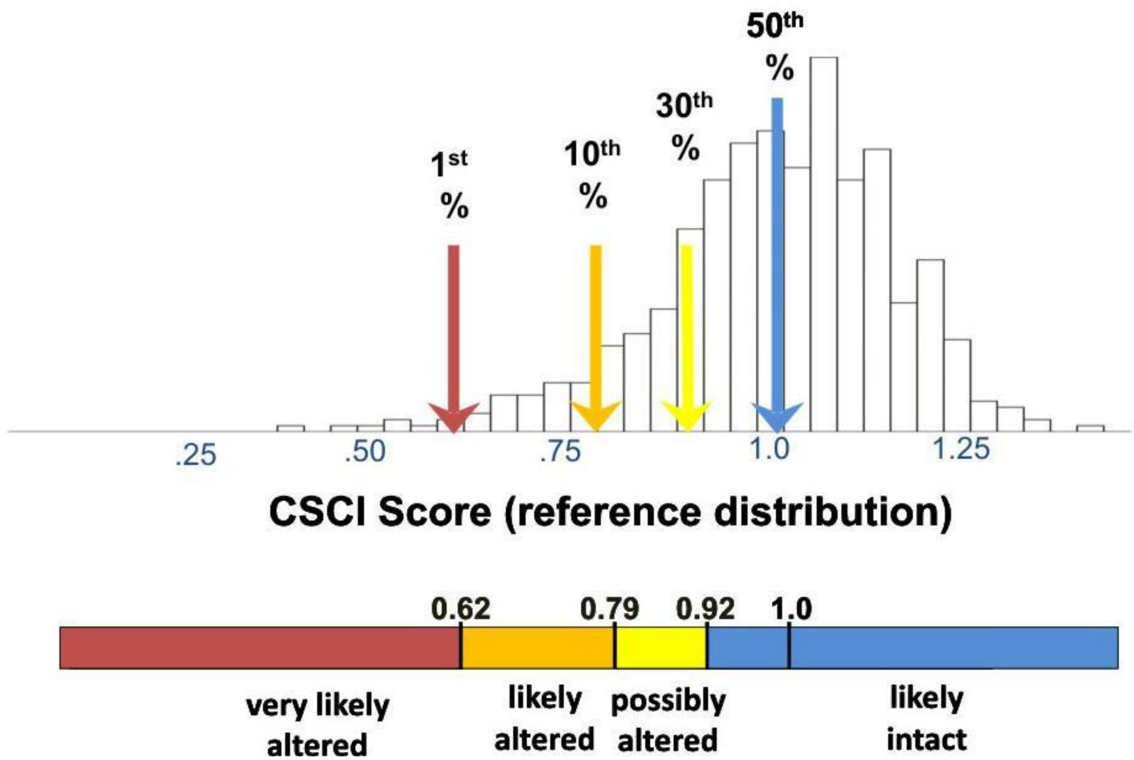


Figure 3. Distribution of CSCI scores at CA reference sites with thresholds and condition categories (Rhen et al., 2015)

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 McLauglin 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).

In the 2021 report, we begin reporting on the physical habitat condition of a stream site using the Index of Physical Habitat Integrity (IPI). The index is an easily interpretable measure of physical habitat condition (Rehn et al., 2018). The index includes metrics that are broadly categorized into 5 thematic groups that capture different habitat elements including: substrate, riparian vegetation, flow habitat variability, in-channel cover and channel morphology. Scores for the IPI close to 0 indicate departure from reference condition and those greater than 1 indicate that a site has better physical habitat than is predicted based on environmental setting. The thresholds for IPI are similar to the

CSCI and are based on 30^{th}, 10^{th}, and 1^{st} percentiles of scores at reference sites. The thresholds are: >0.94=likely intact, 0.93 to 0.84 indicate possibly altered, 0.83 to 0.71 indicate likely altered; and <0.70 indicate very likely altered condition.

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 Table B-1 4. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
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

Table B-1 5. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
2019													
Effluent	LAR00318	Los Angeles River	0.47	0	0.43	0	0.51	0.01	38	25	67.67	33.33	25
	LAR0232	Los Angeles River	0.72	0.04	0.59	0.01	0.86	0.23	36	25	62.5	33.33	25
Natural	LAR01808	Alder Creek	0.76	0.07	0.62	0.02	0.90	0.31	83	80.56	90.29	75	87.5
	LAR04204	Santa Anita Wash	0.98	0.45	0.75	0.08	1.21	0.86	75	58.33	93.29	100	50
	LAR0552	Arroyo Seco	1.03	0.56	1.08	0.67	0.97	0.44	76	63.89	93.29	83.33	62.5
	LAR08641	Big Tujunga Creek	0.88	0.23	0.69	0.04	1.07	0.64	79	61.11	96.54	88.33	75
	LAR08647	Big Tujunga Creek	0.92	0.3	0.81	0.14	1.02	0.54	74	47.22	100	100	50
Urban	LAR01004	Arroyo Seco	0.49	0	0.40	0	0.57	0.01	36	25	62.5	33.33	25
	LAR08645	Bull Creek	0.62	0.01	0.44	0	0.80	0.14	56	69.44	67.67	50	37.5
	LAR08646	Eaton Wash	0.67	0.02	0.61	0.01	0.74	0.08	36	25	62.5	33.33	25
2020													
Effluent	LAR0232	Los Angeles River	0.59	0	0.59	0.01	0.58	0.01	36	25	62.5	33.33	25
	LAR08656	Los Angeles River	0.74	0.05	0.58	0.01	0.89	0.29	36	25	62.5	33.33	25
	LAR08659	Los Angeles River	0.66	0.02	0.58	0.01	0.74	0.08	38	25	67.67	33.33	25
Natural	LAR05020	Arroyo Seco	1.11	0.76	1.33	0.97	0.89	0.29	75	47.22	100	91.67	62.5
	LAR0552	Arroyo Seco	1.18	0.87	1.11	0.73	1.24	0.9	79	77.78	93.29	83.33	62.5
	LAR05640	Big Tujunga Creek	1.17	0.85	1.07	0.65	1.27	0.92	84	83.33	93.29	83.33	75
	LAR06216	Big Tujunga Creek	1.00	0.5	0.88	0.25	1.12	0.74	76	80.56	90.29	83.33	50
	LAR08655	Big Tujunga Creek	1.17	0.85	1.14	0.78	1.20	0.85	85	88.89	93.29	83.33	75
Urban	LAR01208	Los Angeles River	0.45	0	0.46	0	0.44	0	38	25	67.67	33.33	25
	LAR08658	Arroyo Seco	0.71	0.04	0.58	0.01	0.85	0.21	41	33.33	62.5	41.67	25
2021													
Effluent	LAR00318	Los Angeles River	0.33	0	0.19	0	0.47	0	38	25	67.67	33.33	25
	LAR0232	Los Angeles River	0.71	0.04	0.70	0.05	0.72	0.07	36	25	62.5	33.33	25
	LAR08661	Los Angeles River	0.68	0.02	0.57	0.01	0.78	0.12	36	25	62.5	33.33	25
	LAR08663	Los Angeles River	0.84	0.16	0.65	0.02	1.04	0.58	70	69.44	75	75	62.5
Natural	LAR00520	Big Tujunga Creek	0.70	0.03	0.71	0.05	0.70	0.06	79	72.22	82.92	75	87.5
	LAR00924	Arroyo Seco	1.11	0.75	1.20	0.87	1.01	0.52	80	80.56	93.29	83.33	62.5
	LAR01544	Big Tujunga Creek	0.79	0.1	0.70	0.05	0.88	0.27	83	75	90.29	91.67	75
	LAR0552	Arroyo Seco	0.83	0.15	0.78	0.11	0.88	0.27	80	80.56	93.29	83.33	62.5
Urban	LAR08662	Rio Hondo	0.34	0	0.28	0	0.39	0	38	25	67.67	33.33	25
	LAR08672	Los Angeles River	0.42	0	0.34	0	0.51	0	38	25	67.67	33.33	25

Appendix C – Analyte List, Reporting 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 was completed to detect statistically significant positive or negative trends ($p<0.05$) at individual revisit sites based on CSCI and CRAM scores.

3. *Results*

a. *Biotic Condition*

A pattern of better biotic and physical habitat conditions is consistently seen in CSCI, ASCI, IPI, 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). 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 hybrid scores, a proxy for water quality (Figure 4, Figure 5).

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 biological reference condition and have altered biological condition. Over the 2009-2021 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 conditions (CRAM) were altered or were below reference thresholds at roughly 60% of sites, while for algal communities (ASCI - Hybrid) approximately 80% of sites were altered or below reference thresholds. The majority of watershed sites are altered based on assessments that capture the quality of riparian and physical habitat, and water quality.

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 2009-2021 range from 0.65 to 1.35 at natural sites, 0.33 to 0.84 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 hybrid scores mirrored other biotic indicators, showing higher median scores for the natural sites than effluent-dominated or urban sites (Figure 9). ASCI scores were lowest in effluent dominated sub-regions and highest in the natural sub-region. Soft Algae ASCI did not separate the sub-regions as well as other bioindicators.

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 GN 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.

Ash free dry mass, a measure of organic matter, was highest in urban and natural sub-regions. Chlorophyll a, on the other hand, was highest in effluent and urban sub-regions (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 high ash free dry mass as urban sites may be indicative of organic matter export from upstream or lateral sources.

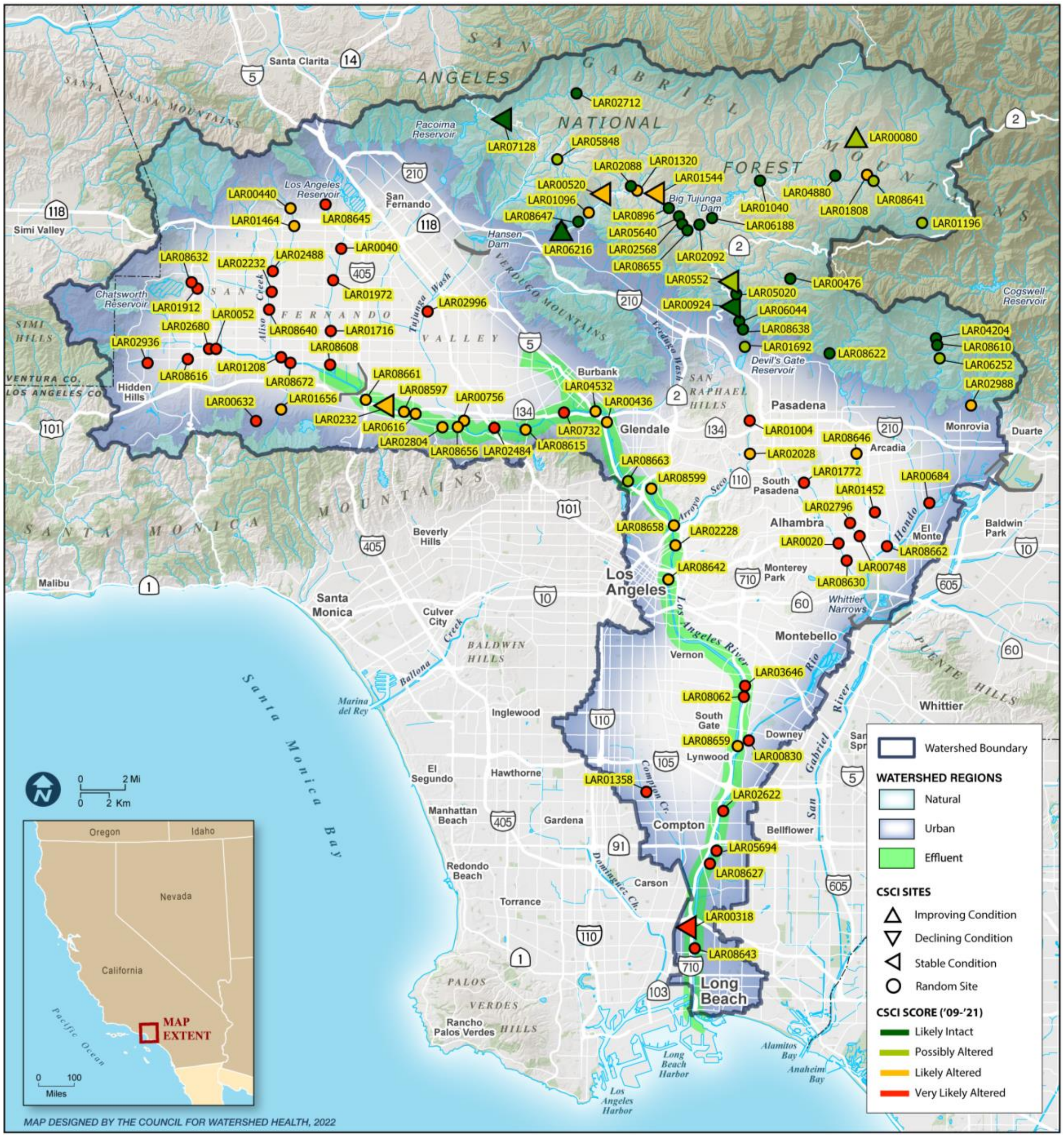


Figure 4. CSCI scores based on probabilistic sites sampled from 2009 to 2021. Likely intact condition = CSCI ≥0.92; possibly altered condition = CSCI 0.91 to 0.80; likely altered condition = CSCI 0.79 to 0.63; very likely altered condition = CSCI ≤0.62. The trend at sites with 3 or more revisits are also symbolized with the direction of each triangle depicting positive, negative, or stable trends.

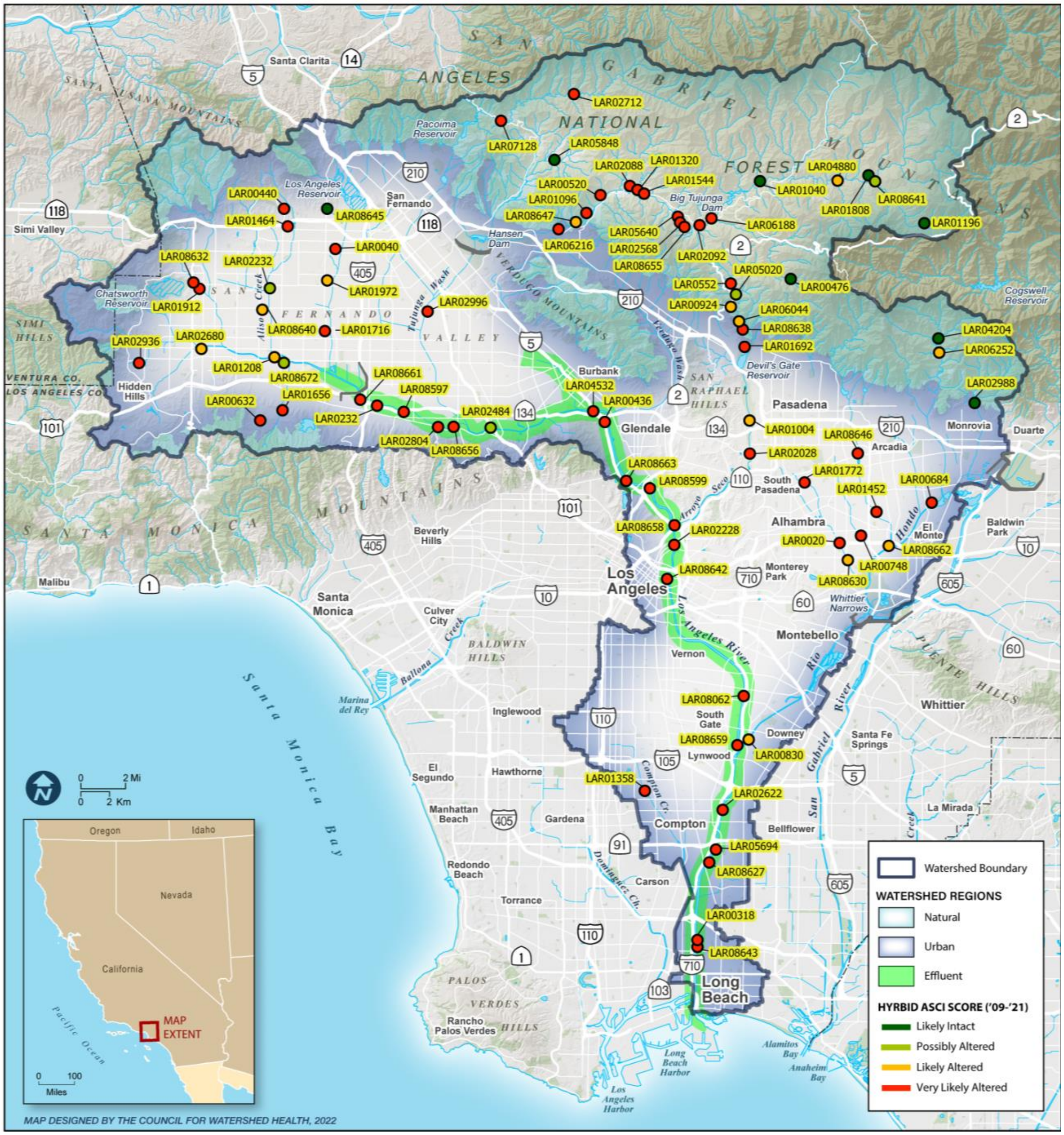


Figure 5. ASCI hybrid scores for LARWMP probabilistic sites sampled from 2009 to 2021. Likely intact condition = ASCI ≥0.94; possibly altered condition = ASCI 0.93 to 0.86; likely altered condition = ASCI 0.86 to 0.75; very likely altered condition = ASCI ≤0.74.

Figure 6. IPI scores LARWMP probabilistic sites sampled from 2009 to 2021. Likely intact condition = ≥0.94; possibly altered condition = 0.93 to 0.84; likely altered condition = 0.83 to 0.71; very likely altered condition = ≤ 0.70.

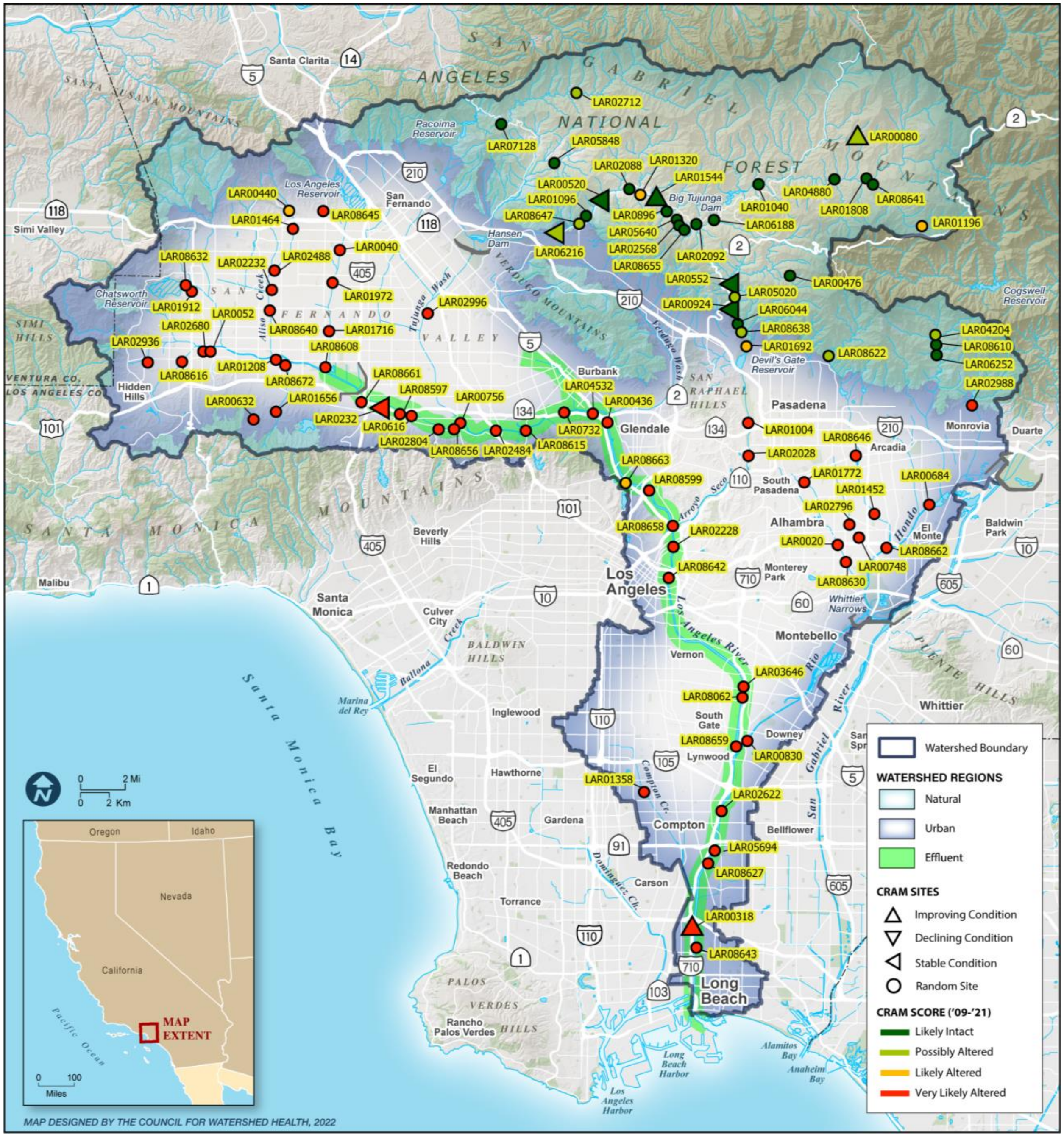


Figure 7. CRAM scores based on probabilistic sites sampled from 2009 to 2021. Likely intact condition = CRAM ≥79; possibly altered condition = CRAM 79 to 72; likely altered condition = CRAM 72 to 63; very likely altered condition = CRAM ≤63. Sites with 3 visits or more were examined for trends and are symbolized using triangles.

Table 7. Summary statistics for biotic conditions and water quality analytes at all random sites combined, collected from 2009 to 2021.

