



# MARU STREAM BIOASSESSMENT: 2022 ANNUAL REPORT



Photo: Upper Bell Canyon Creek, Sampled in 2022

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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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# 1. Introduction

This technical report was produced by the California Water Quality Control Board San Diego Region's (San Diego Water Board) Monitoring, Assessment and Research Unit (MARU). The MARU supports San Diego Water Board regulatory and non-regulatory programs by conducting water quality monitoring and data assessment, as well as by guiding and/or conducting scientific research to better protect and restore beneficial uses of the San Diego Region's waters. This technical report includes a summary of stream biological assessment conducted by MARU in 2022. MARU regularly conducts stream bioassessment at up to 20 stream sites on an annual basis.

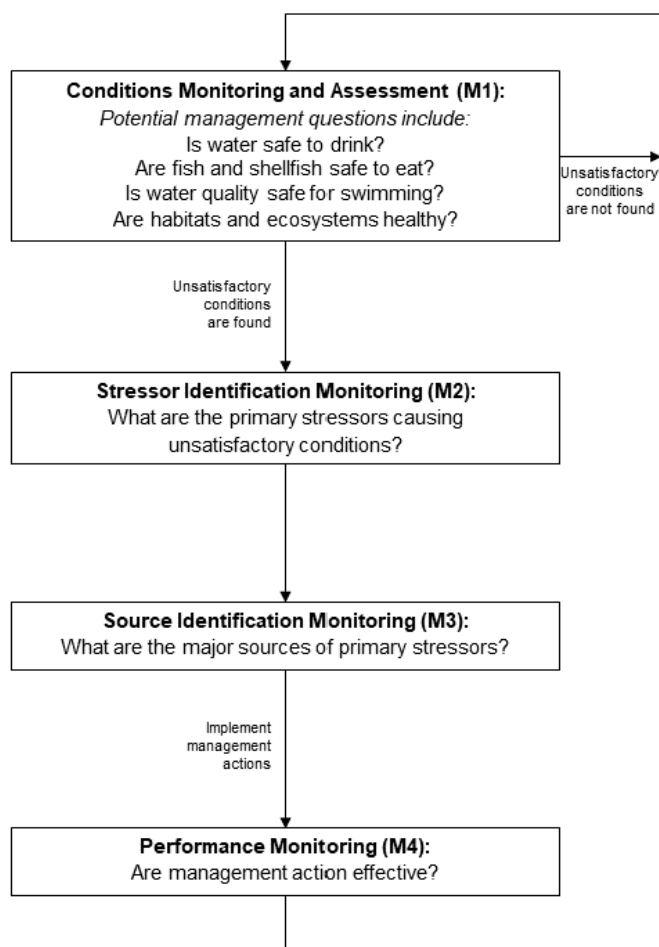
## 2. Bioassessment Background and Purpose

Biological assessment, or bioassessment, is the science of evaluating the health or integrity of an ecosystem by assessing the organisms that live within it. Bioassessment allows for the San Diego Water Board to better protect and restore waters by facilitating a broader evaluation of the cumulative effects of stressors beyond analyzing for individual chemicals. The use of bioassessment mirrors the goal of the Clean Water Act (CWA) to protect and restore the biological integrity of waters (33 U.S. Code § 1251), and of Porter-Cologne which defines the Quality of Water to include chemical, physical, biological, bacteriological, and radiological properties (CWC section 13050). Unlike traditional chemistry-based monitoring, which provides only limited information about a relatively narrow portion of the environment at a discrete point in time, bioassessment can account for living organisms exposed to multiple chemicals and other stressors such as altered habitats and changes in water-flow patterns over extended time periods. Bioassessment therefore has the potential to provide a more integrated reflection of the condition of an aquatic ecosystem. Bioassessment also is more closely tied to environmental managers' end-goal focus on ecosystem protection and serves as an important way to monitor and protect populations of endangered species and fisheries.

Biological assessment is a critical component of implementation of the San Diego Water Board's [monitoring and assessment framework](#) ("Monitoring Framework", see Figure 1). Biological assessment can and should be used to conduct waterbody-oriented monitoring and assessment, specifically to:

- 1) Answer the M1 question: "Are habitats and ecosystems healthy?"
- 2) Guide the M2 and M3 Stressor Identification Process, and
- 3) Evaluate M4 performance monitoring to document success.

Figure 2. Water Body-Oriented Monitoring and Assessment



## 2.1. Stream Bioassessment Background

While bioassessment can and should be used to assess the condition of all surface waterbody types, this report focuses on bioassessment done on perennial and intermittent wadeable streams. The State of California has been conducting bioassessment on wadeable streams in the San Diego region since the 1990s, with early sampling conducted by the San Diego Water Board, the State Water Board's Surface Water Ambient Monitoring Program (SWAMP), and USEPA.

The San Diego Water Board, in December of 2020, adopted biological objectives for streams using stream bioassessment, specifically the California Stream Condition Index (CSCI, see Mazor et al. 2016), discussed in section 2.2.1 below. Stream bioassessment has been used in multiple San Diego Water Board program areas for over two decades. These include programs like municipal stormwater, CWA assessment under sections 305(b) and 303(d), ambient monitoring, CWA Section 401 water quality certifications, and waste discharge requirements.

Current stream bioassessment includes the following measurements:

- Benthic macroinvertebrates (BMI)
- Benthic algae: diatoms and soft algae, including cyanobacteria
- Physical habitat: instream and riparian
- Water chemistry
- Flow

SWAMP has developed standard operating procedures (SOPs) for bioassessment field sampling, laboratory identification of specimens, quality assurance/control, data management, and reporting. These SOPs are on the SWAMP bioassessment website: [https://www.waterboards.ca.gov/water\\_issues/programs/swamp/bioassessment/](https://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/)

All San Diego Water Board bioassessment data is available to the public via the California Environmental Data Exchange Network ([CEDEN](#)) database.



## 2.2. Indices of Integrity and Water Quality Objectives

### 2.2.1. Biological Indices

To assess bioassessment data, biological scoring tools are needed to translate complex species identification information into a condition determination. The development of these biological scoring tools, often referred to as indices or metrics of biological integrity, has been on-going since the 1990s, with various regional indices developed throughout the State. In 2015, the State of California released a peer-reviewed statewide CSCI (Mazor et al. 2016) for assessing the biological condition of wadeable streams throughout the State based on benthic macroinvertebrates. The CSCI uses a combined-reference-site approach to determine the site-specific benthic community expected to be present at any sampled site. In 2020, an additional peer-reviewed statewide Algal Stream Condition Index (ASCI, Theroux et al. 2020) was released. The ASCI uses an approach that mirrors the CSCI, except multiple indices were developed, with a diatom-specific index (d-ASCI) and combined “hybrid” diatom/soft algae index (h-ASCI).

Both the CSCI and ASCI are indices that score from a scale of 0-1. As the indices use a reference approach, a score of 1 indicates a sampled stream site is scoring equivalent to expected conditions at similar reference sites, while lower scores show deviation from expected condition, indicating degradation. The CSCI and ASCI publications calculated thresholds for scores, below which a site could be considered impaired (Table 1). The CSCI threshold of 0.79 was adopted by the San Diego Water Board as a water quality objective in 2020.

### 2.2.2. Physical Habitat Indices

In addition to biological condition indices, the State of California developed an [Index of Physical Habitat Integrity](#) (IPI) in 2018 that relies on in-stream measures of physical habitat. Like the CSCI and ASCIs, the IPI uses a reference approach to determine what a site's physical habitat expectations are. The IPI is also scored on a 0-1 scale.

Table 1. Impairment Thresholds for Bioassessment Indices

Index	Threshold
CSCI	0.79
d-ASCI	0.86
h-ASCI	0.86
IPI	0.85

### 2.2.3. Chemical and Physical Water Quality Objectives

While stream bioassessment focuses on the organisms living in the stream, the SWAMP SOP requires a minimum level of sampling for chemical (e.g. nitrogen) and physical (e.g. turbidity) parameters. These grab samples simply provide a baseline assessment of water quality at the time of sampling. They do not include all potential stressors or matrixes (e.g. sediment), though additional parameters and matrixes can be added to sampling efforts and are noted in this report where conducted. Data for all sites are available on the ([CEDEN](#)) database.

Table 2. Chemical and Physical Water Quality Objectives and Impairment Thresholds

Parameter	Threshold
Temperature	Narrative (Deg C)
Dissolved Oxygen	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	6.5-8.5
Total Nitrogen	1.0 mg/L
Total Phosphorus	0.1 mg/L
Turbidity	20 NTU
Chloride	<sup>b</sup> waterbody-specific mg/L, <sup>c</sup> 230 & 860 mg/L
Sulfate	<sup>b</sup> waterbody-specific mg/L
Conductivity	<sup>a</sup> NA uS/cm
Alkalinity	<sup>a</sup> NA mg/L
Silica	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	<sup>a</sup> NA mg/L
Benthic Ash Free Dry Mass (AFDM)	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chlorophyll a (Chl-a)	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic Carbon:Nitrogen Molar Ratio (C:N)	<sup>a</sup> NA

<sup>a</sup> Informational

<sup>b</sup> [Basin Plan criteria](#) are specific to non-aquatic use

<sup>c</sup> [USEPA recommended freshwater criteria](#) for 4-day and 1-hour exposure, respectively. Assumes an association with sodium.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

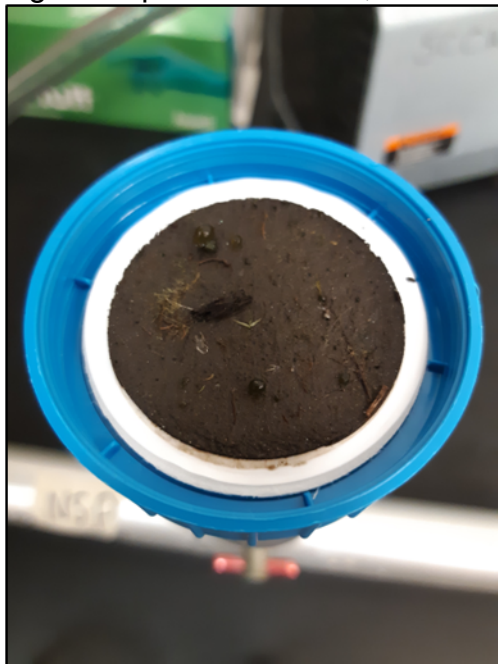
## 2.3. Supplemental Sampling

The San Diego Water Board often will conduct supplemental sampling or special studies at bioassessment sites. This can allow for efficiencies in testing new methods, take advantage of existing sampling of reference sites, or be done to support the work of sister agencies (e.g. California Department of Fish and Wildlife). In 2022, MARU conducted three types of supplemental sampling as described below.

### 2.3.1. **Molecular benthic algal analysis**

Molecular benthic algal analysis is a Region 9 funded SWAMP project to evaluate the potential transition from traditional microscope-based benthic algae analysis to a molecular DNA-based approach. For this analysis, there is no change in the SWAMP collection method for benthic algae; only a small subsample of the collected algal composite is needed (see Figure 3). Molecular algal analysis is being done by SWAMP and partners statewide, with the San Diego Water Board funding the analysis and development of independent or supplemental indices of biological integrity. MARU has conducted this sampling since 2017. In 2022, samples for molecular algal analysis were collected at all sites. Also, one site was sampled twice (Kitchen Creek) and another three times (Nobel Creek) to evaluate within-season variability in traditional microscopy and molecular results.