	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)	133	0.73	±	0.26	0.21	1.35	42	0.49	±	0.15	0.21	0.80	32	0.61	±	0.14	0.33	0.84	59	0.96	±	0.14	0.65	1.35
MMI	133	0.66	±	0.26	0.18	1.43	42	0.45	±	0.12	0.23	0.69	32	0.52	±	0.17	0.18	1.04	59	0.88	±	0.17	0.58	1.43
O/E	133	0.79	±	0.29	0.12	1.32	42	0.53	±	0.22	0.12	0.99	32	0.69	±	0.17	0.19	0.89	59	1.03	±	0.17	0.70	1.32
Attached Algae																								
ASCI Hybrid	113	0.67	±	0.19	0.29	1.14	34	0.68	±	0.18	0.35	1.14	27	0.47	±	0.11	0.29	0.71	52	0.76	±	0.15	0.45	1.14
ASCI Diatom	113	0.64	±	0.19	0.25	1.08	34	0.65	±	0.16	0.35	0.97	27	0.44	±	0.10	0.25	0.68	52	0.75	±	0.17	0.38	1.08
ASCI Soft Algae	114	0.81	±	0.19	0.00	1.26	35	0.79	±	0.16	0.31	1.07	27	0.75	±	0.12	0.43	1.06	52	0.86	±	0.23	0.00	1.26
Index of Physical Habiat	51	0.65	±	0.38	0.12	1.21	13	0.32	±	0.22	0.12	0.81	16	0.40	±	0.24	0.13	1.07	22	1.02	±	0.14	0.76	1.21
Riparian Habitat (CRAM)	133	56.40	±	21.40	27.00	99.00	42	38.50	±	8.33	27.00	67.00	32	38.63	±	7.35	27.00	70.00	59	78.78	±	6.96	63.00	99.00
Biotic Structure	133	47.74	±	24.26	22.22	97.22	42	29.50	±	11.90	22.22	69.44	32	28.82	±	9.43	22.22	69.44	59	71.00	±	14.24	38.89	97.22
Buffer Landscape	133	74.41	±	18.43	25.00	100.00	42	59.16	±	13.76	25.00	87.50	32	62.43	±	10.32	25.00	75.00	59	91.77	±	5.28	75.00	100.00
Hydrology	133	57.30	±	25.18	25.00	100.00	42	36.90	±	9.59	25.00	58.33	32	36.46	±	10.53	25.00	75.00	59	83.13	±	9.93	58.33	100.00
Physical Structure	133	45.86	±	23.92	25.00	100.00	42	27.68	±	9.38	25.00	75.00	32	26.56	±	6.92	25.00	62.50	59	69.28	±	14.56	37.50	100.00
InSitu Measurements																								
Temperature (C°)	132	21.16	±	5.57	10.97	36.69	42	24.30	±	6.21	13.84	36.69	32	23.63	±	4.41	16.30	32.80	58	17.51	±	2.97	10.97	25.03
Dissolved Oxygen (mg/L)	133	9.29	±	2.33	3.72	17.45	42	10.34	±	2.82	5.30	16.81	32	9.95	±	2.59	3.72	17.45	59	8.19	±	0.95	5.46	10.48
pH	133	8.31	±	0.67	6.99	10.80	42	8.75	±	0.84	7.34	10.80	32	8.43	±	0.46	7.42	9.36	59	7.94	±	0.35	6.99	8.51
Salinity (ppt)	132	0.45	±	0.33	0.13	1.93	42	0.71	±	0.46	0.14	1.93	31	0.51	±	0.06	0.32	0.60	59	0.24	±	0.05	0.13	0.37
Specific Conductivity (us/cm)	133	892	±	623	8	3681	42	1368	±	851	8	3681	32	1036	±	106	736	1171	59	474	±	103	245	751
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
Calcium (mg/L)	10	62.05	±	26.55	42.20	135.00	2	98.90	±	51.05	62.80	135.00	4	49.90	±	8.58	42.20	60.20	4	55.78	±	4.17	52.30	61.50
Chloride (mg/L)	130	89.07	±	95.23	4.60	554.42	41	162.31	±	112.84	11.20	554.42	32	136.59	±	17.00	109.00	162.68	57	9.72	±	2.84	4.60	18.40
Magnesium (mg/L)	10	22.64	±	13.07	14.90	58.10	2	41.75	±	23.12	25.40	58.10	4	20.10	±	4.02	16.30	24.10	4	15.63	±	0.54	14.90	16.20
Sodium (mg/L)	10	71.86	±	47.97	0.11	138.00	2	99.95	±	53.81	61.90	138.00	4	108.00	±	5.94	101.00	115.00	4	21.68	±	16.66	0.11	37.40
Sulfate (mg/L)	130	160.56	±	288.37	2.60	2360.00	41	340.84	±	456.29	17.00	2360.00	32	165.45	±	34.44	123.00	302.00	57	28.14	±	23.06	2.60	135.00
TSS (mg/L)	118	36.61	±	141.27	0.25	1330.00	35	92.67	±	249.76	2.00	1330.00	30	28.99	±	39.10	6.40	218.00	53	3.90	±	5.11	0.25	26.40
Nutrients																								
Ammonia as N (mg/L)	133	0.17	±	0.87	0.03	9.95	42	0.33	±	1.53	0.03	9.95	32	0.17	±	0.14	0.03	0.63	59	0.06	±	0.07	0.03	0.40
Nitrate as N (mg/L)	133	1.29	±	1.80	0.01	6.48	42	1.32	±	1.67	0.01	6.48	32	3.50	±	1.49	0.36	5.87	59	0.08	±	0.10	0.01	0.53
Nitrite as N (mg/L)	133	0.03	±	0.06	0.01	0.41	42	0.02	±	0.04	0.01	0.20	32	0.08	±	0.11	0.01	0.41	59	0.01	±	0.01	0.01	0.05
Nitrogen Total (mg/L)	133	3.28	±	4.59	0.00	38.84	42	5.34	±	6.68	0.23	38.84	32	5.71	±	1.57	2.56	8.41	59	0.50	±	0.91	0.00	6.46
OrthoPhosphate as P (mg/L)	133	8.06	±	10.80	0.18	102.22	42	12.26	±	10.16	1.63	42.00	32	7.99	±	1.35	6.48	11.90	59	5.11	±	13.04	0.18	102.22
Phosphorus as P (mg/L)	133	62.05	±	26.55	42.20	135.00	2	98.90	±	51.05	62.80	135.00	4	49.90	±	8.58	42.20	60.20	4	55.78	±	4.17	52.30	61.50
Dissolved Organic Carbon (mg/L)	133	6.52	±	5.97	1.20	37.62	42	10.93	±	8.61	1.49	37.62	32	7.13	±	0.74	5.55	9.08	59	3.05	±	1.33	1.20	6.87
Total Organic Carbon (mg/L)	133	22.64	±	13.07	14.90	58.10	2	41.75	±	23.12	25.40	58.10	4	20.10	±	4.02	16.30	24.10	4	15.63	±	0.54	14.90	16.20
Algal Biomass																								
AFDM (mg/cm ^{2})	114	5.27	±	12.42	0.07	113.38	35	6.32	±	11.04	0.16	48.25	27	6.97	±	21.46	0.07	113.38	52	3.68	±	4.58	0.17	26.63
Chl-a (ug/cm 2)	114	6.16	±	6.66	0.41	37.00	35	6.98	±	6.89	0.41	34.00	27	9.70	±	8.37	0.50	37.00	52	3.77	±	4.23	0.41	25.00
Dissolved Metals																								
Arsenic (ug/L)	97	1.78	±	1.23	0.03	6.52	33	2.27	±	1.28	0.11	6.52	21	1.74	±	0.70	0.31	3.48	43	1.43	±	1.29	0.03	5.35
Cadmium (ug/L)	101	0.08	±	0.10	0.01	0.41	35	0.08	±	0.08	0.01	0.32	21	0.19	±	0.10	0.01	0.41	45	0.03	±	0.05	0.01	0.35
Chromium (ug/L)	99	1.29	±	1.37	0.06	7.50	33	1.81	±	1.65	0.22	7.50	21	0.95	±	0.60	0.41	2.46	45	1.06	±	1.30	0.06	7.26
Copper (ug/L)	101	5.59	±	6.36	0.04	30.60	35	10.53	±	8.02	0.58	30.60	21	6.50	±	2.68	1.47	13.10	45	1.33	±	0.73	0.04	3.12
Iron (ug/L)	101	134	±	911	0	9180	35	54	±	62	0	253	21	26	±	34	0	156	45	246	±	1363	0	9180
Lead (ug/L)	101	0.26	±	0.52	0.01	5.04	35	0.44	±	0.85	0.02	5.04	21	0.31	±	0.13	0.06	0.64	45	0.10	±	0.07	0.01	0.32
Mercury (ug/L)	101	0.00	±	0.01	0.00	0.05	35	0.01	±	0.01	0.00	0.05	21	0.00	±	0.00	0.00	0.00	45	0.00	±	0.01	0.00	0.04
Nickel (ug/L)	101	4.48	±	9.73	0.41	78.00	35	8.50	±	15.69	0.65	78.00	21	4.61	±	1.47	1.69	7.81	45	1.30	±	0.86	0.41	4.15
Selenium (ug/L)	101	1.04	±	1.80	0.05	11.50	35	2.09	±	2.69	0.10	11.50	21	1.17	±	0.36	0.22	1.77	45	0.17	±	0.14	0.05	0.70
Zinc (ug/L)	101	12.26	±	14.28	0.52	59.30	35	9.63	±	10.33	1.47	59.30	21	33.86	±	12.09	8.39	58.20	45	4.23	±	4.49	0.52	20.30

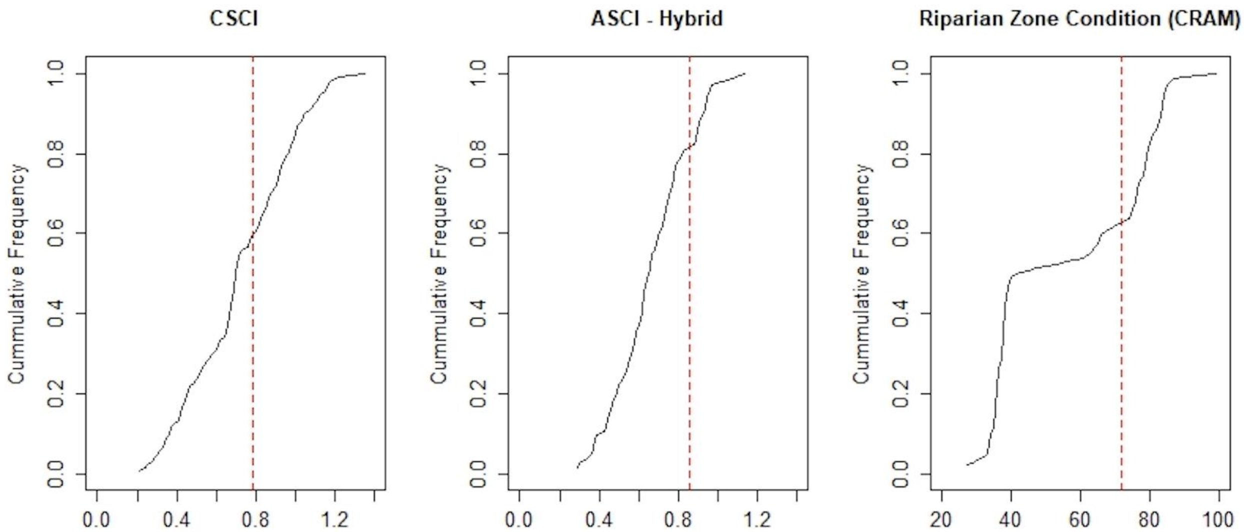


Figure 8. Cumulative frequency distribution of CSCI, ASCI hybrid, and CRAM scores at random sites from 2009-2021. Vertical dashed bar represents the 10th percentile of the reference distribution for each index.

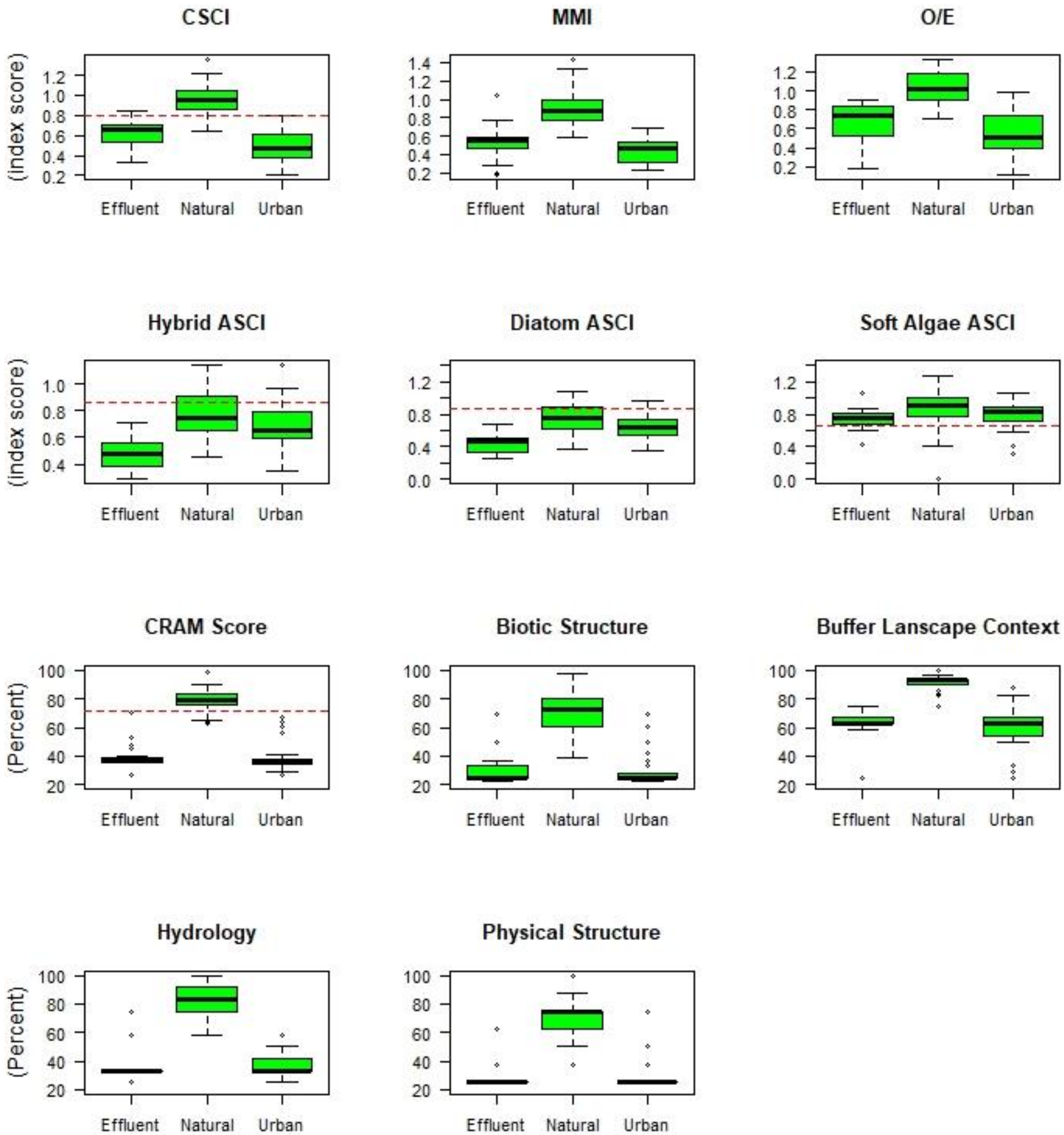


Figure 9. CSCI, ASCI (hybrid, diatom, and soft algae), and CRAM scores and attribute scores for effluent, natural, and urban random sites from 2009-2021. CRAM attribute scores include measures of biotic structure, buffer landscape context, hydrology, and physical structure.

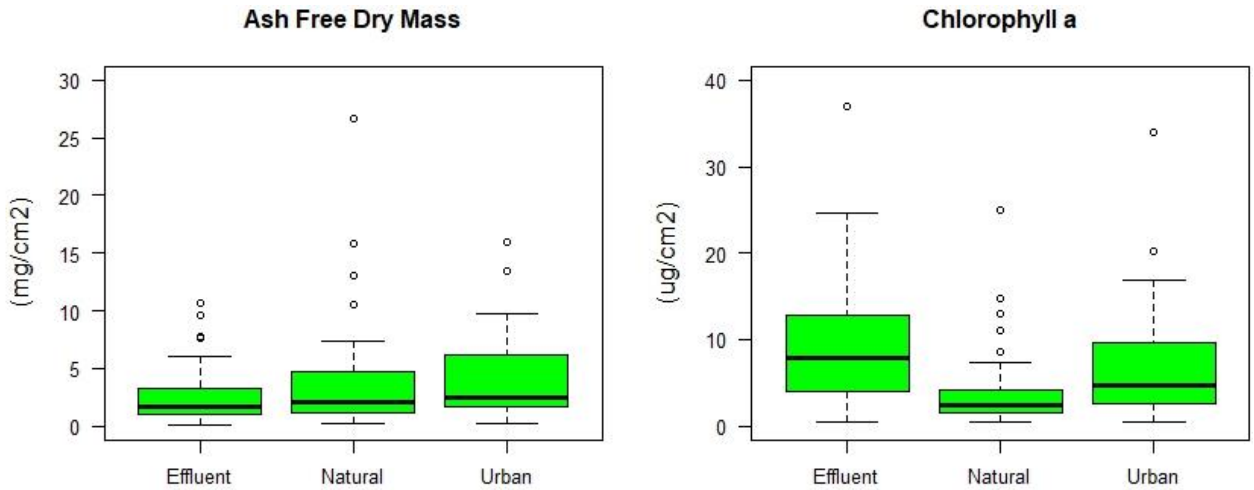


Figure 10. Ash free dry mass and chlorophyll A concentrations in effluent, natural, and urban regions in the watershed.

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 2021. 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 sub-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 eight 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).

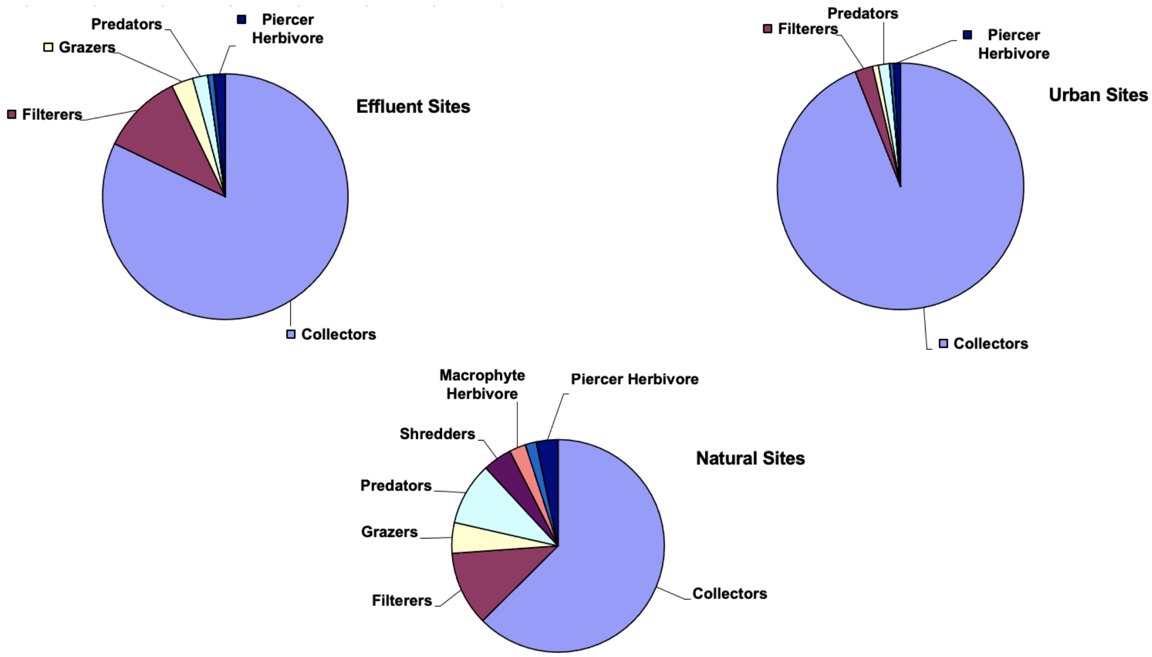


Figure 11. Relative proportion of benthic macroinvertebrate functional feeding groups in each watershed sub-region for 2008-2021 random sites

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 2021. We found that the CRAM scores of random sites are generally stable for each sub-region over time (Figure 12), with a weak improving trend at natural sites (R=0.55). CSCI scores within each sub-region are variable but show no overall declining trend (Figure 13). In terms of CSCI score, natural and effluent subregions show a variable but weakly improving trend over time (R = 0.58 and 0.45) and urban sites appear to be generally stable (R = 0.11).

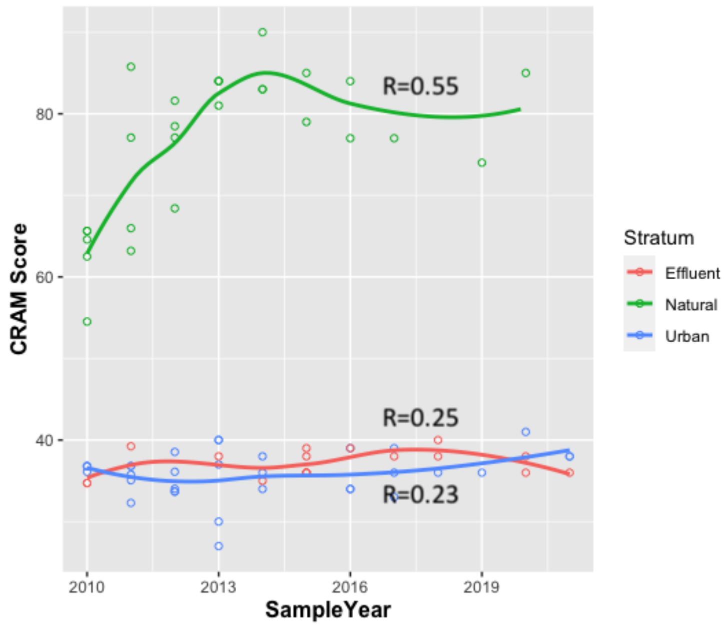


Figure 12 CRAM scores at random sites for each subregion over time with correlation coefficients above each line;

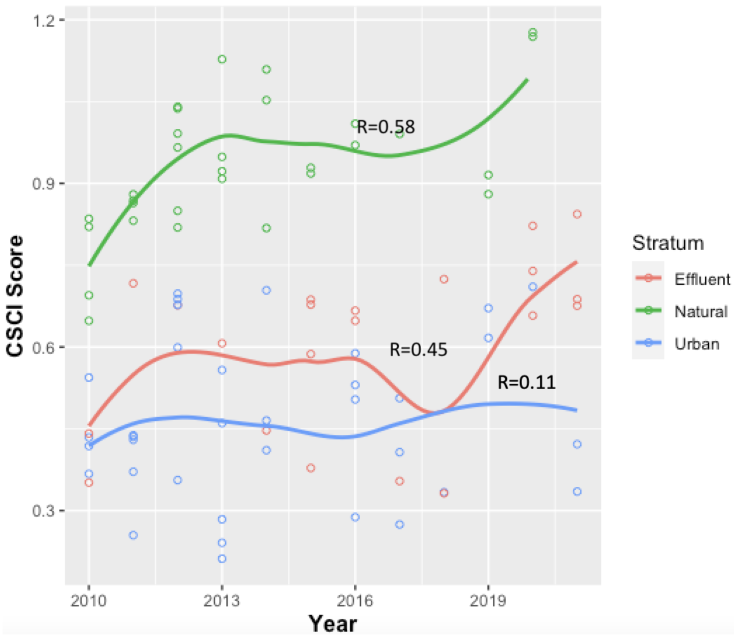


Figure 13 CSCI scores at random sites over time from 2008 to 2021 with correlation coefficients above each line

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, there are no worsening trends in CRAM. In fact, several sites appear to show improving CRAM scores over time and they include: LAR00080, LAR00318, LAR01544 (

Figure 14). Most of these sites are natural sites in the footprint of the 2009 Station Fire, with the exception of LAR00318 which is located just below Wardlow Street in Long Beach.

On the other hand, in terms of CSCI score, the majority of sites have shown more year to year variability with no strongly increasing or decreasing trends (

Figure 15). The exception is LAR06216, which has a strongly improving trend over time (R=0.99). 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. LAR00080 has a weakly improving trend and is located in Lynx Gulch in the natural sub-region (R=0.67). The site is also within the perimeters of the 2009 Station Fire. Our ability to detect trends across a larger extent will be strengthened as the LARWMP program begins to prioritize revisiting under sampled sites.

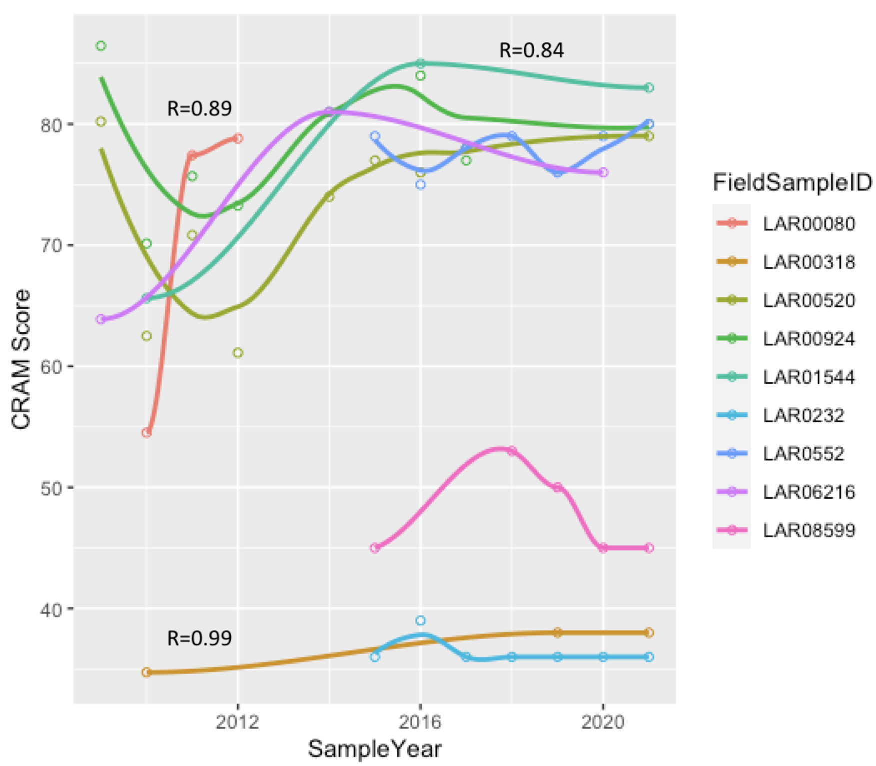


Figure 14 Trend in CRAM scores at revisit sites in the watershed. The correlation coefficient is noted for sites with strong increasing/decreasing trends.

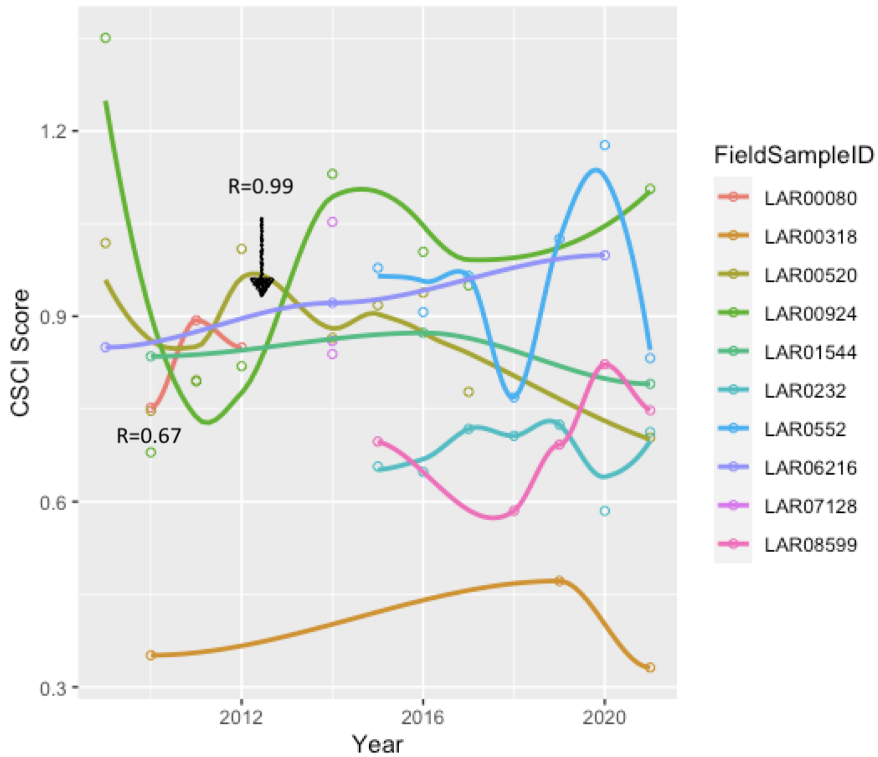


Figure 15 Trend in CSCI scores at revisit sites in the watershed. The correlation coefficient is noted for sites with the strongest increased/decreasing trends

c. Aquatic Chemistry and Physical Habitat

The differences in nutrient concentrations between watershed subregions is shown in Figure 16. Effluent-dominated and urban sites had greater median concentrations of many nutrients compared to natural sites. For example, median total phosphorus, nitrate-N, ammonia-N, and total nitrogen concentrations were highest in the effluent-dominated stream segments. The only exceptions to this pattern are for organic matter and orthophosphate, which are higher in the urban subregion.

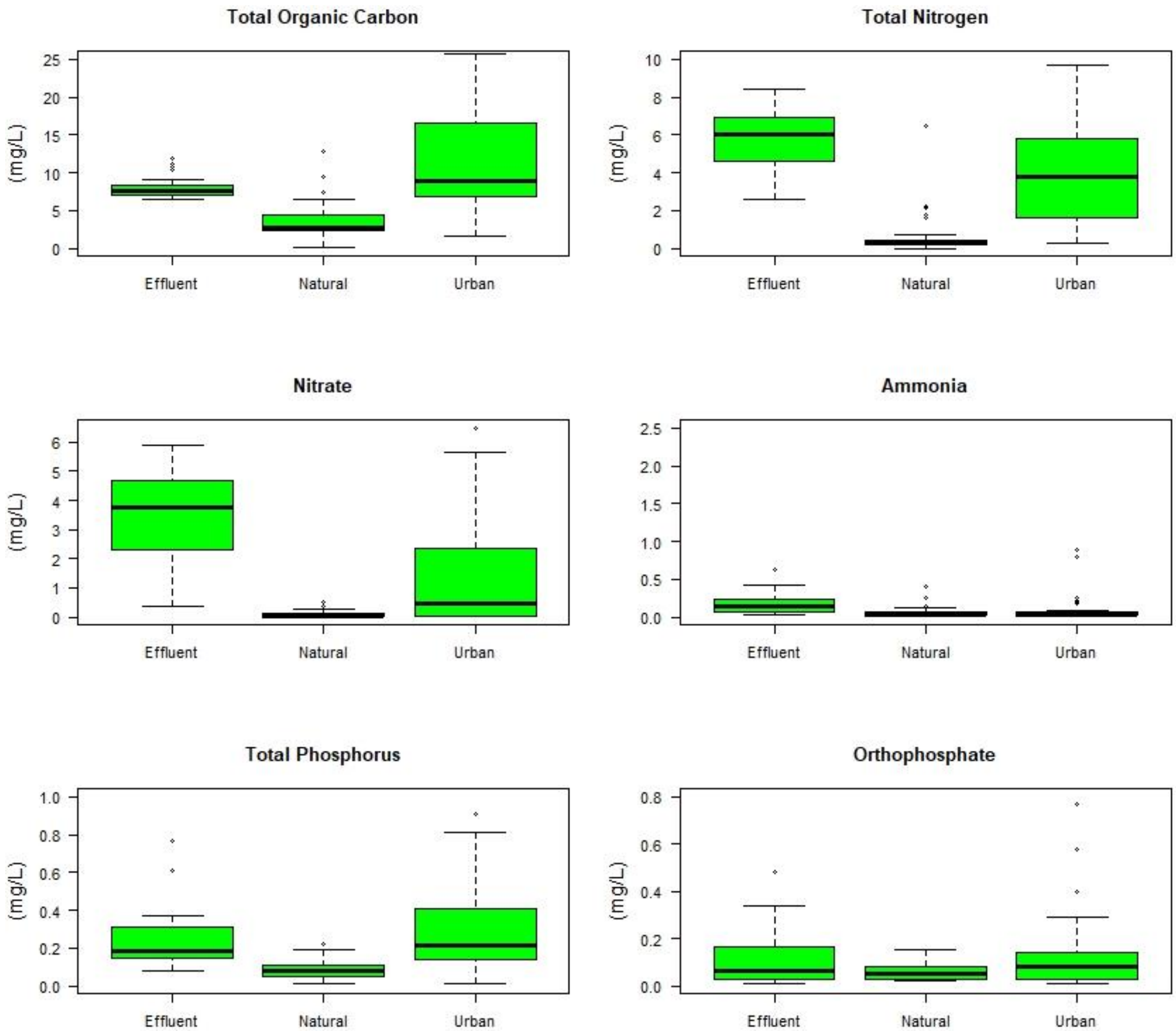


Figure 16. Box-and-whisker plots showing the median and range of representative nutrients measures in each of the three Los Angeles River watershed regions from 2009-2021

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 17), 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. The Index of Physical

Integrity, which incorporates several physical habitat metrics, showed the majority of natural sites had physical habitat condition that were in the possibly altered/likely intact categories compared to effluent and urban sites.

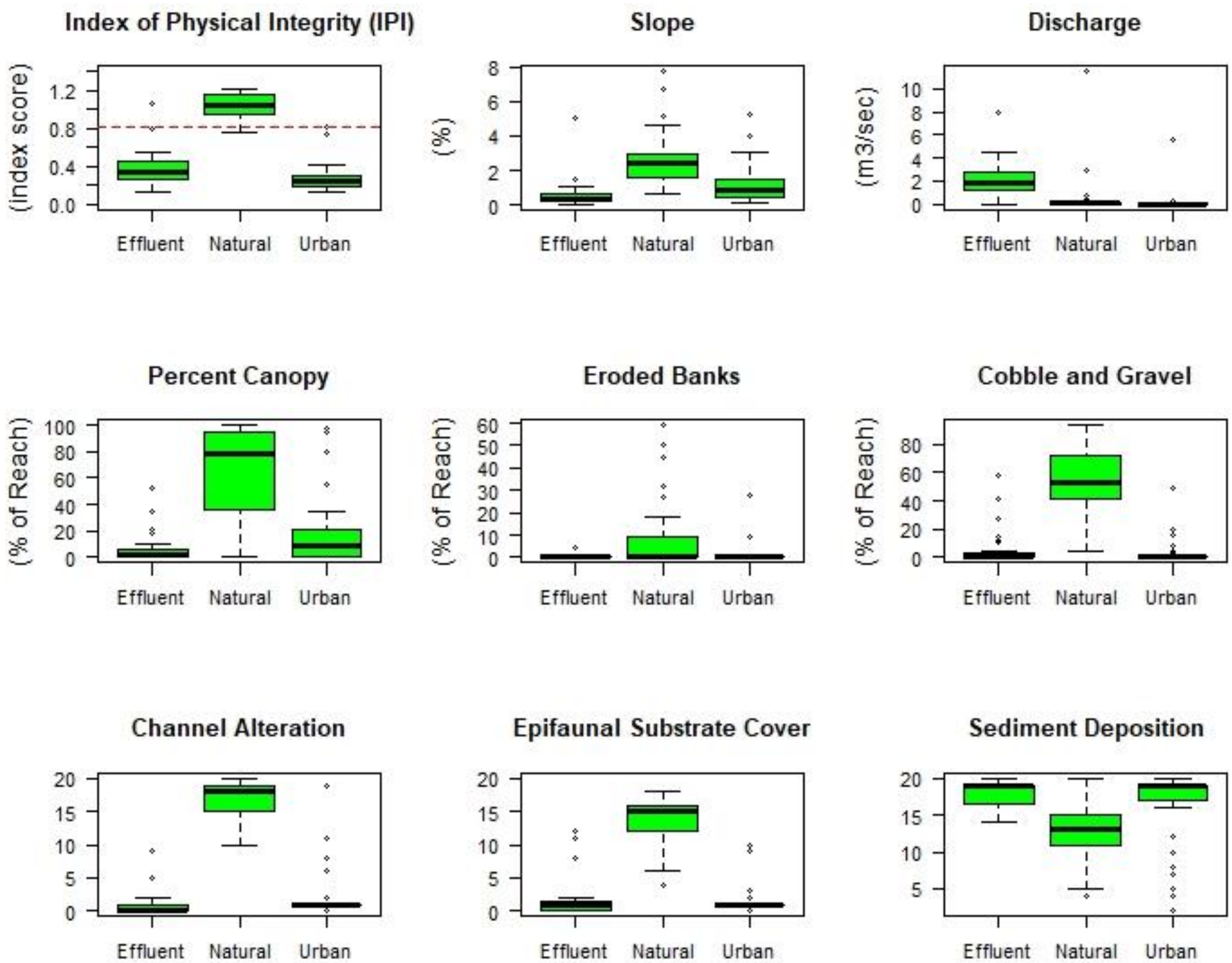


Figure 17. Box-and-whisker plots showing the median and range of representative physical habitat parameters measured in each of the three Los Angeles River watershed regions from 2009-2021. Channel alteration, epifaunal substrate cover, and sediment deposition are scored assessments, higher scores denote 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 18). Biodegradable items, fabric/cloth items, and metal items were also common across the three sub-regions, but each region had a unique trash-profile. There were trash profiles that were unique to some sub-regions. For example, large trash items (like couches and televisions) were not a prominent trash category in natural sites, opposed to urban and effluent regions. Trash sub-categories also had a unique profile across regions. For example, wrappers and hard and soft plastic pieces were the most prevalent trash type at natural sites. At urban sites, foam and hard and soft plastic pieces were the most prevalent. While at effluent sites, foam and paper/cardboard were the most prevalent trash items (Figure 19). Figure shows the sites assessed for trash between 2018-2021 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 and glass were generally located along the effluent dominated sub-region (Figure 20).

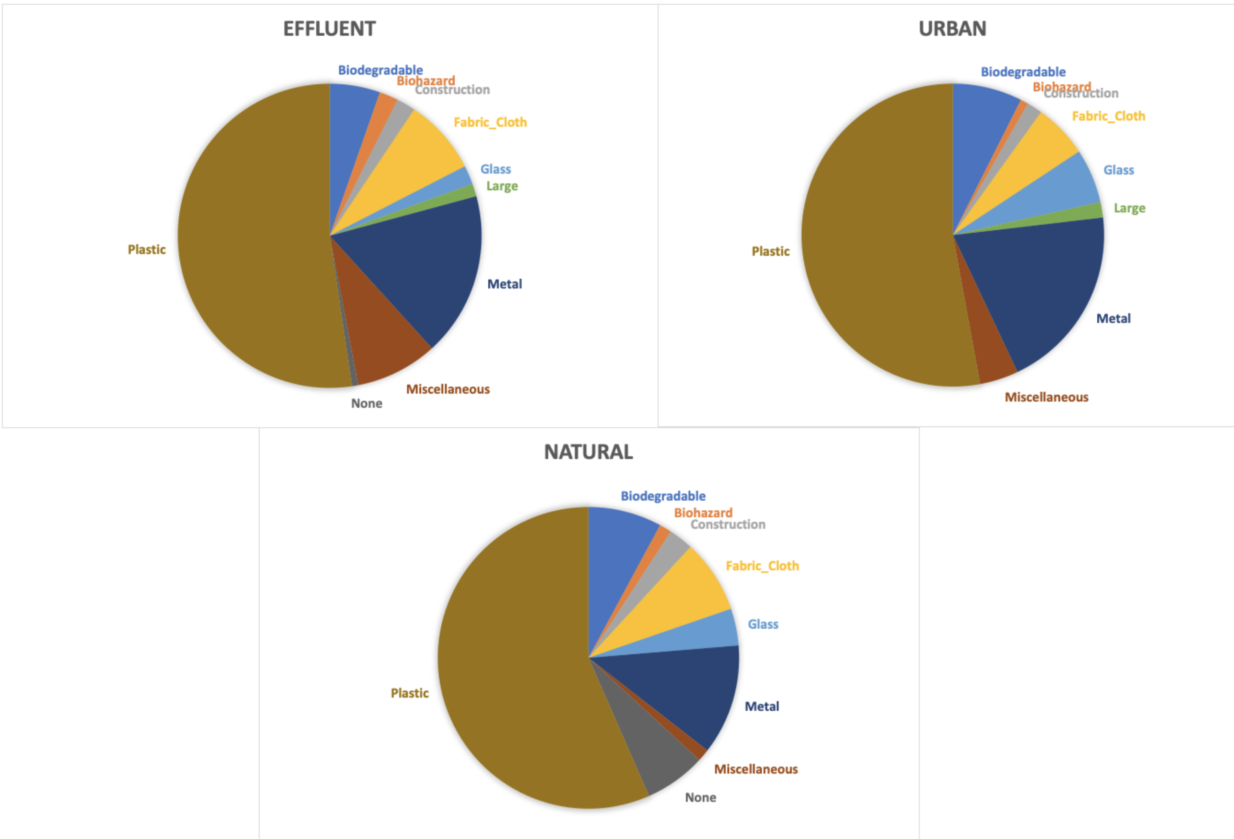


Figure 18 Most common trash types in each sub-region of the watershed for LARWMP sites sampled from 2018-2021.

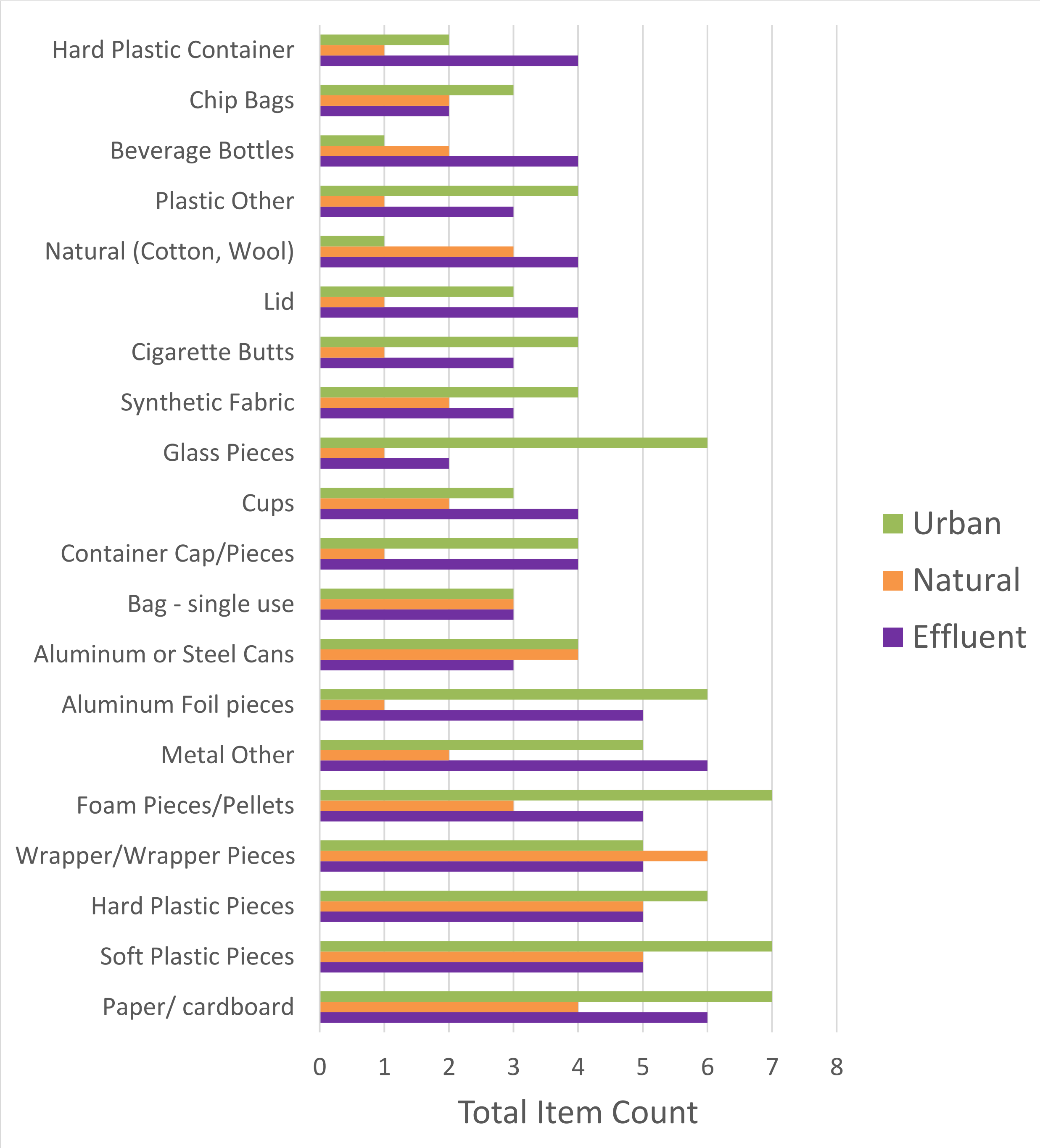


Figure 19 Mean trash sub-types by sub-region for LARWMP random sites sampled from 2018-2021.

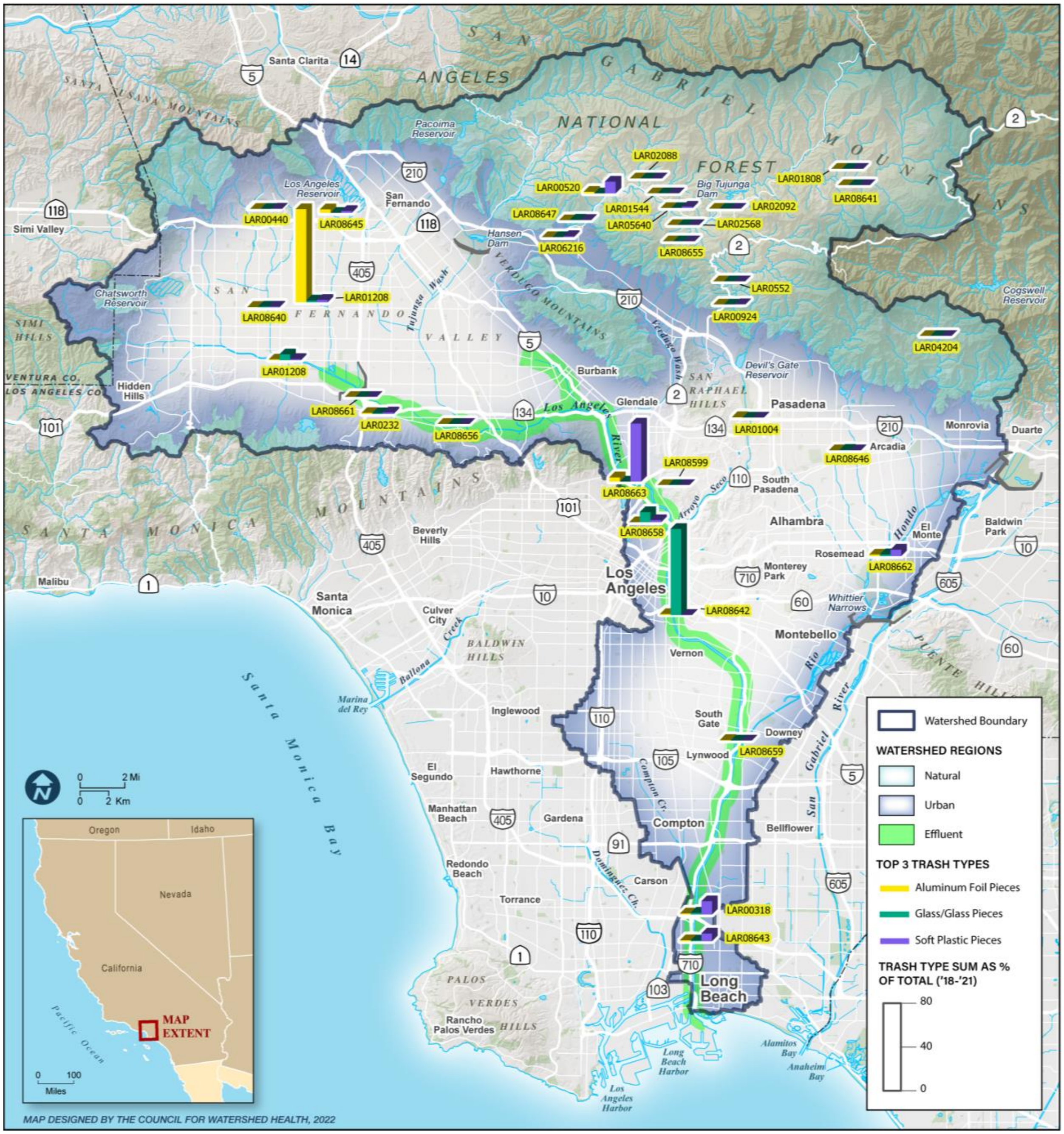


Figure 20 Map of sites assessed for trash between 2018 and 2021. The top 3 trash types graphed at each site are the trash sub-categories with the highest counts of trash across all regions.