Figure 3. A filter for benthic algal molecular analysis. Typically, 15-25 ml of the collected algal composite is filtered, and three replicates are prepared.





### **2.3.2. Environmental DNA (eDNA)**

Sampling for eDNA was done at six sites using pre-packaged metabarcoding kits from Jonah Ventures provided by the statewide SWAMP eDNA Metabarcoding Monitoring and Analysis Project (SeMMAP). In brief, eDNA sampling using these kits involved the filtration of 200-400 ml of stream water through a DNA filter, which was then mailed to a lab for analysis. Metabarcoding does not target single species but looks at the overall community. Notable eDNA results for higher-trophic level species are presented in the site summaries below.

### **2.3.3. Particulate carbon and nitrogen (PCN)**

Analysis of particulate carbon and nitrogen was done for the first time this year. PCN analysis provides insight into the carbon and nitrogen sources typical of a given waterbody. Specifically, the Carbon:Nitrogen ratio (C:N) tells us about a stream's relative proportions of carbon-rich sources (leaves) or nitrogen-rich sources (algae, animal waste). A higher C:N ( $> 16$ ) indicates a stream is dominated by terrestrial carbon sources, whereas a lower C:N ( $< 8$ ) indicates a stream is dominated by algal sources or external nitrogen loading. A C:N between 8 and 16 indicates a mix of the two. PCN is being explored by SWAMP as a potential future addition to, or replacement of, the AFDM parameter. PCN analysis requires no change in the SWAMP collection method for benthic algae; only a small subsample of the collected algal composite is needed.

### **2.3.4. Laboratories Used for Sample Analyses**

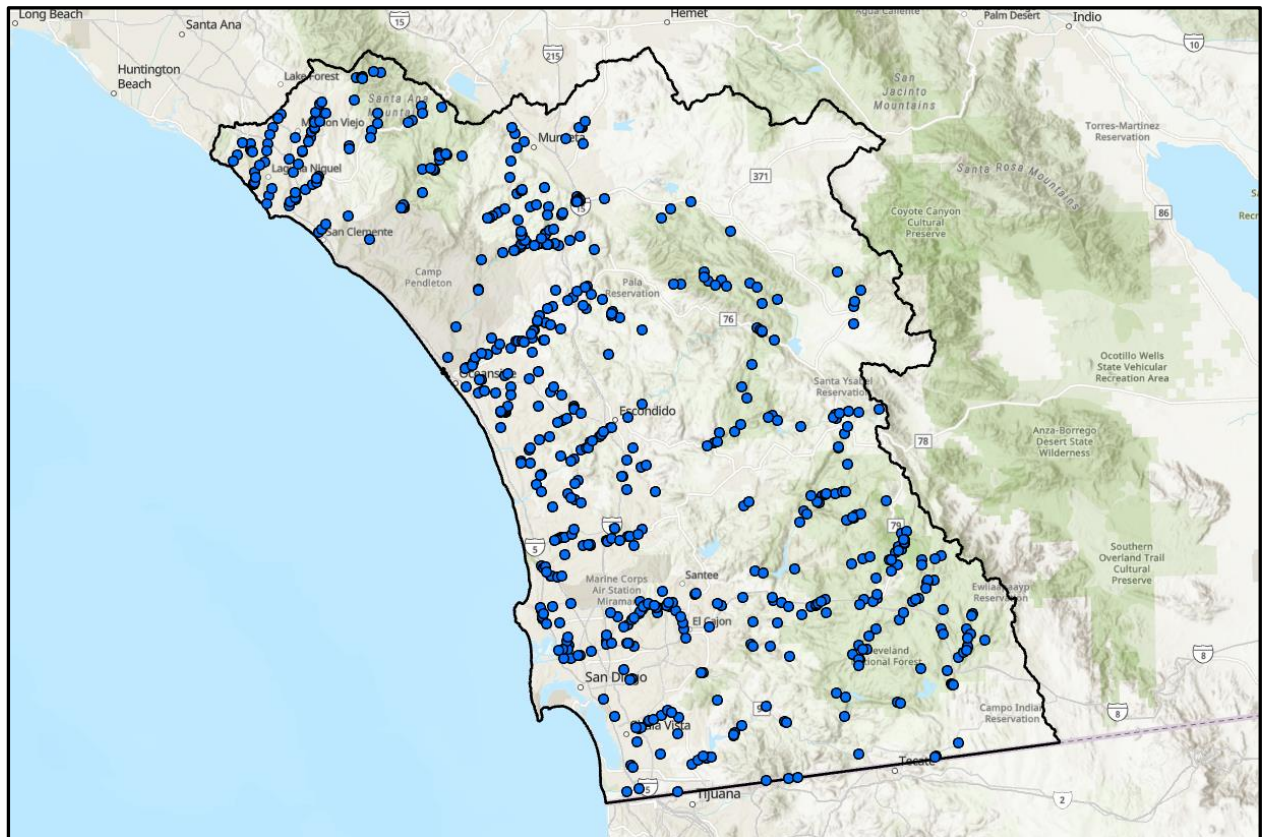
The laboratories used to process supplemental and standard bioassessment samples were: CSU Chico (BMI identification); CSU San Marcos (Algal identification); Babcock Laboratories (Chemistry); SCCWRP (Molecular algal analyses); Jonah Ventures (eDNA); and UCSB Marine Science Institute (PCN).