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. The methods that were used to better understand the conditions of sites that are unique areas of interest are consistent with those described in the previous chapter. 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, two 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 conditions (Figure 21). These sites differ from the random sites used to assess ambient watershed conditions 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 proposed a new site of interest, LMP. In 2021 all confluence sites were discontinued from the program. The 2021 monitoring program included the LMP, a random site that was sampled in 2015, dredged in 2018, and was a revisit site in 2019, and a site along the GN, an area that is relatively under sampled by the LARWMP.
- The Los Angeles River Estuary: 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 for alignment with sediment quality objectives.
- High-value habitat sites: nine locations were chosen to assess trends in riparian zone conditions 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. Since CRAM scores do not vary greatly from year to year, these sites are rotated and each site is sampled every 2-4 years.

2. Trends at Freshwater Target Sites

A total of 55 samples have been collected from the four confluence locations during the twelve annual surveys from 2008 to 2020 (Figure 21 and

Table 8). In 2018, the TSG agreed to begin rotating confluence sites to support monitoring near LMP, a site that would aid the TSG in understanding the impact of sediment removal to stream health. In 2021, Los Angeles County Flood Control District discontinued all confluence sites and began to monitor a site in the soft bottom section of the main-channel (LAR10210), an area that has been poorly sampled by the LARWMP. 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.

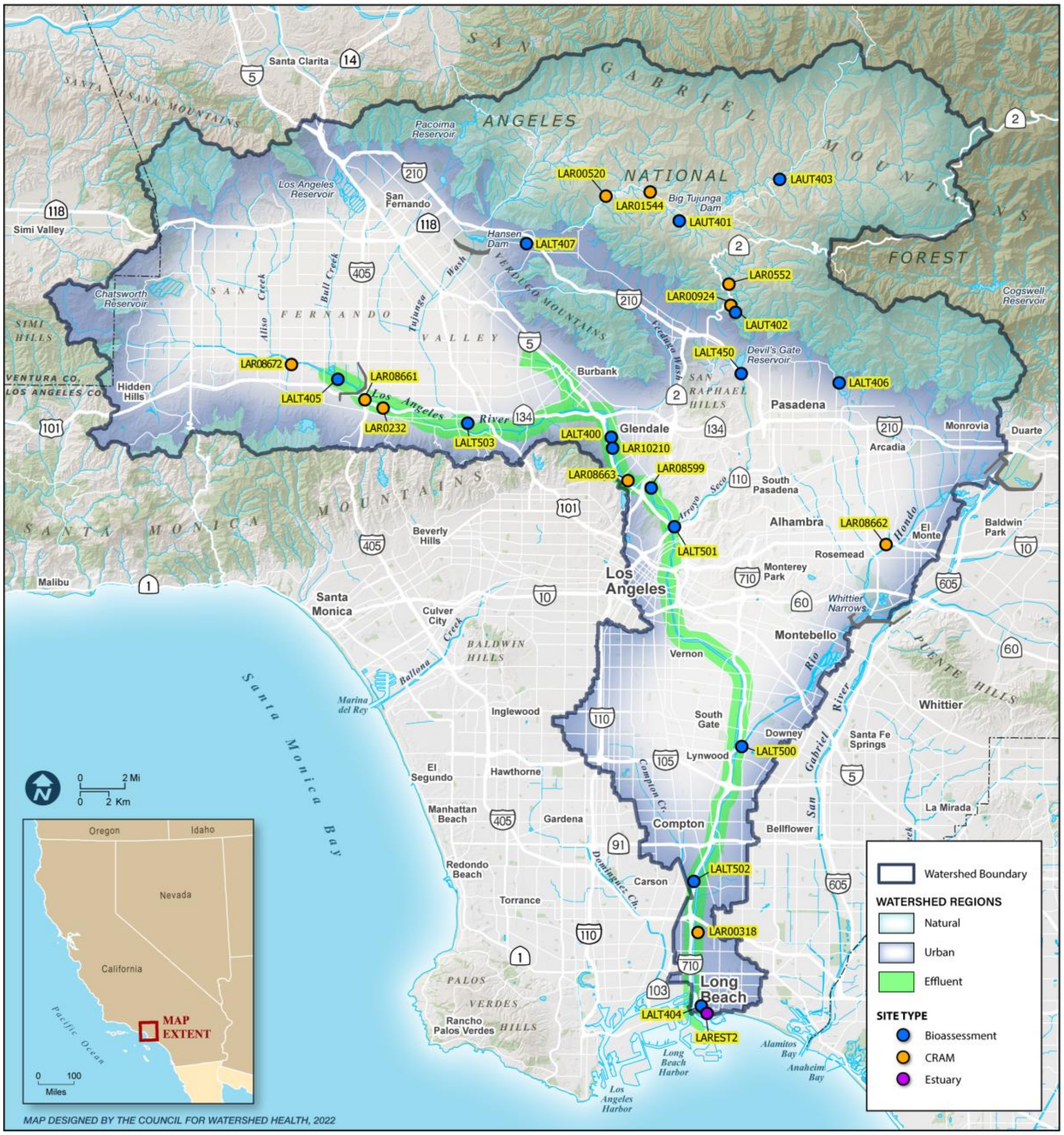


Figure 21. Location of bioassessment, CRAM, and estuary sites.

Table 8. Location of targeted sites sampled in 2021

Targeted Confluence Locations	Channel Type	Site ID	Latitude	Longitude
LMP	Unlined	LAR08599	34.10603	-118.24338
GN	Unlined	LAR10210	34.13224	-118.27407

a. Aquatic Chemistry

In 2021, the LMP (LAR08599) and GN Site (LAR10210) were monitored. LMP (LAR08599) was notable in the general stability of general chemistry constituent concentrations from year to year, including in 2021 (
Figure 22). Since GN (LAR10210) was measured for the first time in 2021, there are no trends to report. However, analyte values were similar to the LMP site.

LMP had nitrate-N and total nitrogen concentrations that decreased from 2015 to 2021 (Figure 23). In 2021, concentrations at the GN Site (LAR10210) were similar to LMP. Nitrate-N concentrations at both sites have been below the water quality thresholds specified in the Los Angeles Basin Plan (<10 mg/L; LARWQCB 2019). In 2021, the concentrations of orthophosphate and total phosphorus at LMP were comparable to those at the GN Site.

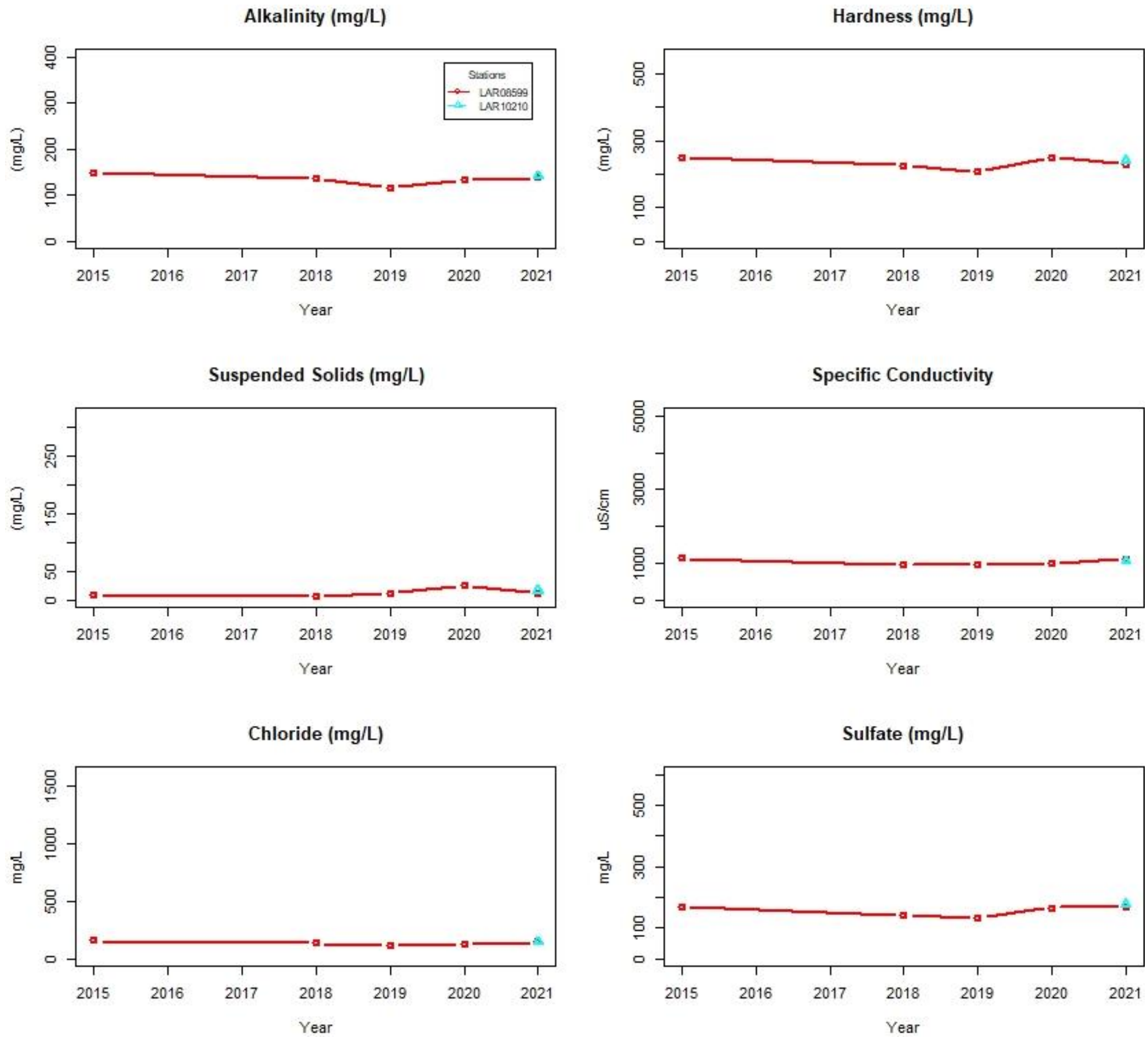


Figure 22. General chemistry at confluence sites sampled annually from 2015 to 2021.

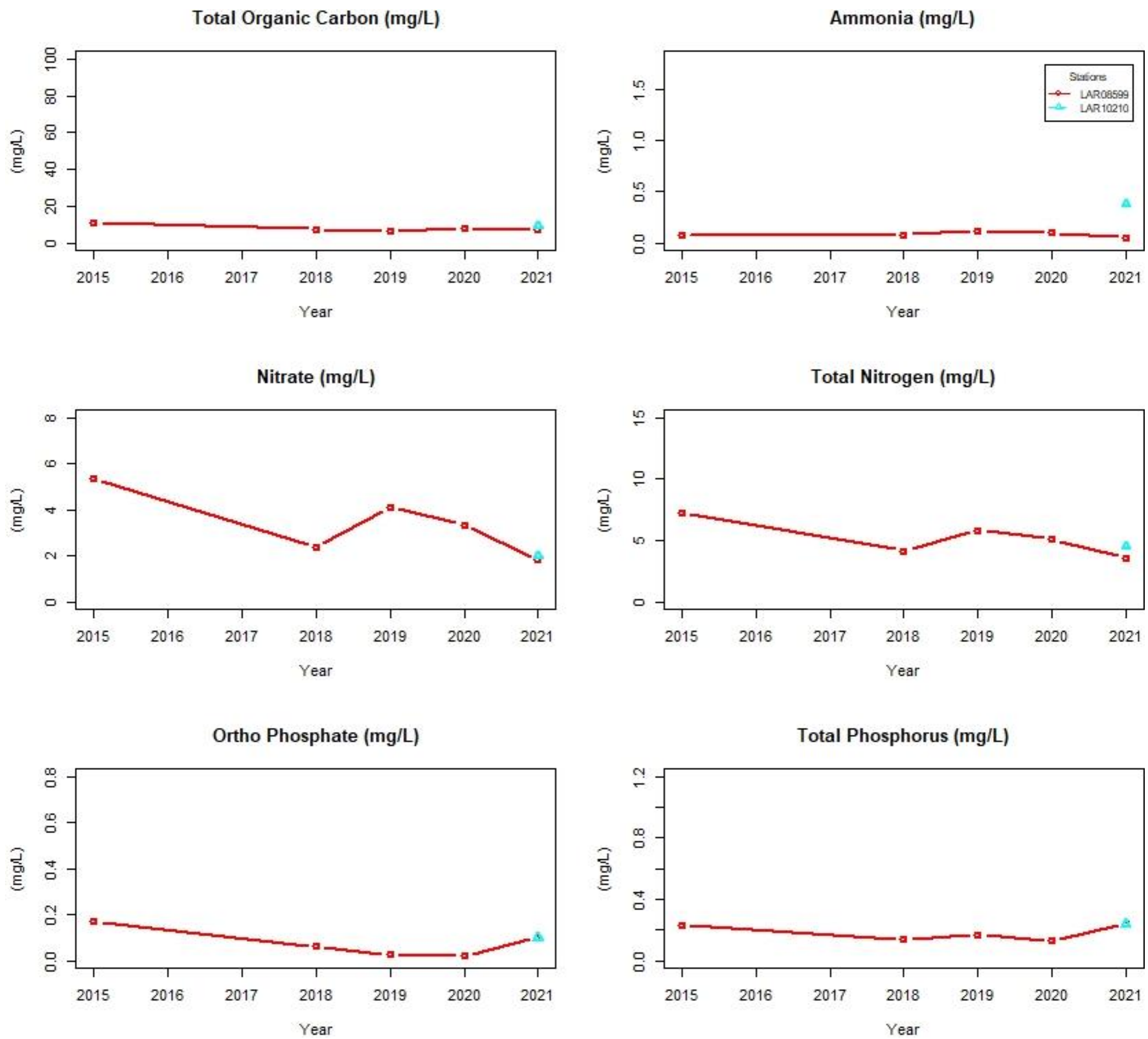


Figure 23. Nutrient concentrations at confluence sites sampled annually from 2015 to 2021.

b. Biological and Riparian Habitat (CRAM) Condition

Figure 24 presents the biotic condition index scores for BMI (CSCI) and riparian habitat scores (CRAM; overall and attribute) for the targeted sites sampled in 2021. After scoring just above the reference threshold (0.79; possibly altered) at the Lewis MacAdams Site in 2020, the biotic condition dropped slightly in 2021 to just below the threshold. The GN site scored similarly to LMP. The GN and LMP sites score higher than the other confluence sites that have been monitored in the past. 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.

Overall CRAM scores at the LMP site, a soft-bottom portion of the river, are stable and did not change in 2021. The GN site had a CRAM score comparable to LMP. Attribute scores at the Lewis MacAdams site, however, did increase significantly for hydrology and physical structure. Attribute scores decreased significantly for biotic structure and buffer and landscape context (CWMW, 2019).

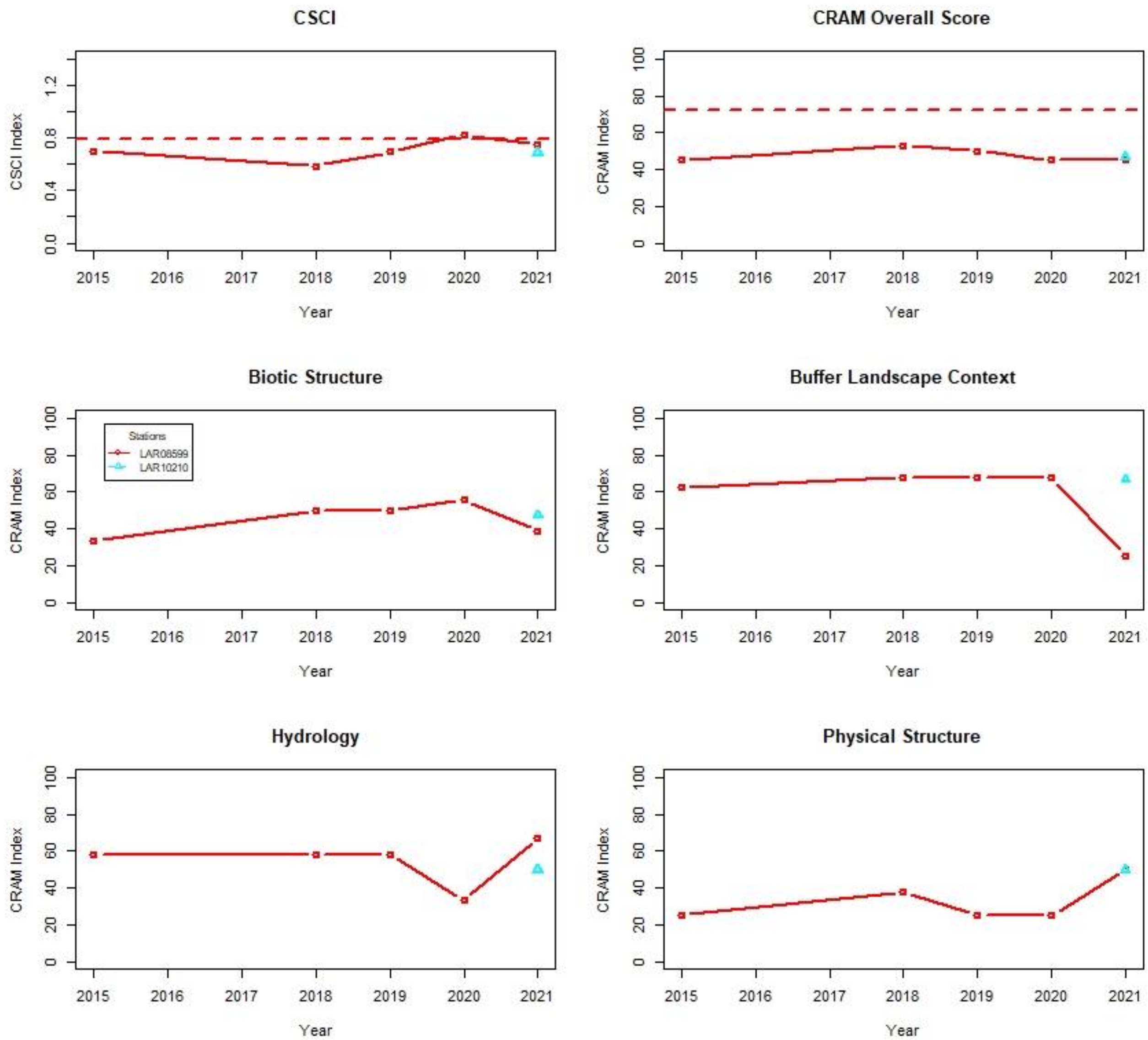


Figure 24. CSCI and CRAM scores (overall and attribute) at confluence sites and selected target sites sampled annually from 2015 to 2021. The red dashed horizontal lines on the CSCI and CRAM Overall Score graphs indicate the threshold, below which the site is in non-reference condition (0.79 for CSCI and 72 for overall CRAM score).

c. Physical Habitat

Figure 25 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.

Despite dredging activities at the LMP 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 improved slightly. 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.

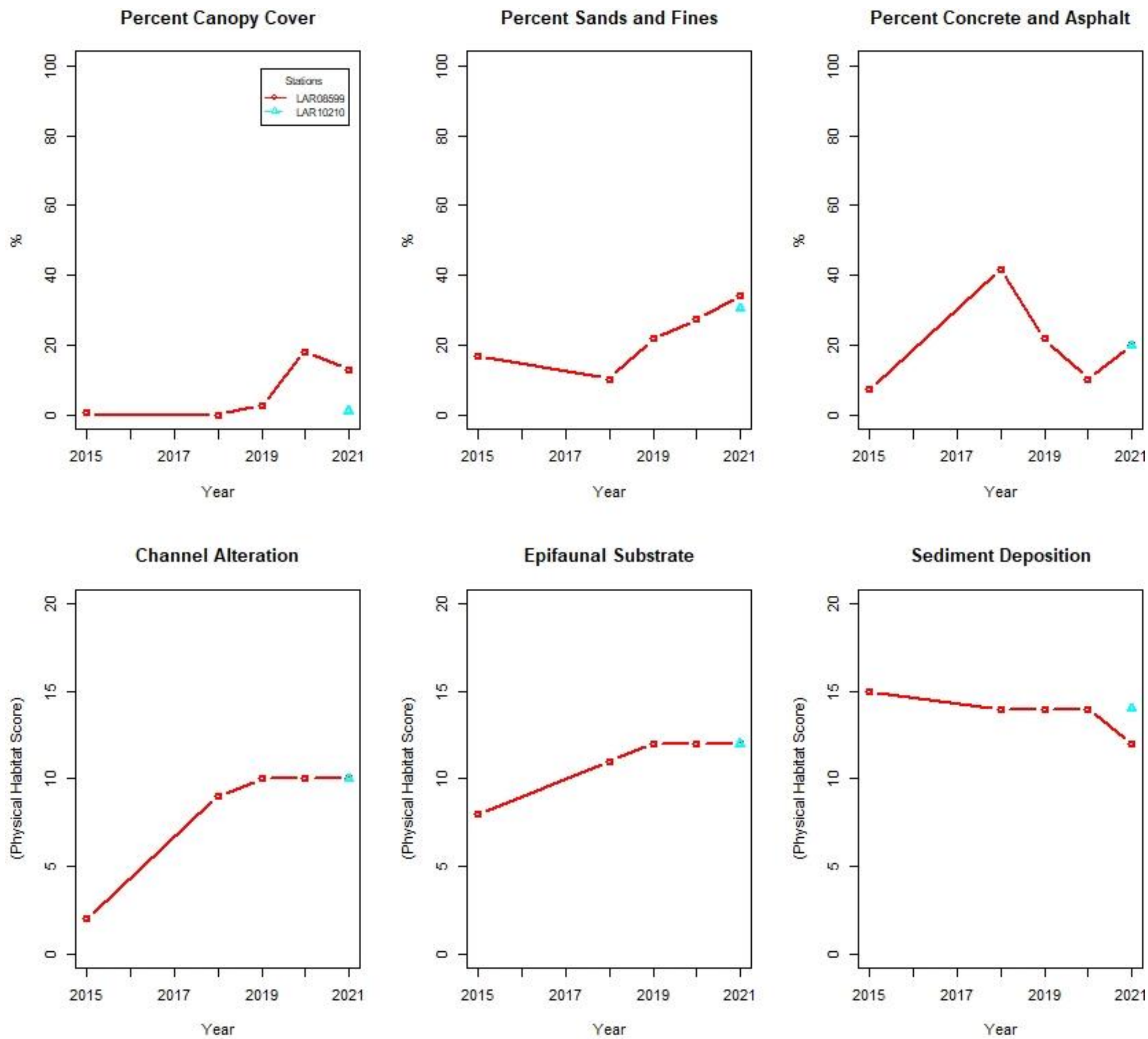


Figure 25. Physical habitat at confluence sites sampled annually from 2015 to 2021.