### 3. Bioassessment Site Types

Stream bioassessment has been conducted in the San Diego Region for over two decades, with sampling at over 550 sites (Figure 4) and with many sites sampled multiple times (1,700+ total samples). Bioassessment samples have been collected by multiple entities and include a mix of site types: reference, non-reference, targeted, probabilistic, trend, and investigation sites. MARU typically conducts stream bioassessment at the following site types:

- 1) Reference Condition Management Program/Reference Sites
- 2) Water Board Program Request Sites
- 3) Causal/Protective Assessment Sites
- 4) Coverage Expansion Sites

Figure 4. Existing Bioassessment Sampling Sites within the San Diego Region.

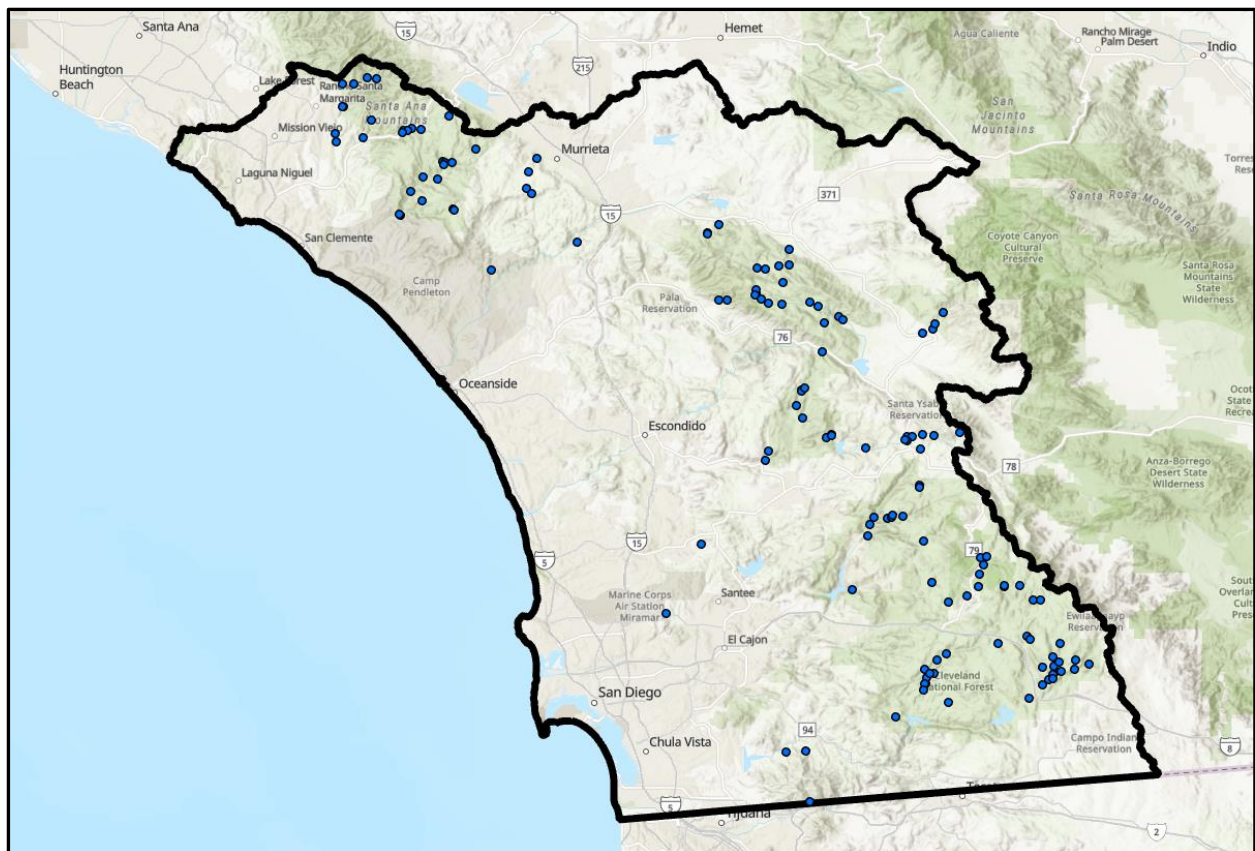


### 3.1. Reference Condition Management Program Sites/Reference Sites

The SWAMP program conducts long-term monitoring at a set of sites that meet GIS reference screening criteria (Ode et al. 2016) as part of the state's [reference condition management program](#) (RCMP). This network of sites, and their on-going monitoring, is critical for establishing reference conditions, which are “healthy” or “biologically intact” conditions in streams with little to no upstream anthropogenic stressors. In addition, the RCMP helps assess longer-term impacts to California’s streams from large-scale changes, such as those associated with climate change.

The San Diego Water Board supports the RCMP in two ways. First, MARU conducts repeat sampling at long-term RCMP sites. Second, MARU identifies new reference sites to add to the potential State reference site pool (Figure 5, also section 3.5 below).

Figure 5. Bioassessment Sites in the San Diego Region that meet reference screens. Reference sites are those that meet GIS screening criteria under Ode et al. 2016.





### **3.2. Program Request Sites**

Program request sites are those sites that have been identified by internal San Diego Water Board staff/programs as a priority for monitoring to determine condition (M1 of the Monitoring Framework). Monitoring may be done to investigate discharge impacts, determine the success of mitigation measures, monitor trends for CWA section 305(b)/303(d) assessment, etc. In addition, some program request sites include requests from partner agencies who manage sensitive native species, such as the California Department of Fish and Wildlife (CDFW), United States Geologic Survey (USGS), and United States Fish and Wildlife Service (USFWS), and from partner nonprofit organizations such as the San Diego River Park Foundation.

### **3.3. Causal/Protective Assessment Sites**

For stream bioassessment sites that score poorly, determining the likely stressor(s) causing the poor condition allows for actions to be taken to improve biological condition (M2 of the Monitoring Framework). The process for investigating and determining likely stressors is referred to as “causal assessment.” This process can also be used to assess whether sites scoring above an index threshold might be at risk from stressors, especially for sites close to the threshold (“protective assessment”). MARU may conduct stream bioassessment revisits, combined with extra stressor-related sampling, to support causal and protective assessment efforts.

### **3.4. Trend Sites**

Trend sites are sites that have been previously sampled and are targeted for re-sampling due to the time since prior sampling or a change in upstream development or management, or for regular monitoring associated with other factors (e.g. sensitive species). These sampling events are typically M1 or M4 of the Monitoring Framework.

### **3.5. Coverage Expansion Sites**

While bioassessment has been conducted at more than 550 sites in the San Diego Region (Figure 3), many streams have never been bioassessed. MARU is working to conduct stream bioassessment at previously unsampled streams (M1 of the Monitoring Framework). Doing so helps clarify the condition of streams across the region, identify new reference sites, and determine baseline condition for anti-degradation purposes (e.g. in the event of a spill).

## 4. Sites Sampled in 2022

### 4.1. Site Type and Location

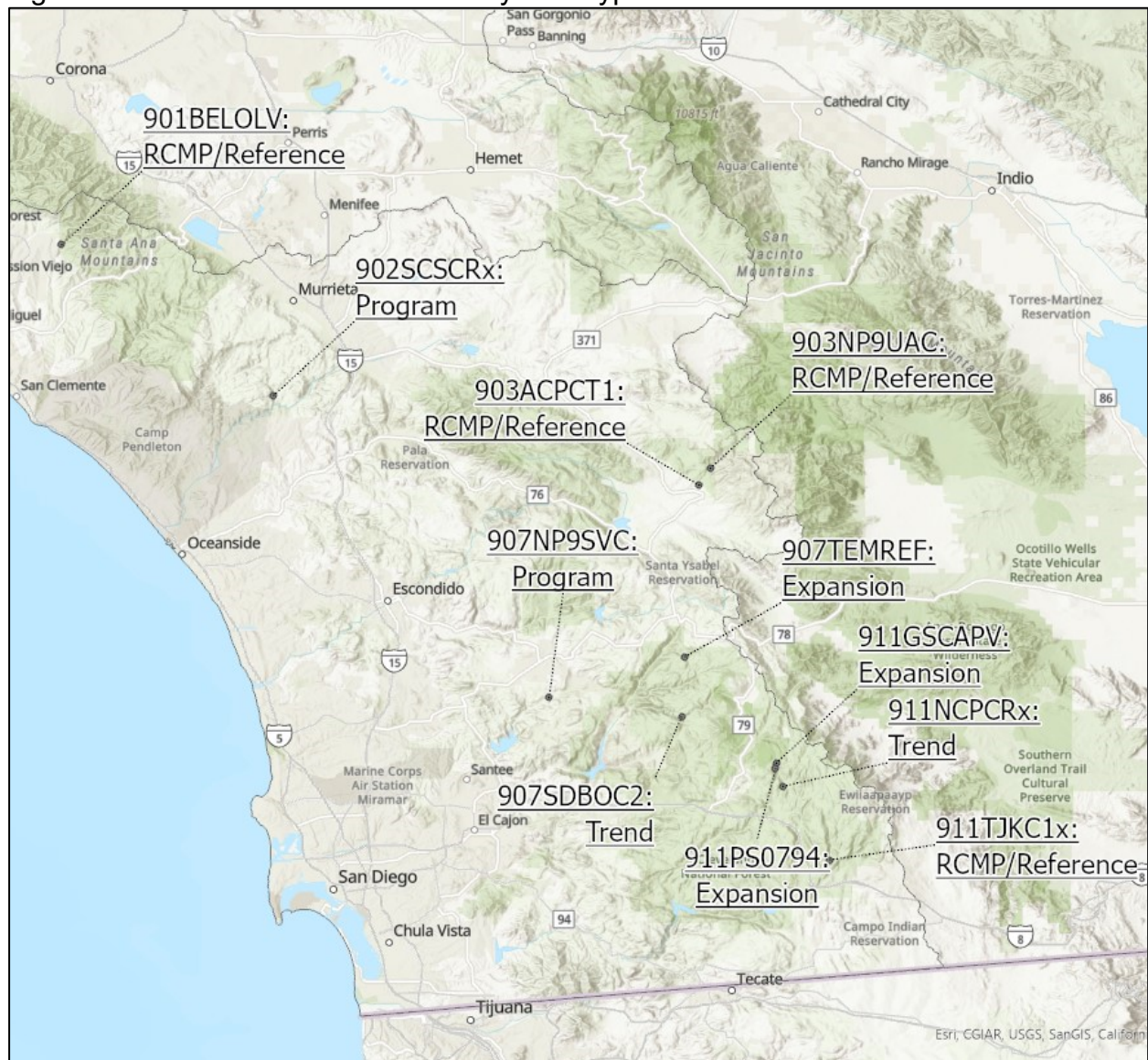
MARU conducted bioassessment at 11 sites from March 2022 to June 2022. Table 3 provides basic information on the sites sampled. Figure 6 shows site locations within the Region.