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.

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. The Workgroup determined that subsequent visits would occur every two to three years since conditions at these locations were not changing rapidly.

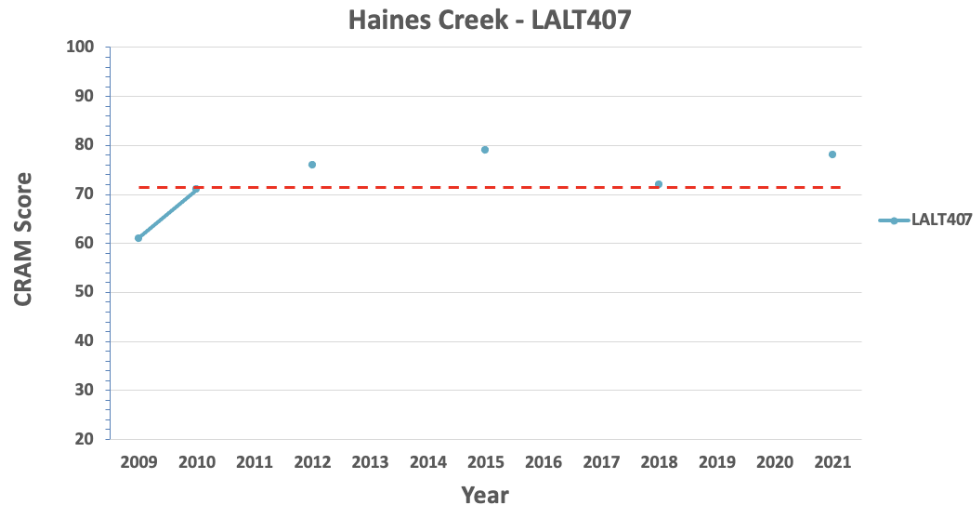
CRAM scores at lower watershed sites (prefix LALT) have usually fallen below the 10^{th} percentile of the reference distribution of sites throughout California, indicating they are 'likely altered'(Question 1. What is the condition of streams in the Los Angeles River Watershed?). Some high value sites 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 GN (LALT400), Sepulveda Basin (LALT405), Eaton Wash (LALT406) and Golden Shore Wetlands (LALT404) are normally below reference condition. This pattern continued in 2021. In 2021 the Haines Creek and Pool (LALT407), and Eaton Wash (LALT406) were assessed for riparian habitat condition. Haines Creek and Pool (LALT407) was above reference condition, as in previous years.

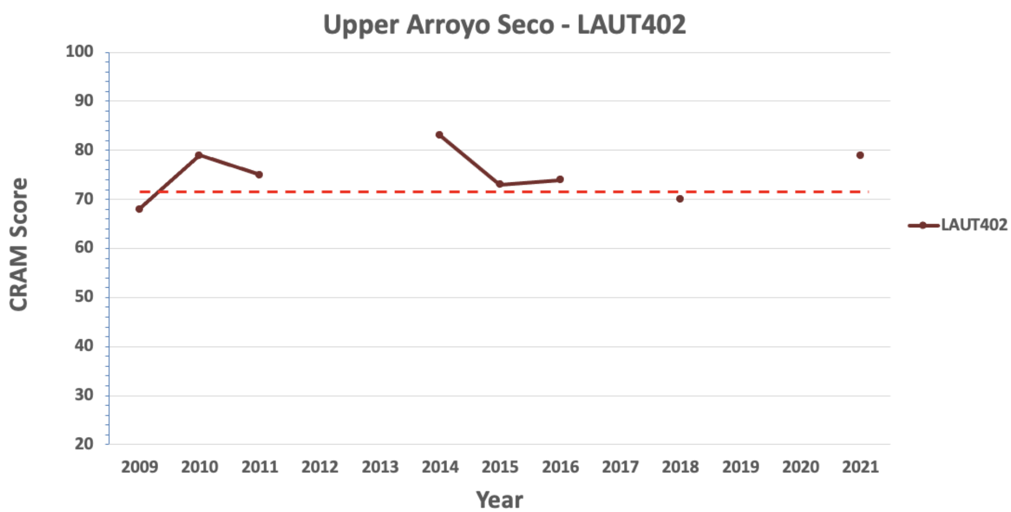
The best riparian zone conditions have been found consistently at sites located in the upper watershed (prefix LAUT). The 2009 Station Fire created the opportunity for the LARWMP program to better understand the impact of fire to riparian habitats and recovery. Upper watershed sites that burned included: LAUT401, LAUT402, and LAUT403—located in the Tujunga Sensitive Habitat, Upper Arroyo Seco, and Alder Creek. The Upper Arroyo (LAUT402) Seco site has largely stayed in above reference condition since the 2009 fire, including in 2021.

Figure 26 shows the individual CRAM scores from these sites for the period of 2009 to 2021. CRAM scores at Upper Arroyo Seco (LAUT402) and Haines Creek (LAUT407) showed significant improvement since the sites were last assessed (scores improved by 6 points or more) (Figure 21). While scores at Eaton Wash were stable since last measured (LALT406).

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





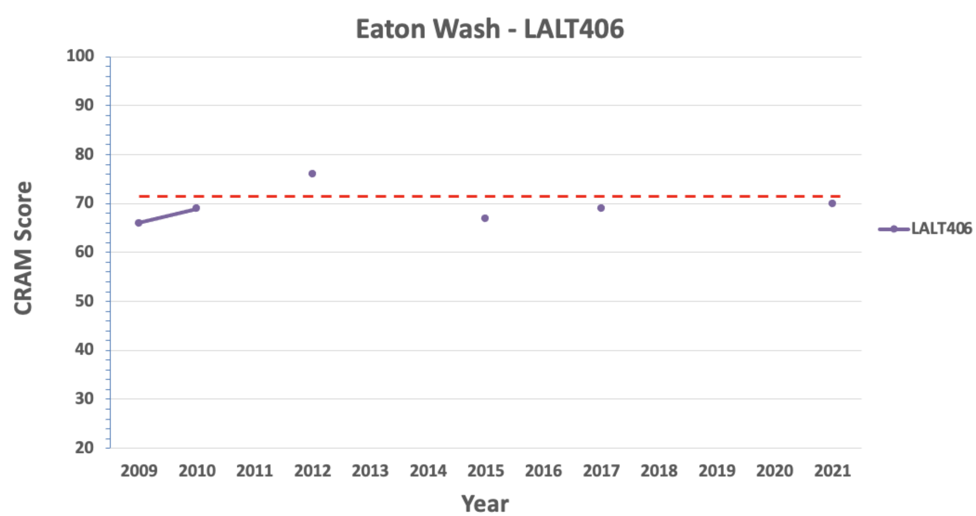


Figure 26. Riparian zone condition (CRAM scores) at select high-value sites from 2009-2021. The red horizontal line represents the 10th percentile of the reference distribution of sites in California. Scores below this line represent 'likely altered' habitat.

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

1. 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 2021 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 27, 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	NO_3-N+NO_2-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)
WQO	8 mg/L	10	1

Figure 27. Locations of NPDES receiving water sites monitored by the City of Los Angeles and the City of Burbank.

2. *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 28. The 2017 NPDES permits of DCTWRP and LAGWRP have *E. coli* receiving water limitations of 235/100 mL for single sample limits and 126/100mL for geometric mean limits. Until the new water quality objectives for *E. coli* (320 MPN/100mL, STV) are adopted into DCT's and LAG's permit, 235 MPN/100 mL will be used to assess the water quality upstream and downstream of the discharge. The statistical threshold value (STV) water quality objective of 235 MPN/100mL for REC-1 beneficial use was attained for approximately 92% of upstream samples and 74% of the downstream samples during the 2021 sampling year.

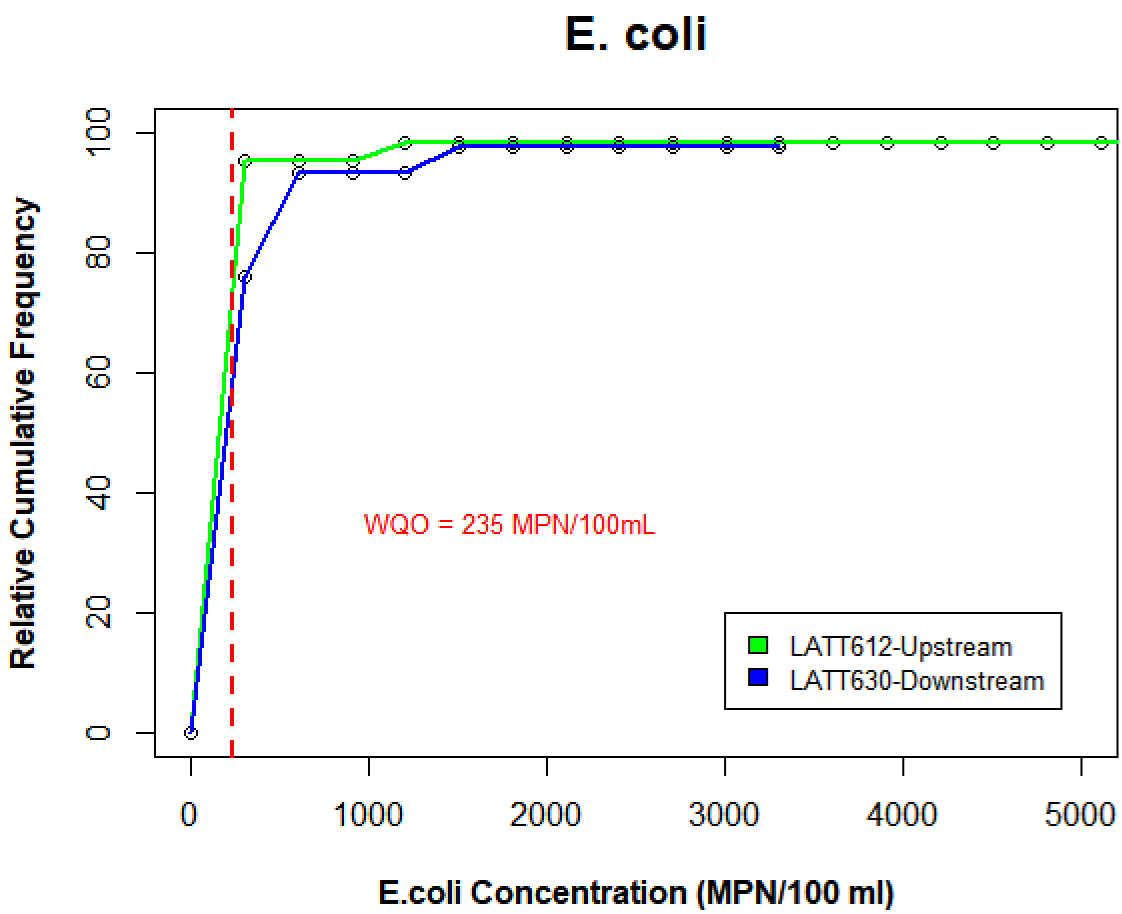


Figure 28. Cumulative frequency distributions of *E. coli* concentrations above and below the DCTWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Table 12 shows the average concentrations of several nitrogen species observed at a site upstream and downstream of DCTWRP discharge. Nitrate-N, nitrite-N, and ammonia-N were tested weekly. Average downstream concentrations of nitrate-N and nitrite-N were below water quality objectives (Table 11) and max values for nitrogen species show that downstream samples did not exceed WQO in 2021.

Ammonia is toxic to aquatic life and the proportion of toxic ammonia-N (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-N samples collected upstream and downstream of

DCTWRP effluent (Figure 29). There were five exceedances upstream of DCTWRP effluent and three exceedances of the ammonia-N WQO downstream.

Table 12. Range of nutrient concentrations upstream and downstream of DCTWRP discharge in 2021.

Position	N Species	Mean	Med	Max	SD
Upstream	NH3-N	0.88	0.68	4.01	0.79
	NO2-N	0.24	0.21	0.97	0.15
	NO3-N	3.69	3.57	6.09	0.87
Downstream	NH3-N	0.28	0.27	0.76	0.18
	NO2-N	0.10	0.09	0.42	0.06
	NO3-N	1.33	1.29	3.06	0.72

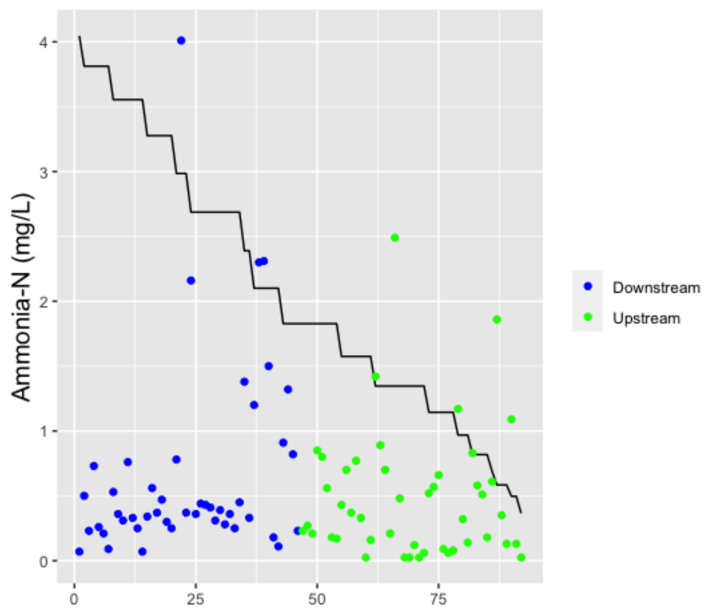


Figure 29 Ammonia-N concentrations upstream and downstream of DCTWRP in 2021. The line represents the reach specific WQO, a function of pH and temperature at time of sampling.

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	CONSTITUENT	2/2/21	8/3/21
Upstream	BROMODICHLOROMETHANE	0.10	0.10
	BROMOFORM	0.14	0.04
	CHLOROFORM	0.10	0.07
	DIBROMOCHLOROMETHANE	0.12	0.05
	Total	0.46	0.25
Downstream	BROMODICHLOROMETHANE	0.52	1.97
	BROMOFORM	0.14	0.04
	CHLOROFORM	2.46	3.85
	DIBROMOCHLOROMETHANE	0.12	0.69
	Total	3.24	6.55

The metals concentrations shown in Figure 30 are compared to the California Toxics Rule (CTR) chronic and acute standards. 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 30 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.

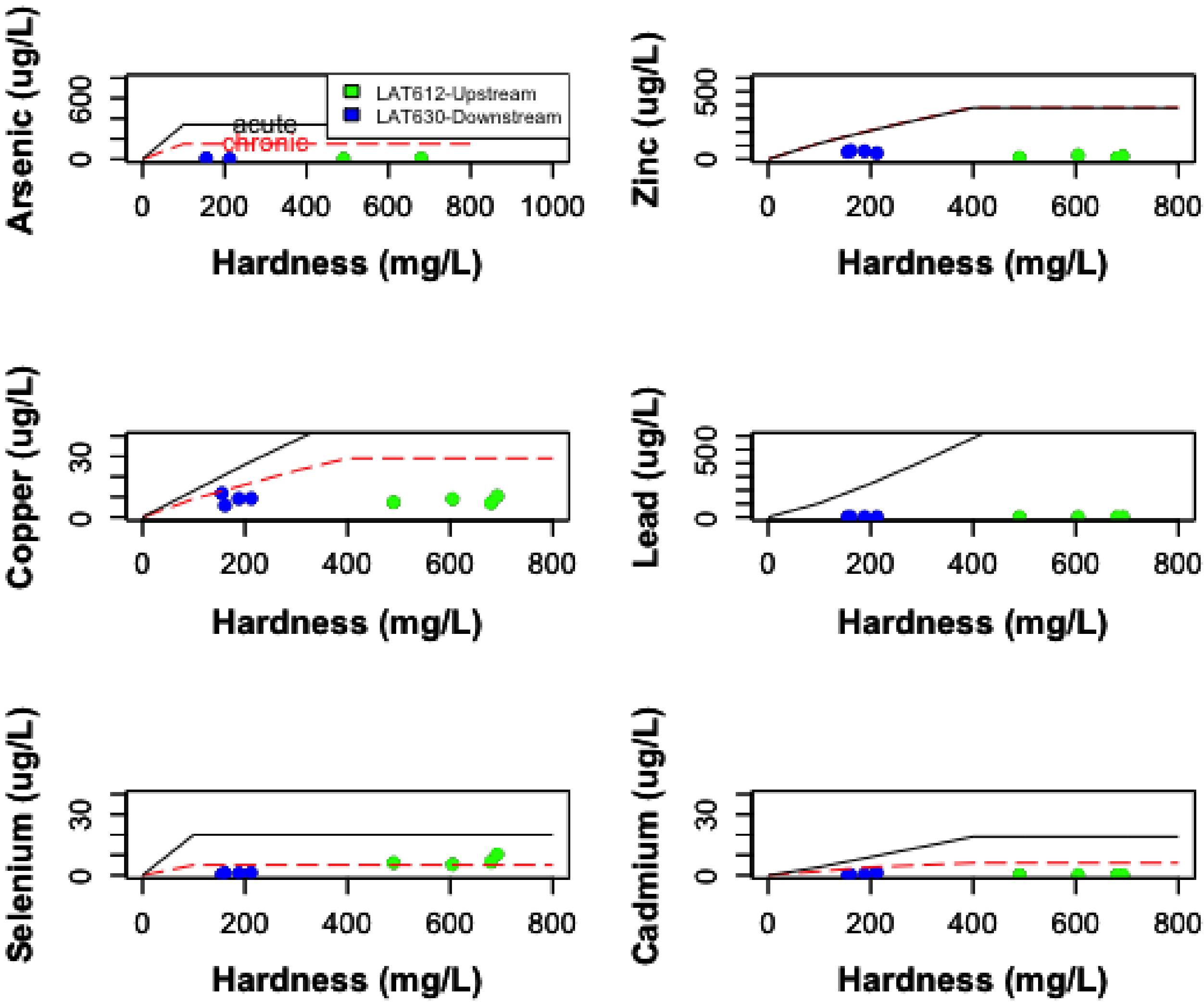


Figure 30. Converted dissolved metals concentrations above and below the DCTWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Black lines indicate acute CTR thresholds and red line indicates chronic CTR thresholds. Lead does not have a CTR threshold because the EPA has not established human health criteria for this contaminant. Values are estimated in instances where there were non-detects that did not meet the laboratory's reporting limit.

3. City of Los Angeles – LAGWRP

Figure 31 shows the cumulative frequency distributions for *E. coli* at sites above and below the discharge point for the LAGWRP. Approximately 6.5% of the *E. coli* samples met the WQO at the upstream site, while approximately 58% of the samples met the WQO at the downstream site. Cumulative frequencies of *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.

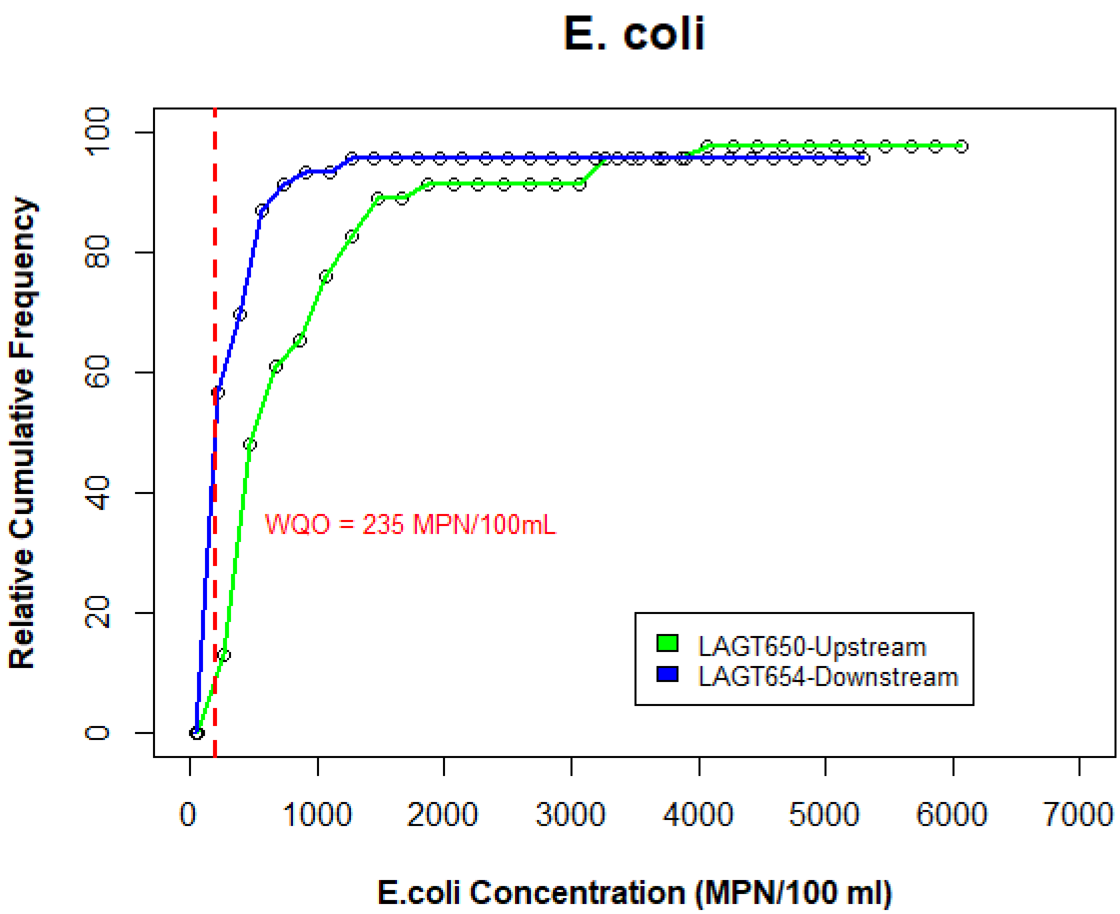


Figure 31. Cumulative frequency distribution of *E. coli* above and below the LAGWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Table 14 shows average concentration of regulated nitrogen species above and below the LAGWRP discharge. Nitrate-N, nitrite-N, and ammonia-N were tested weekly. Most of the nitrogen downstream and upstream of the POTW was in the form of nitrate-N.

Table 14. Range of concentrations of ammonia-N, nitrite-N, and nitrate-N at locations upstream and downstream of LAGWRP during 2021.

Position	Nutrient	Mean	Med	Max	SD
Upstream	NH3-N	0.07	0.05	0.47	0.08
	NO2-N	0.47	0.45	3.20	0.45
	NO3-N	3.00	3.10	6.30	1.12
Downstream	NH3-N	0.87	0.81	2.30	0.31
	NO2-N	0.45	0.42	5.10	0.68
	NO3-N	3.56	3.50	7.10	1.10

The monthly average ammonia-N WQO for reach 3 of the Los Angeles River was graphed alongside ammonia-N samples collected upstream and downstream of LAGWRP effluent (Figure 32). There were no exceedances of the NH_3-nitrogen WQO downstream of LAGWRP and one exceedance upstream.