Table 3. Bioassessment Sites Sampled in 2022

Site Type	SWAMP Code	Stream	Latitude	Longitude	Date
RCMP	901BELOLV	Bell Canyon Creek	33.6406	-117.5531	4/14
RCMP	903ACPCT1	Agua Caliente Creek	33.2960	-116.6385	4/27
RCMP	903NP9UAC	Upper Agua Caliente Creek	33.3199	-116.62275	5/12
RCMP	911TJKC1x	*Kitchen Creek	32.7588	-116.45119	4/6
Program Request	907NP9SVC	San Vicente Creek	32.9910	-116.85408	4/5
Program Request	902SCSCRx	Sandia Creek	33.4245	-117.2490	6/3
Trend	907SDBOC2	Boulder Creek	32.9635	-116.66413	5/3
Trend	911NCPCRx	*Noble Canyon Creek	32.8641	-116.51847	4/13
Coverage Expansion	907TEMREF	Temescal Creek	33.0500	-116.65900	3/25
Coverage Expansion	911GSCAPV	Granite Spring Creek	32.8976	-116.52806	4/18
Coverage Expansion	911PS0794	Upper Pine Valley Creek	32.8893	-116.52900	4/19

\*Sampled more than once during 2022.

Figure 6. 2022 Bioassessment Sites by Site Type.





## 4.2. Overview of Results

The low and high values recorded for indices and other parameters are below. All but two streams (Boulder and Temescal) were sampled at base flow condition, and all were narrow (0.9-4 m wide on average), shallow (8-29 cm deep on average), and high gradient (2.5- 9%) over the 150-meter sampled reach.

Range of index scores among the streams

Index	Results	Threshold
CSCI	0.75 to 1.14	0.79
d-ASCI	0.52 to 1.11	0.86
h-ASCI	0.45 to 1.16	0.86
IPI	0.76 to 1.26	0.85

Range of chemical and physical water quality results among the streams

Parameter	Results	Threshold
Temperature	9.8 to 18.9	Narrative (Deg C)
Dissolved Oxygen	6.7 to 10.4	5.0 (WARM BU), 6.0 (COLD BU) mg/L
pH	7.2 to 8.2	6.5-8.5
Total Nitrogen	ND <sup>+</sup> to 1.9	1.0 mg/L
Total Phosphorus	ND <sup>+</sup> to 0.09	0.1 mg/L
Turbidity	0.1 to 4.8	20 NTU
Chloride	21 to 420	<sup>b</sup> waterbody-specific mg/L, <sup>c</sup> 230 & 860 mg/L
Sulfate	13 to 350	<sup>b</sup> waterbody-specific mg/L
Conductivity	343 to 2342	<sup>a</sup> NA uS/cm
Alkalinity	98 to 383	<sup>a</sup> NA mg/L
Silica	26 to 44	<sup>a</sup> NA mg/L
Diss. Org. Carbon	1.1 to 8.5	<sup>a</sup> NA mg/L
Benthic AFDM	5 to 167	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	0.2 to 19.2	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	10.7 to 17.2	<sup>a</sup> NA

\*Non-detect    <sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

Out of interest, the number of BMI and algal taxa found at each stream was compiled. For BMI, final IDs are at various levels (species, genus, family, group), and “notable taxa” for this report are those in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa). For algae, final IDs are at the level of species or genus, and “sensitive taxa” are those with a California Biological Condition Gradient (BCG) rating of 1 or 2 (see Paul et al. 2020).

Range of BMI and algal taxa present among the streams

	# Taxa	# Notable or Sensitive taxa
BMI	19 to 52	2 to 14
Algae	45 to 126	1 to 16

## 5. Site Summaries

### 5.1. RCMP/Reference Sites

#### 5.1.1. 901BELOLV: Bell Canyon Creek



Bell Canyon Creek is a long-term RCMP site that has been sampled by the SWAMP Program and San Diego Water Board since 2013, with a permanent flow logger installed since 2013. The site is in Orange County on the Starr Ranch property, which is owned and managed by the National Audubon Society. The site is upstream of historic ranch infrastructure, and the tributary watershed is entirely within undeveloped portions of the Cleveland National Forest. While downstream portions of Bell Creek are perennial and support native stickleback, the sampling reach is intermittent and flows every year for a varied duration depending on rainfall.

Bell Creek scored as expected, with biologically intact benthic macroinvertebrate and algae communities, as well as intact physical habitat.

Index	Result	Threshold
CSCI	1.01	0.79
d-ASCI	1.01	0.86
h-ASCI	1.03	0.86
IPI	1.21	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan. Sulfate exceeded the Basin Plan objective for non-aquatic life use (drinking water).

Parameter	Results	Threshold
Temperature	15.1	Narrative (Deg C)
Dissolved Oxygen	7.5	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.3	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.2	20 NTU
Chloride	23	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	270	<sup>b</sup> waterbody-specific mg/L
Conductivity	968	<sup>a</sup> NA uS/cm
Alkalinity	201	<sup>a</sup> NA mg/L
Silica	28	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	1.1	<sup>a</sup> NA mg/L
Benthic AFDM	22	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	0.5	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	16.1	<sup>a</sup> NA

\*Non-detect <sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

## Taxa

	# taxa	# sensitive taxa
BMI	52	9
Algae	81	10

## Notable BMI:

- Ephemeroptera: *Baetis*; *Centroptilum*; *Fallceon*; Leptophlebiidae; *Paraleptophlebia*
- Plecoptera: *Isoperla*
- Trichoptera: Hydroptilidae; *Ochrotrichia*; *Wormaldia*
- Other: Corydalidae: *Neohermes*

## Sensitive algae:

- Diatoms: *Epithemia adnate*; *E. turgida*; *Meridion circulare*
- Cyanobacteria: *Calothrix marchica*; *C. parietina*; *Tolypothrix distorta*; *Chamaesiphon polymorphus*
- Other: *Paralemanea catenate*; *Spirogyra weberi*; *Zygnema* sp 1

For BMI, a field duplicate was collected at this site. The duplicate sample resulted in a CSCI score of 0.96 and a total of 49 taxa and 10 EPT taxa. Notable BMI recorded in the duplicate were those above minus *Centroptilum* and Leptophlebiidae, plus *Baetis adonis* (Ephemeroptera), *Malenka* (Plecoptera), and *Micrasema* (Trichoptera).

eDNA metabarcoding at Bell Canyon Creek did not detect any notable higher-trophic level aquatic wildlife. A two-striped garter snake (*Thamnophis hammondi*) and California tree frogs (*Pseudacris cadaverina*) were observed when sampling.



### 5.1.2. 903ACPCT1: Agua Caliente Creek



Agua Caliente Creek is a long-term RCMP site that has been sampled by the SWAMP Program and San Diego Water Board since 2013, with a permanent flow logger installed since 2015. The site is in San Diego County on the Cleveland National Forest upstream of the Pacific Crest Trail crossing, with the tributary watershed almost entirely within the national forest and Los Coyotes Band of Cahuilla & Cupeno Indians of the Los Coyotes Reservation. The sampling reach is intermittent and flows every year for a varied duration depending on rainfall. While never observed in the sampling reach, federally endangered arroyo toad are commonly observed downstream.

Agua Caliente Creek scored as expected, with biologically intact benthic macro-invertebrate and algae communities, as well as intact physical habitat.

Index	Result	Threshold
CSCI	1.09	0.79
d-ASCI	1.11	0.86
h-ASCI	1.16	0.86
IPI	1.09	0.85



Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	13.7	Narrative (Deg C)
Dissolved Oxygen	8.5	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.4	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.1	20 NTU
Chloride	34	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	92	<sup>b</sup> waterbody-specific mg/L
Conductivity	542	<sup>a</sup> NA uS/cm
Alkalinity	126	<sup>a</sup> NA mg/L
Silica	42	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	4.5	<sup>a</sup> NA mg/L
Benthic AFDM	5	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	0.2	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	13.0	<sup>a</sup> NA

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa	# sensitive taxa
BMI	48	14
Algae	112	11

#### Notable BMI:

- Ephemeroptera: *Ameletus*; *Baetis*; *Baetis tricaudatus*; *Centroptilum*; *Drunella flavilinea*; *Fallceon*; *Siphonurus*
- Plecoptera: Capniidae; *Haploperla chilnualna*; *Isoperla*; *Isoperla denningi*
- Trichoptera: Hydroptilidae; *Hydroptila*; *Oxyethira*
- Other: Corydalidae: *Neohermes*

#### Sensitive algae:

- Diatoms: *Epithemia adnate*; *Gomphonema kobayasii*; *Meridion circulare*; *Psammothidium marginulatum*
- Cyanobacteria: *Calothrix marchica*; *C. parietina*
- Other: *Chaetophora elegans*; *Chaetophora incrassate*; *Spirogyra cf weberi*; *Zygnema* sp 1; *Zygnema* sp 2

For algae, a field duplicate was collected at this site. The duplicate d-ASCI and h-ASCI scores were 0.85 and 0.94, respectively, somewhat lower than the other sample. The duplicate AFDM, Chl-a, and C:N results were 6.32 g/m<sup>2</sup>, 0.62 mg/m<sup>2</sup>, and 12.63, respectively. The duplicate had a total of 102 taxa and 6 sensitive taxa. Sensitive taxa recorded were those above, minus the four diatoms and *Calothrix marchica*.

### 5.1.3. 903NP9UAC: Upper Agua Caliente Creek



Upper Agua Caliente Creek is a long-term RCMP site that has been sampled by the SWAMP Program and San Diego Water Board since 2015, with a flow logger installed since 2015 (note this logger has been lost or damaged multiple times due to high flows). The sampling site is in San Diego County in the Cleveland National Forest near where the Pacific Crest Trail begins its ascent away from the drainage. The tributary watershed is almost entirely within the national forest and Los Coyotes Band of Cahuilla & Cupeno Indians of the Los Coyotes Reservation. The sampling reach is considered to be perennial and has had flow during all site visits, including during the fall in drought years. Arroyo chub was historically documented in Upper Agua Caliente Creek but has not been observed during sampling.

Upper Agua Caliente Creek scored as expected, with biologically intact benthic macroinvertebrate and algae communities, as well as intact physical habitat.

Index	Result	Threshold
CSCI	1.06	0.79
d-ASCI	0.94	0.86
h-ASCI	1.01	0.86
IPI	1.26	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	15.7	Narrative (Deg C)
Dissolved Oxygen	9.1	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	8.2	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.6	20 NTU
Chloride	24	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	48	<sup>b</sup> waterbody-specific mg/L
Conductivity	386	<sup>a</sup> NA uS/cm
Alkalinity	101	<sup>a</sup> NA mg/L
Silica	43	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	3.8	<sup>a</sup> NA mg/L
Benthic AFDM	12	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	2.0	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	11.6	<sup>a</sup> NA

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa	# sensitive taxa
BMI	49	12
Algae	88	7

#### Notable BMI:

- Ephemeroptera: *Ameletus*; *Baetis*; *Baetis adonis*; *Drunella flavilinea*; *Ephemerella*; *Fallceon*
- Plecoptera: *Haploperla chilnualna*; *Isoperla*
- Trichoptera: *Agapetus*; Hydropsychidae; *Hydroptila*; *Parapsyche*

#### Sensitive algae:

- Diatoms: *Epithemia adnate*; *E. sorex*; *E. turgida*; *E. turgida* var *westermanni*
- Cyanobacteria: *Nostochopsis lobatus*
- Other: *Chaetophora incrassate*; *Paralemanea catenata*

California tree frogs (*Pseudacris cadaverina*) were observed when sampling.