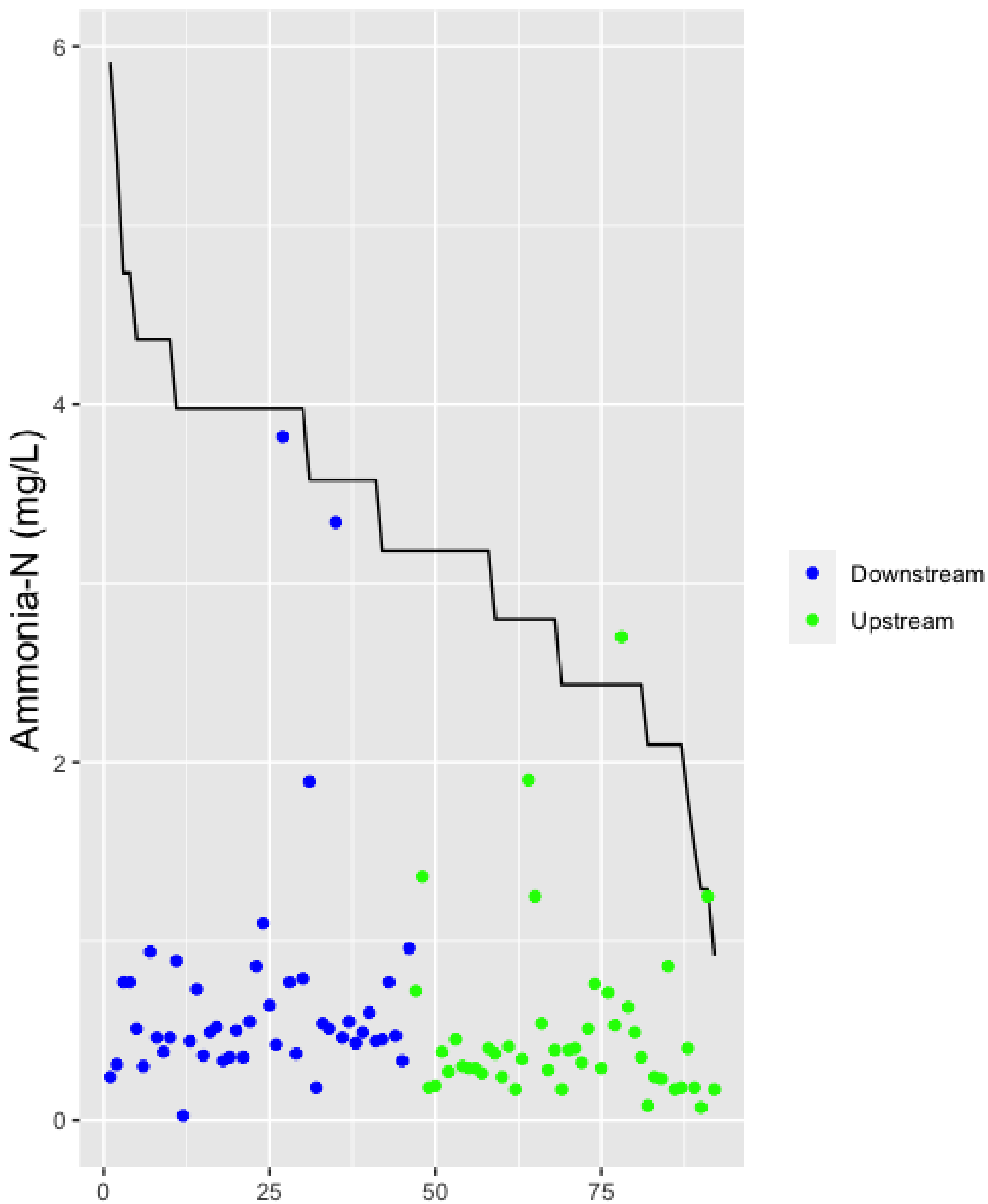


Figure 32 Ammonia-N concentrations upstream and downstream of LAGWRP during 2021. The line represents the reach specific WQO, a function of pH and temperature at time of sampling.

Total recoverable metals were measured both upstream and downstream of the LAGWRP discharge (Figure 33). 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.

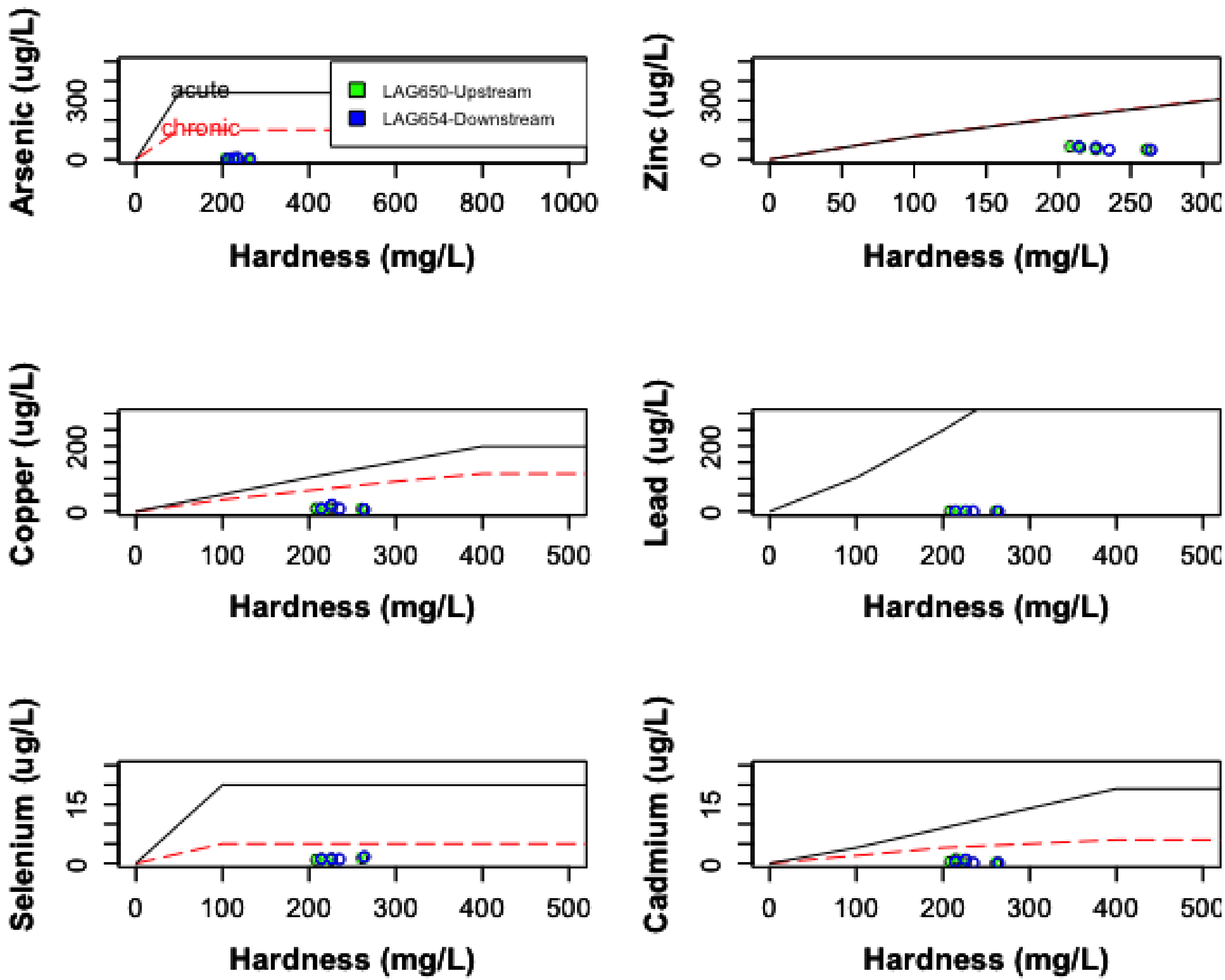


Figure 33. Converted dissolved metals concentrations above and below the LAGWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Black lines indicate acute CTR thresholds and redlines indicate chronic CTR thresholds. Lead does not have a CTR threshold because the EPA has not established human health criteria for this contaminant. 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).

Site	Parameter	2/3/21	8/2/21
Upstream	Bromodichloromethane	0.22	0.22
	Bromoform	0.135	0.135
	Chloroform	0.145	0.145
	Dibromochloromethane	0.175	0.175
	Total	0.675	0.675
Downstream	Bromodichloromethane	2.4	1.7
	Bromoform	0.135	0.135
	Chloroform	4	4.7
	Dibromochloromethane	0.87	0.74
	Total	7.405	7.275

4. 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 34. Approximately 15% of upstream and downstream locations met the WQO.

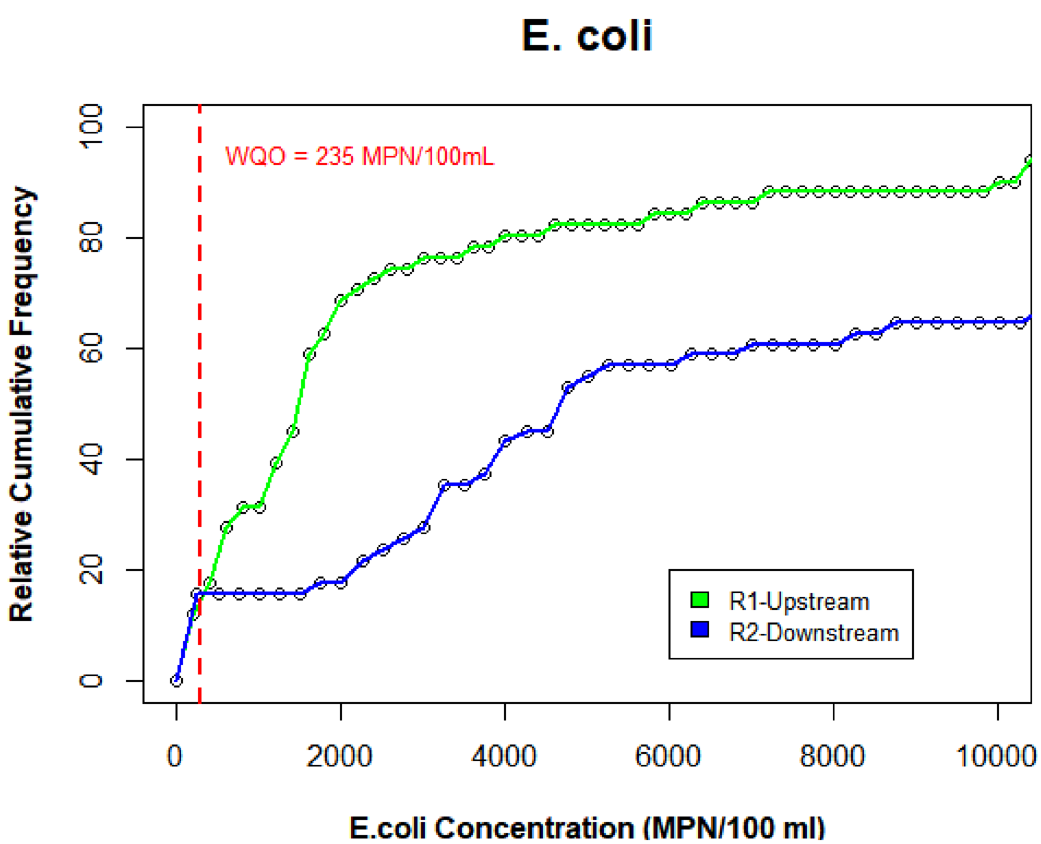


Figure 34. Cumulative frequency distributions for *E. coli* above and below the BWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

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-N and nitrate-N plus nitrite-N were higher downstream and, on average, met WQO. However, some nitrite-N values exceeded WQO (max values downstream of the Burbank POWT were 5.10 ug/L) (Table 16). Similarly, downstream concentrations of ammonia-N were higher than upstream concentrations. There was one downstream sample that exceeded established ammonia-N WQO for the Burbank Channel (Figure 35).

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

Position	Nutrient	Mean	Med	Max	SD
Upstream	NH3-N	0.07	0.05	0.47	0.08
	NO2-N	0.47	0.45	3.20	0.45
	NO3-N	3.00	3.10	6.30	1.12
Downstream	NH3-N	0.87	0.81	2.30	0.31
	NO2-N	0.45	0.42	5.10	0.68
	NO3-N	3.56	3.50	7.10	1.10

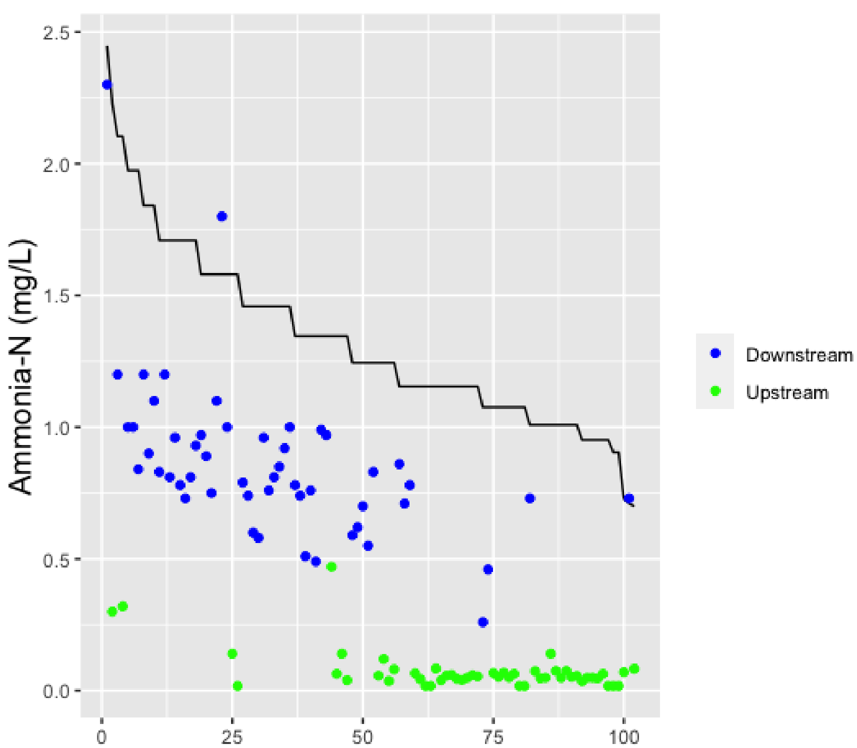


Figure 35 Ammonia-N concentrations of samples collected upstream and downstream of the BWRP graphed with the Burbank Channel pH and temperature dependent WQO for ammonia-N. The line represents the CTR ammonia-N threshold.

Figure 36 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.

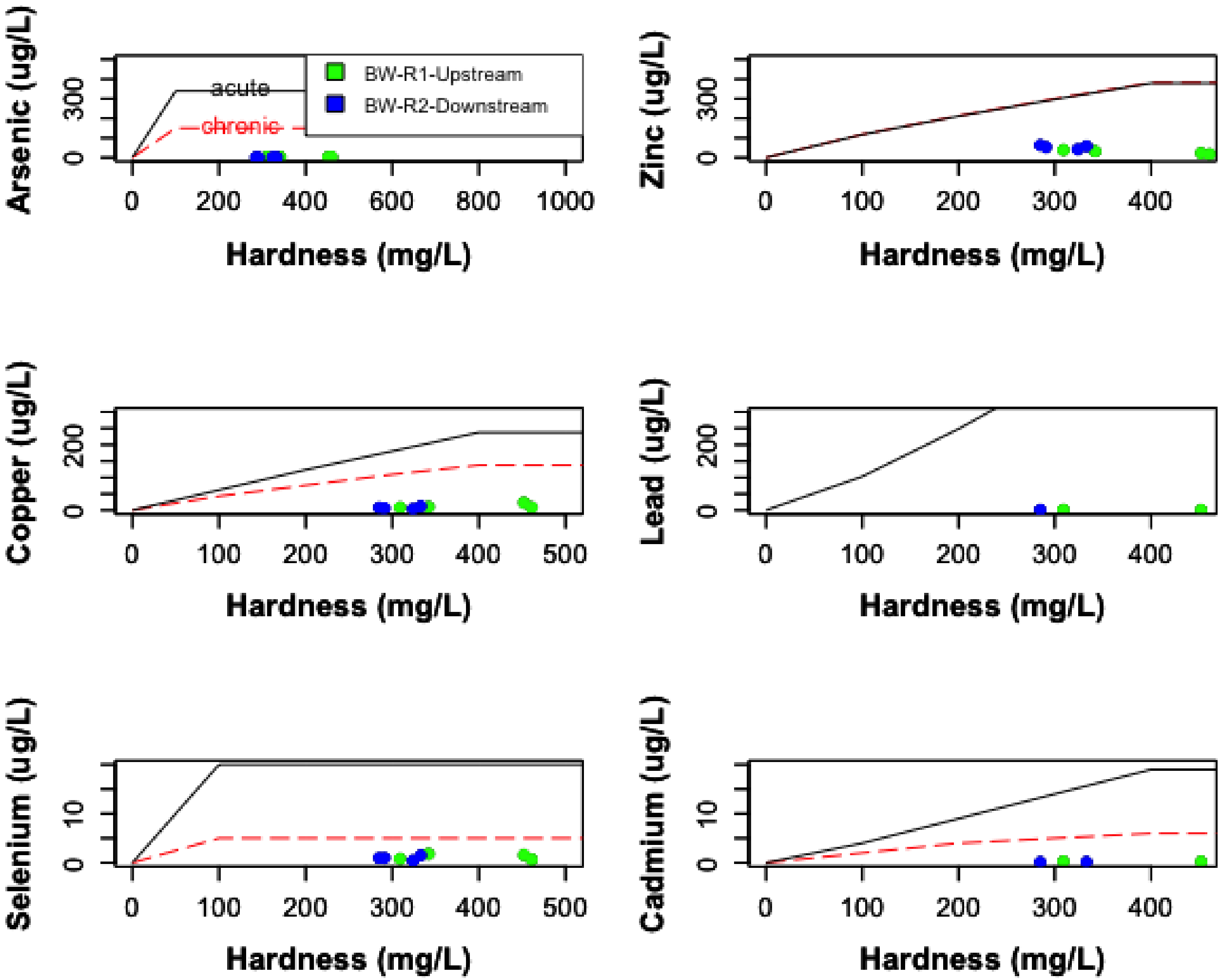


Figure 36. Dissolved metals concentrations above and below the BWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Only copper has a reach specific WER and CTR criteria are adjusted. Black lines indicate acute thresholds and red lines indicate chronic thresholds. Lead does not have a chronic threshold line because the EPA has not established human health criteria for this contaminant. 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) and were, as expected, higher downstream of POTW effluent.

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	2/3/21	8/2/21
Downstream	Bromodichloromethane	2.4	1.7
	Bromoform	0.135	0.135
	Chloroform	4	4.7
	Dibromochloromethane	0.87	0.74
	Sum	7.405	7.275
Upstream	Bromodichloromethane	0.22	0.22
	Bromoform	0.135	0.135
	Chloroform	0.145	0.145
	Dibromochloromethane	0.175	0.175
	Sum	0.675	0.675

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 formal and informal sites in the Los Angeles River Watershed for Water Contact Recreation. 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 and to kayakers in the recreation zones. 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 37 and 1

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).

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).

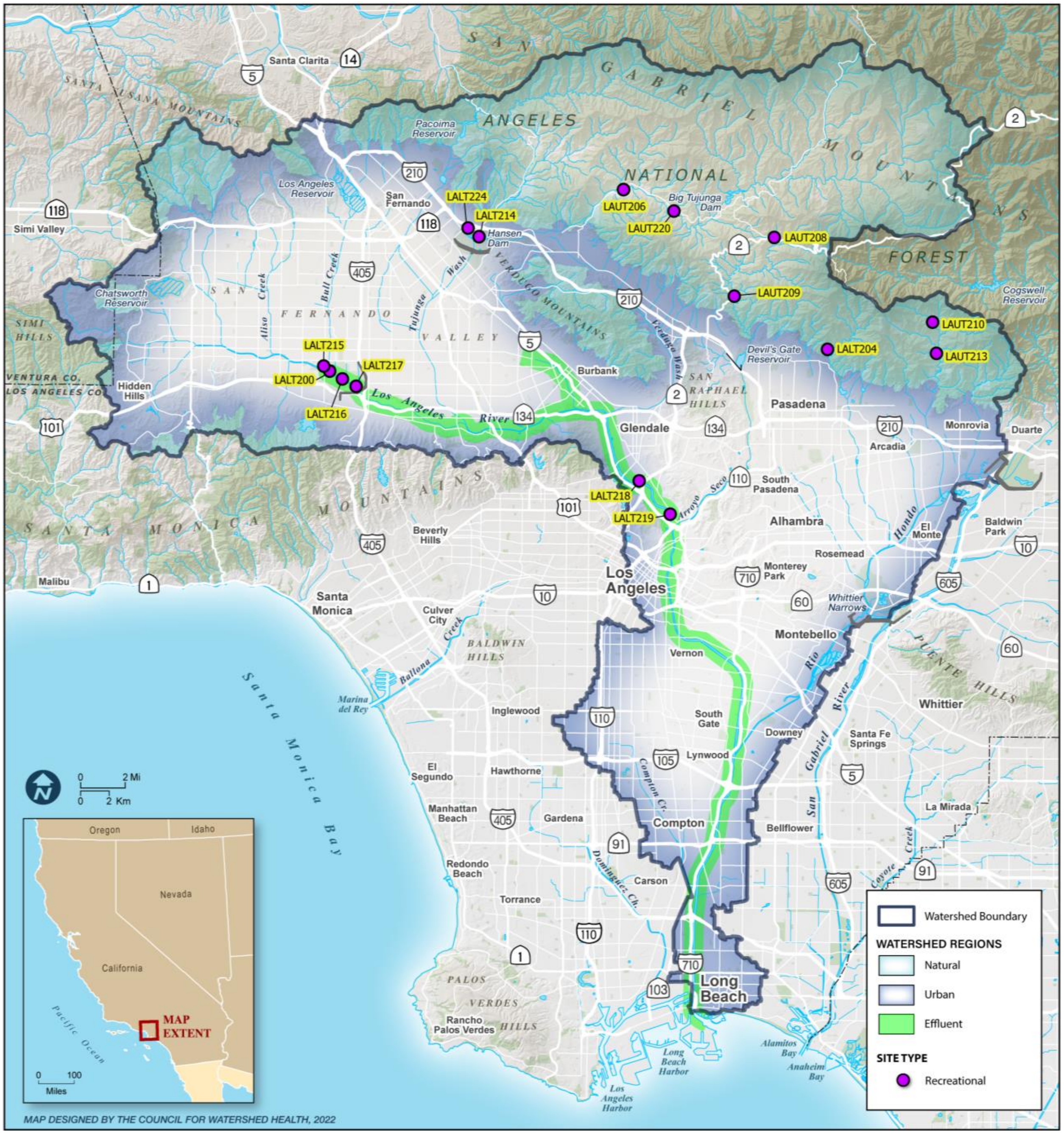


Figure 37. Recreational swim site locations in 2021

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
	Delta Day Use	LAUT206
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 that makes use of the geometric mean 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 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 2021, there was a goal to collect no fewer than five samples per month at each of the swim sites. However, site closure and drought conditions at the end of the season prevented the collection of five monthly samples at select sites.

3. Results

During the summer of 2021, a total of 339 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) and Bull Creek (LALT 200) exceeded the STV two of the three months of sampling. The 6-week rolling geometric mean similarly showed Hansen Dam (LALT 214) and, to a lesser extent, Bull Creek (LALT 200) have consistently high *E. coli* concentrations compared to other informal recreation sites (Table 22). Switzer falls (LAUT 208), Gould Mesa (LAUT 209), and Delta Day (LAUT 206) only exceeded the STV in the last month of sampling and results were mirrored by the 6-week rolling geometric mean, with Gould Mesa having the third highest exceedances of the 6-week rolling geomean WQO.

Kayak sites were compared to the higher 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 15% at the UEV site (LALT218), followed by the Lower Sepulveda Basin site (LALT217), in which 5% of samples exceeded the LREC WQO (Table 22 Geometric mean of E. coli concentrations (MPN/100 mL) at informal sites in the Los Angeles River Watershed. Rolling 6-week means that are above 100 MPN/100 mL are highlighted in red.

	5/26-7/7	6/2-7/14	6/9-7/21	6/16-7/28	6/23-8/4	6/30-8/11	7/7-8/18	7/14-8/25	7/21-9
DATE	Week 1-6	Week 2-7	Week 3-8	Week 4-9	Week 5-10	Week 6 -11	Week 7-12	Week 8-13	Week 9-14
LALT200	268.0	181.6	153.5	146.1	96.7	76.7	81.0	185.4	179.0
LALT204	21.2	16.3	14.9	17.8	18.4	17.1	18.5	16.7	21.1
LAUT208	28.3	57.9	71.5	96.1	138.3	86.1	81.8	209.1	246.7
LAUT209	60.6	62.2	69.7	74.2	91.0	170.3	130.5	162.1	103.2
LAUT206	60.2	89.8	78.3	86.4	80.7	68.9	38.1	97.6	154.5
LAUT211	6.2	6.5	6.5	6.5	6.3	7.9	8.7	9.6	9.6
LAUT220	9.7	18.9	26.9	36.1	49.3	53.8	91.3	72.7	67.0
LALT214	633.4	820.5	873.7	1440.2	1409.9	1342.6	1471.2	1039.0	1342.2
LALT224	7.6	7.1	6.5	6.5	7.1	7.1	5.0	10.0	10.0

Table 23Using the 30-day geometric mean based LREC WQO of 126 MPN, UEV site exceeded the WQO every month of sampling (LALT 218) (

Table 24). The Middle Sepulveda Basin (LALT 216) Kayak Zone exceeded the 30-day geomean 2 of the 5 months that were monitored.

Table 21. Single sample *E. coli* concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from May through August 2021 (<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. Exceedances are highlighted in red.

Site	5/26/21	5/31/21	6/1/21	6/6/21	6/12/21	6/16/21	6/20/21	6/29/21	7/4/21	7/5/21	7/10/21	7/17/21	7/25/21	8/8/21	8/14/21	8/19/21	8/24/21	8/30/21	5/26-6/25 STV Exceedances	6/26-7/25 STV Exceedances	7/26-8/30 STV Exceedances
LALT200	109	882	336	465	388	529	480	121	98	109	20	121	262	30	183	426	548	98	86%	0%	40%
LALT204	41	NS	NS	10	10	<10	52	63	30	20	<10	<10	41	41	52	10	<10	20	0%	0%	0%
LAUT208	20	10	<10	20	20	52	20	86	121	75	389	108	213	<10	NS	9800	355	NS	0%	17%	67%
LAUT209	52	160	31	30	52	31	52	31	341	98	86	75	85	1330	52	374	110	<10	0%	17%	40%
LAUT206	10	20	30	30	86	86	131	134	309	86	41	10	189	52	20	496	884	158	0%	0%	40%
LAUT211	10	<10	<10	<10	<10	<10	10	<10	<10	10	10	<10	<10	20	10	31	<10	<10	0%	0%	0%
LAUT220	<10	<10	<10	<10	<10	20	10	31	<10	75	281	85	52	52	98	327	20	52	0%	0%	20%
LALT214	256	712	231	504	169	3870	609	2480	676	733	833	833	9210	1850	583	465	327	3870	57%	100%	1%
LALT224	10	<10	10	10	<10	<10	<10	<10	10	20	<10	<10	<10	<10	<10	52	31	<10	0%	0%	0%

Table 22 Geometric mean of *E. coli* concentrations (MPN/100 mL) at informal sites in the Los Angeles River Watershed. Rolling 6-week means that are above 100 MPN/100 mL are highlighted in red.

	5/26-7/7	6/2-7/14	6/9-7/21	6/16-7/28	6/23-8/4	6/30-8/11	7/7-8/18	7/14-8/25	7/21-9
DATE	Week 1-6	Week 2-7	Week 3-8	Week 4-9	Week 5-10	Week 6 -11	Week 7-12	Week 8-13	Week 9-14
LALT200	268.0	181.6	153.5	146.1	96.7	76.7	81.0	185.4	179.0
LALT204	21.2	16.3	14.9	17.8	18.4	17.1	18.5	16.7	21.1
LAUT208	28.3	57.9	71.5	96.1	138.3	86.1	81.8	209.1	246.7
LAUT209	60.6	62.2	69.7	74.2	91.0	170.3	130.5	162.1	103.2
LAUT206	60.2	89.8	78.3	86.4	80.7	68.9	38.1	97.6	154.5
LAUT211	6.2	6.5	6.5	6.5	6.3	7.9	8.7	9.6	9.6
LAUT220	9.7	18.9	26.9	36.1	49.3	53.8	91.3	72.7	67.0
LALT214	633.4	820.5	873.7	1440.2	1409.9	1342.6	1471.2	1039.0	1342.2
LALT224	7.6	7.1	6.5	6.5	7.1	7.1	5.0	10.0	10.0

Table 23. Single sample *E. coli* concentrations (MPN/100 mL) at kayak sites in the Los Angeles River Watershed from May through September 2021 (<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.

Site ID	5/18/21	5/25/21	5/27/21	6/1/21	6/3/21	6/8/21	6/10/21	6/15/21	6/17/21	6/22/21	6/24/21	6/29/21	7/1/21	7/6/21	7/8/21	7/13/21	7/15/21	7/20/21	7/22/21
LALT215	63	10	<10	41	243	20	109	41	52	63	63	31	41	41	41	63	10	52	52
LALT216	122	135	97	121	86	121	146	75	146	173	52	86	121	41	30	631	122	20	98
LALT217	98	31	86	63	74	63	75	10	63	20	63	20	41	51	98	31	41	51	98
LALT218	121	1790	256	272	145	201	122	1274	298	256	158	216	309	142	228	156	110	238	201
LALT 221	613	199	313	181	98	146	121	74	109	74	146	41	97	63	146	63	63	20	135
LALT219	85	109	72	74	132	169	75	121	108	86	110	52	110	30	121	41	160	75	86

Site ID	7/27/21	7/29/21	8/3/21	8/5/21	8/10/21	8/12/21	8/17/21	8/19/21	8/24/21	8/26/21	8/31/21	9/2/21	9/7/21	9/9/21	9/14/21	9/16/21	9/21/21	9/23/21	9/28/21	9/30/21	% Exceedance
LALT215	97	31	20	63	10	41	51	52	63	72	85	10	20	201	246	20	63	52	51	20	0%
LALT216	134	262	315	223	201	199	233	121	199	175	211	134	173	135	279	74	331	158	323	246	3%
LALT217	86	85	145	63	109	228	85	823	689	86	253	41	85	73	108	160	131	158	119	85	5%
LALT218	1576	97	52	399	199	292	281	336	156	110	563	345	189	605	733	909	199	228	130	320	15%
LALT 221	185	148	120	41	63	20	20	52	31	20	74	74	73	121	122	171	144	63	97	63	3%
LALT219	3654	213	109	146	120	52	86	86	241	97	86	110	110	75	109	462	135	134	262	295	3%

Table 24 Geometric mean of *E. coli* concentrations at kayak sites from May through September 2021. Geometric means are compared to the LREC-1 geomean objective of 126 MPN/100 mL. Values that were above the geomean WQO are highlighted in gray.

Site ID	30 day GM 5/18-6/17	30 day GM 6/18-7/17	30 day GM 7/18-8/17	30 day GM 8/18-9/17	30 day GM 9/18-9/30
LALT215	48.21	39.0	39.1	54.1	42.8
LALT216	113.86	98.5	152.7	156.8	253.9
LALT217	53.56	40.0	96.2	155.8	120.3
LALT218	301.13	187.1	238.3	353.1	208.4
LALT 221	166.15	79.3	59.4	68.3	86.3
LALT219	100.85	77.4	151.8	125.8	193.4

Table 25 summarizes site observations for the 2021 monitoring year. The most popular sites among the public are Hansen Dam Recreation Lake (LALT 224) and Eaton Canyon (LALT 204), sites that are generally meeting WQO for FIB. 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 2021.

StationID	# On-Shore	#Animals	# Bathers	# Fisherman	Refuse	Algae	Oil	Tar	Sewage	Upstream Stormdrain
LALT200	0.72	0.00	0.00	0.17	Always Present	Absent	Absent	Absent	Absent	Absent
LALT204	6.31	0.56	0.19	0.00	Mostly absent	Absent	Absent	Absent	Absent	Absent
LALT214	0.61	0.50	0.11	0.00	Largely present	Absent	Absent	Absent	Absent	Absent
LALT224	7.94	1.39	0.00	0.00	Mostly absent	Absent	Absent	Absent	Absent	Absent
LAUT206	0.33	2.50	0.17	0.00	Always Present	Absent	Absent	Absent	Absent	Absent
LAUT208	1.33	0.28	0.00	0.00	Largely present	Absent	Absent	Absent	Absent	Absent
LAUT209	0.56	0.50	0.17	0.00	Present about 50% of time	Absent	Absent	Absent	Absent	Absent
LAUT211	0.22	0.06	0.00	0.00	Present about 50% of time	Absent	Occassional present	Absent	Absent	Absent
LAUT220	3.89	0.67	2.50	0.00	Largely present	Absent	Absent	Absent	Absent	Absent

Trash assessments were also completed at recreation sites, excluding kayak sites, from 2018 to 2021 using the methodology described under Question 1- Methods. We found that plastic, miscellaneous items, and metals were the most common categories of trash types across all sites (Figure 38). When analyzing more detailed trash sub-types across all recreation sites, we found that aluminum foil pieces, small plastic pieces, and miscellaneous trash sub-categories were the most prevalent (Figure 39). Vogel Flats (LAUT 220) had the highest total counts than any other swim sites and counts at this site were significantly higher than Tujunga Wash at Hansen Dam (LAUT 214) and Delta Day Use (LAUT 206) (Figure 40).

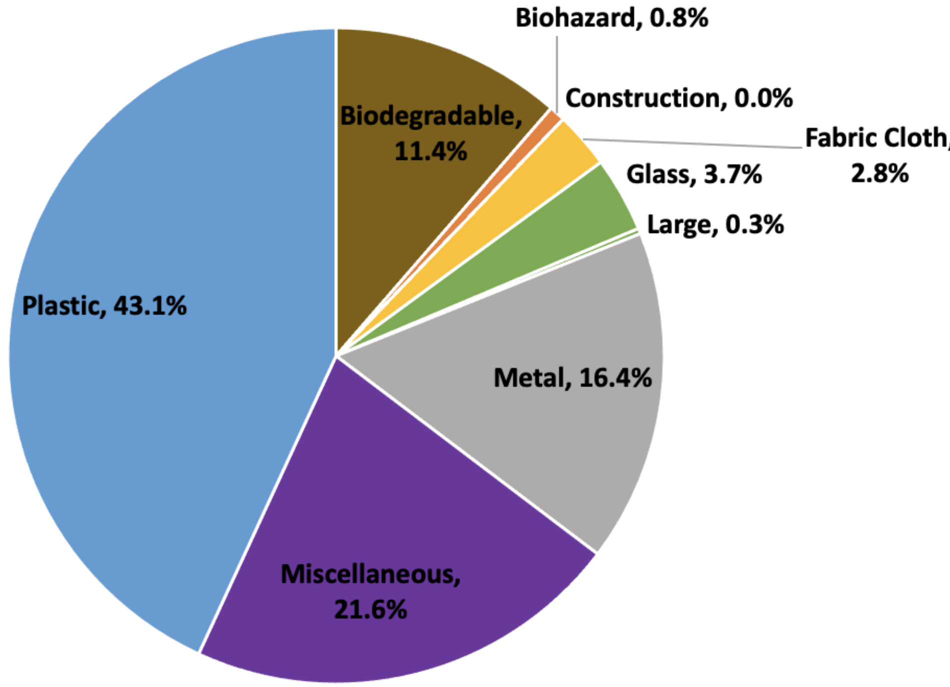


Figure 38 Proportion of trash within each broad trash category at recreation sites surveyed between 2018-2021 by the LARWMP program.

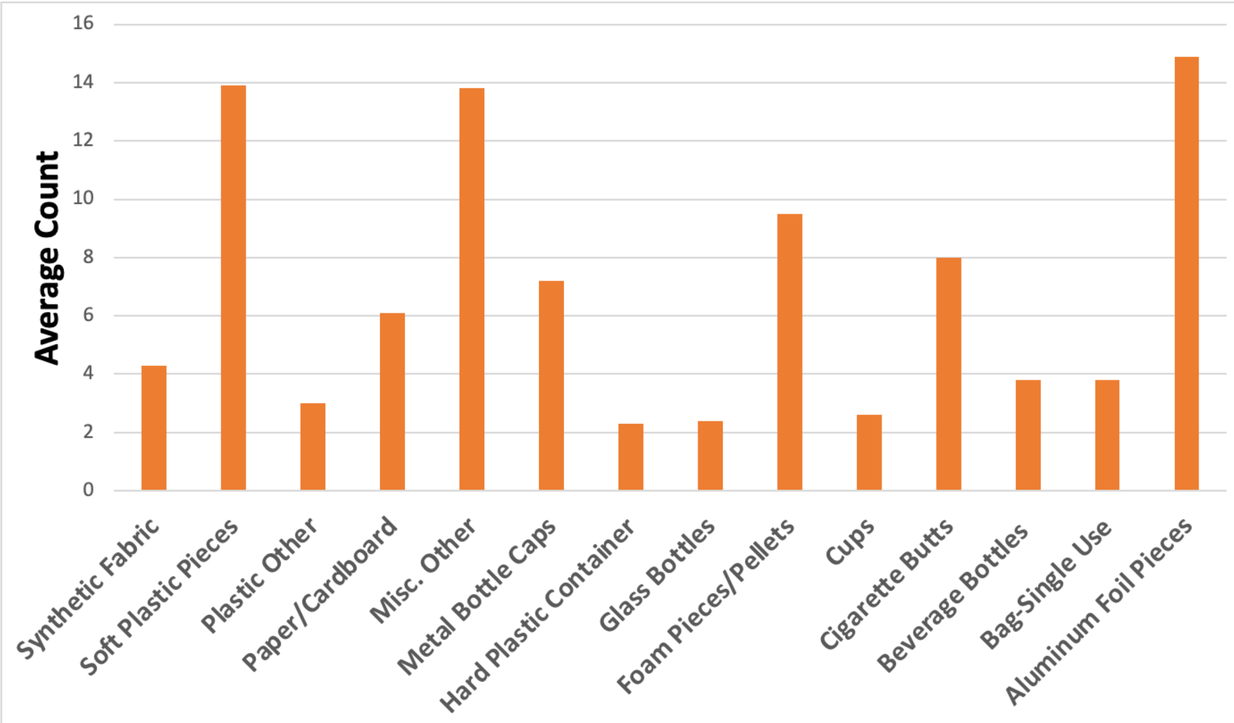


Figure 39 Average count of each trash sub-category across recreation sites sampled between 2018-2021 by the LARWMP program.

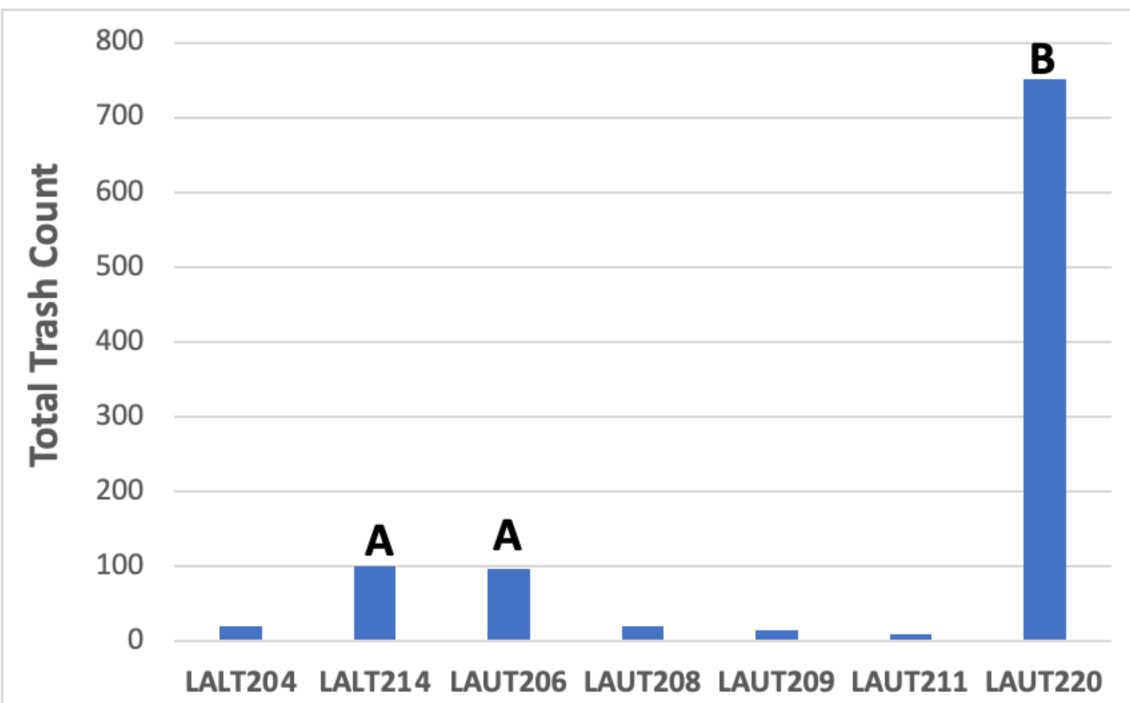


Figure 40 Total counts of trash at swim sites. Letters denote significant differences

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

a. 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.

b. 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 41. Fish tissue sampling location for the 2021 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 4 different types of fish were successfully collected from Legg Lake (Figure 41). The primary sources of water in Legg Lake are runoff from the San Gabriel River and nearby wells and two storm drains that collect runoff from the cities of El Monte and South El Monte. Species that were caught at Legg Lake include common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*). The largest fish captured in the lake was the white catfish (2100 g), while the smallest fish caught, on average, was bluegill (102 g) (Table 28).

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

- Bluegill fish are bottom feeders and their diet include aquatic insects, larvae, and largemouth bass eggs
- Redear sunfish feed on the larval stages of aquatic insects, clams, and snails
- Largemouth bass diets include fish fry, benthic macroinvertebrates, and zooplankton
- Common carp have an omnivorous bottom feeding diet
- White catfish have an omnivorous diet and consume aquatic plants and insects, clams, snails, fish eggs and small fish.

Table 28. Number, average standard weight, and length of the individual and composite fish samples collected in 2021.

Waterbody	Comp #	n	Species Name	Common Name	Avg. Weight (g)	Standard Length Avg. (mm)	Standard Length Min (mm)	Standard Length Max (mm)	Total Length Avg. (mm)	Total Length Min (mm)	Total Length Max (mm)
Legg Lake (LALT308)	1	4	*Lepomis macrochirus*	bluegill	167.5	164	150	180	208	195	223
	2	4	*Lepomis macrochirus*	bluegill	102.5	145	136	156	177	171	184
	1	4	*Cyprinus carpio*	common carp	463.8	579	520	695	721	645	830
	2	2	*Cyprinus carpio*	common carp	595.0	258	231	285	323	297	348
	1	5	*Micropterus salmoides*	largemouth bass	621.6	306	265	325	368	320	390
	2	5	*Micropterus salmoides*	largemouth bass	1240.0	363	346	387	436	418	469
	1	4	*Lepomis microlophus*	redear sunfish	132.5	153	139	169	191	179	206
	1	1	*Ameiurus catus*	white catfish	2100.0	450	450	450	575	575	575

Of the four contaminants measured in each of the composites of fish tissue, all fish types could be eaten based on ATL thresholds but mercury concentrations limited consumption in a subset of fish species (Table 29).

Bluegill, common carp, and redear sunfish are safe to eat. Based on OEHHA guidance, one should limit their consumption to three 8-oz servings a week. However, white catfish should be consumed at lower levels and limited to one serving per week. Largemouth bass fish tissue had different concentrations of mercury between samples with recommended serving ranging from one to two servings a week.

The trophic level three fish included Bluegill, Common carp, and Redear Sunfish. The trophic level four fish include largemouth bass and white catfish (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. A higher trophic level and feeding ecology may explain why white catfish and largemouth bass 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 Legg Lake - LALT308					
Common Name	**Comp. #**	**Mercury (ppb)**	**Selenium (ppb)**	**DDTs (ppb)**	**PCBs (ppb)**
bluegill	1	46	380	33.2	5.4
bluegill	2	47	740	3.6	ND
common carp	1	9	410	23.6	3.4
common carp	2	9	220	2.4	ND
largemouth bass	1	73	470	21.8	3.0
largemouth bass	2	231	231	23.1	3.4
redear sunfish	1	5	310	8.9	ND
white catfish	1	267	100	31.9	11.54

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

Literature Cited

Allen, J.M.; E.T. Jarvis, V. Raxo-Rands, G. Lyon, J.A. Reyes, D.M. Petschauer. Extent of fishing and fish consumption by fishers in Ventura and Los Angeles County watersheds in 2005. SCCWRP Technical Report 574. Southern California Coastal Water Research Project. Costa Mesa, CA.

Alm, E.W., Burke, J., Spain, A. 2003. Fecal indicator bacteria are abundant in wet sand at freshwater beaches. Water research 37, 3978–3982.

Anderson, B.S., J.W. Hunt, M. Hester, and B.M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. pp. 609-624 in: G.K. Ostrander (ed.), Techniques in aquatic toxicology. CRC Press Inc. Boca Raton, FL.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency.

Bay, M.B., D.J. Greenstein, J.A. Ranasinghe, D.W. Diehl and A.E. Fetscher. 2014. Sediment Quality Assessment Technical Support Manual. Technical Report 777. Southern California Coastal Water Research Project. Costa Mesa, CA.

Bay, S.M., L. Wiborg, D.J. Greenstein, N. Haring, C. Pottios, C. Stransky and K. Schiff. 2015. Southern California Bight 2013 Regional Monitoring Program: Volume I. Sediment Toxicity. SCCWRP Technical Report 899. Southern California Coastal Water Research Project. Costa Mesa, CA.

City of Burbank. 2017. Burbank 2017 Wastewater Change Petition. Initial Study/Negative Declaration. https://www.burbankwaterandpower.com/images/RecycledWater/BWP2017_WWChangeFinal_IS-ND_Aug30_2017_reduced.pdf

Colford, J. M., Wade, T. J., Schiff, K. C., Wright, C. C., Griffith, J. F., Sandhu, S. K., Weisberg, S. B. 2007. Water Quality Indicators and the Risk of Illness at Beaches with Nonpoint Sources of Fecal Contamination: Epidemiology, 18(1), 27–35. https://doi.org/10.1097/01.ede.0000249425.32990.b9

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. California Rapid Assessment Method (CRAM) for Wetlands. Version 5.0. 2. 151 pp.

Cone, M. 28 January 2007. Waiting for the DDT tide to turn. Los Angeles Times. http://articles.latimes.com/2007/jan/28/local/me-fish28

CWMW. (2019). Using the California Rapid Assessment Method (CRAM) for project assessment as an element of regulatory, grant, and other management programs. (Technical Bulletin Version 2.0; p.85). https://mywaterquality.ca.gov/monitoring_council/wetland_workgroup/docs/cram_bull.pdf

CREST. 2006. Tier 2 Dry Season Bacteria Source Assessment of the Los Angeles River, Analysis of Measured Flow Rates, Water and Sediment Quality, Bacteria Loading Rates, and Land Uses. The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CREST. 2008. Los Angeles River Bacteria Source Identification Study: Final Report. The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CWH. 2008. Los Angeles River Watershed Monitoring Program 2008 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2009. Los Angeles River Watershed Monitoring Program 2009 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2010a. Los Angeles River Watershed Monitoring Program 2010 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2010b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2010. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2011. Los Angeles River Watershed Monitoring Program 2011 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2012. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2012. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2014a. Los Angeles River Watershed Monitoring Program 2012 to 2014 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2014b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2014. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2015. Los Angeles River Watershed Monitoring Program 2015 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2016a. Los Angeles River Watershed Monitoring Program 2016 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2016b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2016. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2018a. Los Angeles River Watershed Monitoring Program 2018 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2018b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2018. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2019a. Los Angeles River Watershed Monitoring Program 2019 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2019b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2019. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2020a. Los Angeles River Watershed Monitoring Program 2020 Annual Report. Technical report, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2020b. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2020. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

CWH. 2021. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan 2021. Project Plan, Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/reports

California Wetlands Monitoring Workgroup (CWMW). 2012. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.0 pp.95.

California Wetlands Monitoring Workgroup (CWMW). 2013. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.1 pp.67.

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. California Rapid Assessment (CRAM) for Wetlands, v5.0.2. 157 pp. San Francisco Estuary Institute. Oakland, CA.

Fetscher, E.A. and K. McLauglin. 2008. Incorporating bioassessment using freshwater algae into California's surface water ambient monitoring program (SWAMP). Technical Report 563. California Water Boards, Surface Water Ambient Monitoring Program. https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/563_periphyton_bioassessment.pdf

Fetscher, A.E., L. Busse, and P. R. Ode. 2009. Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 002. (updated May 2010)

Fetscher, A.E., M.D. Howard, R. Stancheva, R. Kudela, E.D. Stein, M.A. Sutula, L.B. Busse, and R.G. Sheath. 2015. Wadeable Streams as widespread sources of benthic cyanotoxins in California, USA. Harmful Algae. 49: 105-116.

French R.P. and M.N. Morgan. 1995. Preference of redear sunfish on zebra mussels and ramshorn snails. Journal of Freshwater Ecology, Vol 10:1, pp 49-55.

García-Berthou, E. 2001. Size-and Depth-Dependent Variation in Habitat and Diet of the Common Carp (*Cyprinus carpio*). Aquatic Sciences. 63: n.p.

Garzio-Hadzick, A., Shelton, D.R., Hill, R.L., Pachepsky, Y.A., Guber, A.K., Rowland, R., 2010. Survival of manure-borne *E. coli* in streambed sediment: effects of temperature and sediment properties. water research 44, 2753–2762.

Harwood, V.J., Levine, A.D., Scott, T.M., Chivukula, V., Lukasik, J., Farrah, S.R., Rose, J.B. 2005. Validity of the Indicator Organism Paradigm for Pathogen Reduction in Reclaimed Water and Public Health Protection. Appl. Environ. Microbiol. 71, 3163–3170. doi:10.1128/AEM.71.6.3163-3170.2005

Harwood, V.J., Staley, C., Badgley, B.D., Borges, K., Korajkic, A., 2014. Microbial source tracking markers for detection of fecal contamination in environmental waters: relationships between pathogens and human health outcomes. FEMS microbiology reviews 38, 1–40.

Hodgson, J.R. and Kitchell, J.F. 1987. Opportunistic Foraging by Largemouth Bass (*Micropterus salmoides*). The American Midland Naturalist 118, 323–336. doi:10.2307/2425789

LARWQCB. 2014. Water Quality Control Plan, Los Angeles Region. Los Angeles Regional Water Quality Control Board, Los Angeles, CA. http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan

LARWQCB. 2017. Final Part 2 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California—Tribal and Subsistence Fishing Beneficial Uses and Mercury Provisions. https://www.epa.gov/sites/production/files/201709/documents/ca-part2-tribal.pdf

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, WA.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Mazor, R.D. 2015. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey. Technical Report 844. Southern California Coastal Water Research Project. Costa Mesa, CA.

McGinnis, S.M. 1984. Freshwater Fishes of California. Los Angeles: Univ. California Press. California Natural History Guide #49.

Cambridge, J., McMeekin, 1981. Effects of Solar Radiation and Predacious Microorganisms on Survival of Fecal and Other Bacteria. Applied and Environmental Microbiology 41, 1083–1087.

Moore, S., Hale, T., Weisberg, S., Flores, L., & Kauhanen, P. (2020). *California Trash Monitoring Methods and Assessments Playbook* (#1025). SFEI.

Mouritsen, K.N., Poulin, R. 2005 Parasites Boost Biodiversity and Change Animal Community Structure by Trait Mediated Indirect Effects. Nordic Society Oikos 108, 344-350.

National Weather Service. (n.d.). NOAA National Weather Service Los Angeles, CA. Retrieved June 28, 2017, from http://www.weather.gov/lox/

Ode, P.R., A.E. Fetscher, L.B. Busse. 2016. Standard operating procedures for the collection of field data for bioassessments for California wadeable streams: benthic macroinvertebrates, algae, and physical habitat. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

Ode, R.E., A.C. Rehn, and J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management, Vol. 35, No. 4, pp. 493-504.

Ode, R.E. 2007. Standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

OEHHA (Office of Environmental Health Hazard Assessment). 2005. General protocol for sport fish sampling and analysis. Gassel, M. and R.K. Brodberg. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 11 pg.

OEHHA. Klasing, S. and R. Brodberg. 2008. Development of fish contaminant goals and advisory tissue levels for common contaminants in California sport fish: chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 115 pp.

Page, L.M. and B.M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Pettit, N.E., Naiman, R.J., 2007. Fire in the Riparian Zone: Characteristics and Ecological Consequences. Ecosystems 10, 673–687. doi:10.2307/27823712

Phillips B.M., B.S. Anderson, J.W. Hunt, B. Thompson, S. Lowe, R. Hoenicke, and R.S. Tjeerdema. 2003. Causes of sediment toxicity to *Mytilus galloprovincialis* in San Francisco Bay, California. *Arch. Environ Contam. Toxicol.* 45: 486-491.

Ricca, D.M. and J.J. Cooney. 1998. Coliphages and indicator bacteria in birds around Boston Harbor. *Journal of Industrial Microbiology & Biotechnology* 21:28-30.

Richards, A.B. and D.C. Rogers. 2006. List of freshwater macroinvertebrate taxa from California and adjacent states including standard taxonomic effort levels. Southwest Association of Freshwater Invertebrate Taxonomists. http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf

Regents of the University of California. (n.d.). University of California Agriculture and Natural Resources (UCANR), CA. http://calfish.ucdavis.edu/species/?uid=62&ds=698

Rehn, A.C., R.D. Mazor, P.R. Ode. 2015. The California Stream Condition Indices (CSCI): A New Statewide Biological Scoring Tool for Assessing the Health of Freshwater Streams. SWAMP Technical Memorandum.SWAMP-TM-2015-0002.

Rehn, A.C., R.D. Mazor, P.R. Ode. 2018. An Index to Measure the Quality of Physical Habitat in California Wadeable Streams. SWAMP Technical Memorandum. SWAMP-TM-2018-0005.

SCCWRP. 2008. Southern California Bight 2008 Regional Marine Monitoring Survey (Bight'08) Field Operations Manual. Prepared by Southern California Water Research Project, Costa Mesa, CA.

SCCWRP. 2009. Southern California Regional Watersheds Monitoring Program, Bioassessment Quality Assurance Project Plan, version 1.0. Prepared by Southern California Coastal Water Research Project, Costa Mesa, CA.

SGRRMP. 2009. San Gabriel River Regional Monitoring Program, Annual Report on Monitoring Activities for 2008. Technical report: www.sgrrmp.org.

Sinton, L.W., Hall, C.H., Lynch, P.A., Davies-Colley, R.J., 2002. Sunlight inactivation of fecal indicator bacteria and bacteriophages from waste stabilization pond effluent in fresh and saline waters. Applied and environmental microbiology 68, 1122–1131.

Stormwater Monitoring Condition. 2015. Bioassessment of streams in southern California: A report on the first five years of the SMC Stream Survey. Prepared by SCCWRP. Costa Mesa, CA

Theroux, S., Mazor, R. D., Beck, M. W., Ode, P. R., Stein, E. D., & Sutula, M. (2020). Predictive biological indices for algae populations in diverse stream environments. *Ecological Indicators*, *119*, 106421.

USEPA 600/4-91-003. 1994. Short-Term methods for estimating the chronic toxicity of effluents and receiving water to marine and estuarine organisms. Second Edition, July 1994. [(NSCEP or CD ROM or NEPI. http://www.epa.gov/clariton/clhtml/pubtitleORD.html), superseded by EPA 821/R-02-014]

USEPA 600/R-94-025.1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. (NTIS /PB95-177374 or NEPIS: http://www.epa.gov/clariton/clhtml/pubtitleORD.html or http://www.epa.gov/ost/library/sediment/)

USEPA. 2000. Estimated per capita fish consumption in the United States: based on data collected by the United States Department of Agriculture's 1994-1996 continuing survey of food intake by individuals. Office of Science and Technology, Office of Water, Washington, DC. March.

USEPA 816-F-02-013. 2002. List of Contaminants and their MCLs. July 2002.

USEPA 821-R-02-013. 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition, October 2002. https://www.epa.gov/sites/production/files/2015-08/documents/short-term-chronic-freshwater-wet-manual_2002.pdf

USEPA 823-B-96-007. Kinerson, R.S., J.S. Mattice, and J.F. Stine. 1996. The Metals Translator: Guidance for Calculating A Total Recoverable Permit Limit from A Dissolved Criterion [PDF]. Office of Water. 67 pp. https://www3.epa.gov/npdes/pubs/metals_translator.pdf

USEPA 823-R-10-005. 2010. Sampling and Consideration of Variability (Temporal and Spatial) For Monitoring of Recreational Waters [PDF]. Office of Water. 63 pp. https://www.epa.gov/sites/production/files/2015-11/documents/sampling-consideration-recreational-waters.pdf

USEPA, US GS, US FWS. 2012. Toxic Contaminants in the Chesapeake Bay and its Watershed: Extent and Severity of Occurrence and Potential Biological Effects. USEPA Chesapeake Bay Program Office, Annapolis, MD. December, 2012. 175 pages.

USEPA. 2012. Recreational Water Quality Criteria. Environmental Protection Agency.

E. VanderKooy, Katherine & Rakocinski, Chet & Heard, Richard. (2012). Trophic Relationships of Three Sunfishes (Lepomis spp.) in an Estuarine Bayou. Estuaries. 23. 621-632. 10.2307/1352889.

Vannote, R.L, G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Ca. J. Fish. Aquat. Sci. 37: 130-137.

Wade, T.J., Pai, N., Eisenberg, J.N.S., Colford, J.M., 2003. Do U.S. Environmental Protection Agency water quality guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis. Environ Health Perspect 111, 1102–1109.

Wiener, J. G., R. A. Bodaly, S. S. Brown, M. Lucotte, M.C. Newman, D. B. Porcella, R. J. Reash, and E. B. Swain. 2007. Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. Chapter 4 in R. C. Harris, D. P. Krabbenhoft, R. P. Mason, M. W. Murray, R. J. Reash, and T. Saltman (editors), Ecosystem Responses to Mercury Contamination: Indicators of Change. CRC Press/Taylor and Francis, Boca Raton, Florida. pp. 87-12.

Winfield, M.D., Groisman, E.A., 2003. Role of Nonhost Environments in the Lifestyles of Salmonella and Escherichia coli. Appl. Environ. Microbiol. 69, 3687–3694. doi:10.1128/AEM.69.7.3687-3694.2003.

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/reports). Therefore, the data reported herein from the 2021 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 2021

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 2021 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 2021, two did 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 2021 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 2021.

Analyte	2021					
			Number of Non-Detects (<MDL)			
	Number of Sites	Completeness (%)	Effluent (n=3)	Natural (n=5)	Urban (n=6)	Total
General 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	0	0	0
Turbidity	12	100	0	0	0	0
Chlorophyll a	12	100	0	0	0	0
Ash-Free Dry Mass	12	100	0	0	0	0
Nutrients						
Ammonia as N	12	100	1	4	1	6
Dissolved Organic Carbon	12	100	0	2	0	2
Nitrate as N	12	100	0	0	1	1
Nitrite as N	12	100	2	4	2	8
OrthoPhosphate as P	12	100	0	0	0	0
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
Magnesium	12	100	0	0	0	0
Sodium	12	100	0	1	0	1
Sulfate	12	100	0	0	0	0
Metals						
Arsenic	12	100	0	0	0	0
Cadmium	12	100	2	4	1	7
Chromium	12	100	0	0	0	0
Copper	12	100	0	0	0	0
Iron	12	100	0	0	0	0
Lead	12	100	0	0	0	0
Mercury	12	100	6	4	2	12
Nickel	12	100	0	0	0	0
Selenium	12	100	0	4	0	4
Zinc	12	100	0	0	0	0
Bioassessment						
Benthic Macroinvertebrate ID	12	100	NA	NA	NA	NA
Algae ID	12	100	NA	NA	NA	NA

Table A-2 1. Percent completeness and non-detects for bioaccumulation samples collected in 2021.

Bioaccumulation	2021		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
General Chemistry			
Lipids	8	100	0
Metals			
Mercury	8	100	0
Selenium	8	100	0
Organochlorine Pesticides			
Aldrin	8	0	NA
Chlordane, cis-	8	0	NA
Chlordane, trans-	8	0	NA
DDD(o,p')	8	100	5
DDD(p,p')	8	100	3
DDE(o,p')	8	100	5
DDE(p,p')	8	100	0
DDT(o,p')	8	100	4
DDT(p,p')	8	100	5
Dieldrin	8	0	NA
Endosulfan I	8	0	NA
Endosulfan II	8	0	NA
Endosulfan Sulfate	8	0	NA
Endrin	8	0	NA
Endrin Aldehyde	8	0	NA
HCH, alpha	8	0	NA
HCH, beta	8	0	NA
HCH, delta	8	0	NA
HCH, gamma	8	0	NA
Heptachlor	8	0	NA
Heptachlor Epoxide	8	0	NA
Methoxychlor	8	0	NA
Mirex	8	0	NA
Nonachlor, cis-	8	0	NA
Nonachlor, trans-	8	0	NA
Oxychlordane	8	0	NA
Toxaphene	8	0	NA

Table A-2 2. Percent completeness and non-detects for bioaccumulation samples collected in 2021 (continued)

Bioaccumulation	2021		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
PCBs			
PCB 003	8	0	NA
PCB 008	8	0	NA
PCB 018	8	100	5
PCB 027	8	0	NA
PCB 028	8	100	5
PCB 029	8	0	NA
PCB 031	8	0	NA
PCB 033	8	0	NA
PCB 037	8	100	5
PCB 044	8	100	5
PCB 049	8	100	5
PCB 052	8	100	5
PCB 056	8	0	NA
PCB 056/060	8	0	NA
PCB 060	8	0	NA
PCB 064	8	0	NA
PCB 066	8	100	4
PCB 070	8	100	5
PCB 074	8	100	5
PCB 077	8	100	5
PCB 081	8	100	5
PCB 087	8	100	5
PCB 095	8	0	NA
PCB 097	8	0	NA
PCB 099	8	100	3
PCB 101	8	100	5
PCB 105	8	100	3
PCB 110	8	100	3
PCB 114	8	100	5
PCB 118	8	100	0
PCB 119	8	100	5
PCB 123	8	100	5

Table A-2 3. Percent completeness and non-detects for bioaccumulation samples collected in 2021 (continued).

Bioaccumulation	2021		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
PCB 126	8	100	5
PCB 128	8	100	3
PCB 128/167	8	0	NA
PCB 137	8	0	NA
PCB 138	8	0	NA
PCB 141	8	0	NA
PCB 146	8	0	NA
PCB 149	8	100	1
PCB 151	8	100	5
PCB 153	8	0	NA
PCB 156	8	100	5
PCB 157	8	100	5
PCB 158	8	100	5
PCB 167	8	100	5
PCB 168	8	0	NA
PCB 168/132	8	0	NA
PCB 169	8	100	5
PCB 170	8	100	3
PCB 174	8	0	NA
PCB 177	8	100	5
PCB 180	8	100	4
PCB 183	8	100	5
PCB 187	8	100	5
PCB 189	8	100	5
PCB 194	8	100	5
PCB 195	8	0	NA
PCB 198/199	8	0	NA
PCB 200	8	100	5
PCB 201	8	100	4
PCB 203	8	0	NA
PCB 206	8	100	5
PCB 209	8	0	NA

Table A-3 Lab Blanks

Analyte	Sampling Year	Sample Type	Batch ID	Result	Unit	Minimum Detection Limit	Reporting Limit
Ions							
Calcium	2021	LabBlank	5104	0.0244	mg/L	0.015	0.015
Metals							
Nickel	2021	LabBlank	5100	0.38	ug/L	0.31	0.31
Zinc	2021	LabBlank	5138	1.67	ug/L	0.95	0.95
Zinc	2021	LabBlank	5100	1.8	ug/L	0.95	0.95

Table A-4 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
Ions (Samplewater)									
Calcium	SMC00520	9-Jun-21	5112	Samplewater	80 - 120 %	90	54	50	< 25 %
Sodium	SMC00520	9-Jun-21	5112	Samplewater	80 - 120 %	91	69	28	< 25 %
Calcium	LAR08599	15-Jun-21	5128	Samplewater	80 - 120 %	70	46	41	< 25 %
Magnesium	LAR08599	15-Jun-21	5128	Samplewater	80 - 120 %	68	77	12	< 25 %
Sodium	LAR08656	14-Jul-20	5128	Samplewater	80 - 120 %	0	41	100	< 25 %

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

Table B-1 1. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021.

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

Table B-1 2. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
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 Angeles 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 3. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
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

Table B-1 3. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
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 4. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
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

Table B-1 5. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2021 (continued).

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
2019													
Effluent	LAR00318	Los Angeles River	0.47	0	0.43	0	0.51	0.01	38	25	67.67	33.33	25
	LAR0232	Los Angeles River	0.72	0.04	0.59	0.01	0.86	0.23	36	25	62.5	33.33	25
Natural	LAR01808	Alder Creek	0.76	0.07	0.62	0.02	0.90	0.31	83	80.56	90.29	75	87.5
	LAR04204	Santa Anita Wash	0.98	0.45	0.75	0.08	1.21	0.86	75	58.33	93.29	100	50
	LAR0552	Arroyo Seco	1.03	0.56	1.08	0.67	0.97	0.44	76	63.89	93.29	83.33	62.5
	LAR08641	Big Tujunga Creek	0.88	0.23	0.69	0.04	1.07	0.64	79	61.11	96.54	88.33	75
	LAR08647	Big Tujunga Creek	0.92	0.3	0.81	0.14	1.02	0.54	74	47.22	100	100	50
Urban	LAR01004	Arroyo Seco	0.49	0	0.40	0	0.57	0.01	36	25	62.5	33.33	25
	LAR08645	Bull Creek	0.62	0.01	0.44	0	0.80	0.14	56	69.44	67.67	50	37.5
	LAR08646	Eaton Wash	0.67	0.02	0.61	0.01	0.74	0.08	36	25	62.5	33.33	25
2020													
Effluent	LAR0232	Los Angeles River	0.59	0	0.59	0.01	0.58	0.01	36	25	62.5	33.33	25
	LAR08656	Los Angeles River	0.74	0.05	0.58	0.01	0.89	0.29	36	25	62.5	33.33	25
	LAR08659	Los Angeles River	0.66	0.02	0.58	0.01	0.74	0.08	38	25	67.67	33.33	25
Natural	LAR05020	Arroyo Seco	1.11	0.76	1.33	0.97	0.89	0.29	75	47.22	100	91.67	62.5
	LAR0552	Arroyo Seco	1.18	0.87	1.11	0.73	1.24	0.9	79	77.78	93.29	83.33	62.5
	LAR05640	Big Tujunga Creek	1.17	0.85	1.07	0.65	1.27	0.92	84	83.33	93.29	83.33	75
	LAR06216	Big Tujunga Creek	1.00	0.5	0.88	0.25	1.12	0.74	76	80.56	90.29	83.33	50
	LAR08655	Big Tujunga Creek	1.17	0.85	1.14	0.78	1.20	0.85	85	88.89	93.29	83.33	75
Urban	LAR01208	Los Angeles River	0.45	0	0.46	0	0.44	0	38	25	67.67	33.33	25
	LAR08658	Arroyo Seco	0.71	0.04	0.58	0.01	0.85	0.21	41	33.33	62.5	41.67	25
2021													
Effluent	LAR00318	Los Angeles River	0.33	0	0.19	0	0.47	0	38	25	67.67	33.33	25
	LAR0232	Los Angeles River	0.71	0.04	0.70	0.05	0.72	0.07	36	25	62.5	33.33	25
	LAR08661	Los Angeles River	0.68	0.02	0.57	0.01	0.78	0.12	36	25	62.5	33.33	25
	LAR08663	Los Angeles River	0.84	0.16	0.65	0.02	1.04	0.58	70	69.44	75	75	62.5
Natural	LAR00520	Big Tujunga Creek	0.70	0.03	0.71	0.05	0.70	0.06	79	72.22	82.92	75	87.5
	LAR00924	Arroyo Seco	1.11	0.75	1.20	0.87	1.01	0.52	80	80.56	93.29	83.33	62.5
	LAR01544	Big Tujunga Creek	0.79	0.1	0.70	0.05	0.88	0.27	83	75	90.29	91.67	75
	LAR0552	Arroyo Seco	0.83	0.15	0.78	0.11	0.88	0.27	80	80.56	93.29	83.33	62.5
Urban	LAR08662	Rio Hondo	0.34	0	0.28	0	0.39	0	38	25	67.67	33.33	25
	LAR08672	Los Angeles River	0.42	0	0.34	0	0.51	0	38	25	67.67	33.33	25

Appendix C – Analyte List, Reporting Limits and Methods

Table C-1 Analyte list and method for each program element in 2021.

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	EPA 200.8	ug/L	1
Cadmium	EPA 200.8	ug/L	0.2
Chromium	EPA 200.8	ug/L	0.5
Copper	EPA 200.8	ug/L	0.5
Iron	EPA 200.7	ug/L	0
Lead	EPA 200.8	ug/L	0.5
Mercury	SM 3112 B or EPA 7470 A	ug/L	0.2
Nickel	EPA 200.8	ug/L	1
Selenium	EPA 200.8	ug/L	1
Zinc	EPA 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

Table C-1 Analyte list and method for each program element in 2021 (continued).

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

Table C-1 Analyte list and method for each program element in 2021 (continued).

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	1000
Phosphorus as P	SM 4500-PE	mg/Kg dw	50
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	µg/Kg dw	0.5-20
Polychlorinated Biphenyl (PCBs)	EPA 8082	µg/Kg dw	0.5-1.0
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.