#### 5.1.4. 911TJKC1x: Kitchen Creek



Kitchen Creek is a long-term RCMP site that has been sampled by the SWAMP Program for over a decade, with regular monitoring conducted by SWAMP and the San Diego Water Board since 2015. A permanent flow logger has been installed at the site since 2015. The site is in San Diego County in the Cleveland National Forest alongside Kitchen Creek Road. It is intermittent and flows every year for a varied duration depending on rainfall. The site meets reference screening criteria but does have upstream development, including Kitchen Creek Road and a public campground.



Kitchen Creek scored as expected, with biologically intact benthic macroinvertebrate and algae communities, as well as intact physical habitat. While scoring above the 10<sup>th</sup> percentile of the reference distribution, Kitchen Creek's CSCI was lower than expected, as was the physical habitat score. This is likely because the 2022 sample contained a high proportion of Ostracoda, which sometimes can occur at this site due to the dominance of bedrock sections. The IPI score is also likely slightly skewed by the predominance of bedrock, which reduces habitat diversity metrics. The IPI is being updated to better represent this stream type.

Index	Result	Threshold
CSCI	0.80	0.79
d-ASCI	1.02	0.86
h-ASCI	1.05	0.86
IPI	0.87	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	12.9	Narrative (Deg C)
Dissolved Oxygen	9.9	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.6	6.5-8.5
Total Nitrogen	ND <sup>+</sup>	1.0 mg/L
Total Phosphorus	ND <sup>+</sup>	0.1 mg/L
Turbidity	0.4	20 NTU
Chloride	40	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	13	<sup>b</sup> waterbody-specific mg/L
Conductivity	540	<sup>a</sup> NA uS/cm
Alkalinity	230	<sup>a</sup> NA mg/L
Silica	44	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	5.1	<sup>a</sup> NA mg/L
Benthic AFDM	59	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	1.4	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	17.2	<sup>a</sup> NA

\*Non-detect    <sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa	# sensitive taxa
BMI	29	7
Algae	126	13

#### Notable BMI:

- Ephemeroptera: *Baetis tricaudatus*; *Centroptilum*; *Ephemerellidae*
- Plecoptera: *Isoperla*
- Trichoptera: *Hydroptilidae*; *Ochrotrichia*; *Rhyacophila sibirica* group

Sensitive algae:

- Diatoms: *Epithemia adnate*; *E. sorex*; *E. turgida*; *Fragilariforma virescens*; *Gomphonema americobtusatum*; *Meridion circulare*
- Cyanobacteria: *Calothrix parietina*; *Homoeothrix varians*
- Other: *Chaetophora*; *Chaetophora elegans*; *C. incrassate*; *Klebsormidium rivulare*; *Zygnema* sp 1

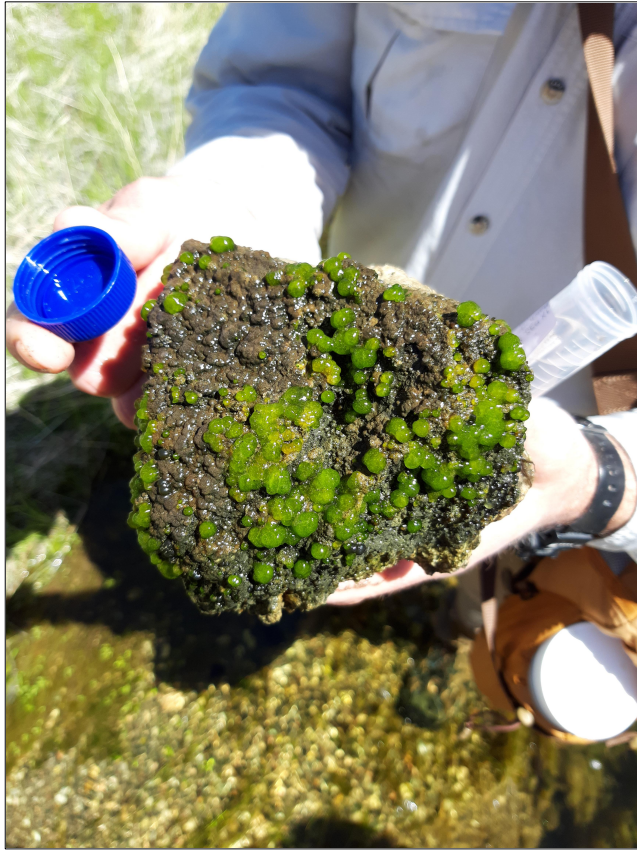
Kitchen Creek was sampled again for algae on April 25. The d-ASCI and h-ASCI scores were 0.92 and 1.00, respectively. A total of 114 taxa and 10 sensitive taxa were present. Sensitive taxa were those above minus *Fragilariforma virescens*, *Homoeothrix varians*, *Chaetophora*; and *Chaetophora elegans* plus *Tribonema affine* (Other).

Chemical and physical water quality results (4/25) met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	10.7	Narrative (Deg C)
Dissolved Oxygen	10.4	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	8.0	6.5-8.5
Turbidity	0.1	20 NTU
Conductivity	545	<sup>a</sup> NA uS/cm
Alkalinity	243	<sup>a</sup> NA mg/L
Benthic AFDM	122	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	1.9	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	10.7	<sup>a</sup> NA

eDNA metabarcoding at Kitchen Creek did not detect any notable higher-trophic level aquatic wildlife. A pair of mallard ducks were observed on both visits, possibly nesting.

Figure 6. *Chaetophora elegans* at Kitchen Creek 4/6/22



## Program Sites

### 5.1.5. 907NP9SVC: San Vicente Creek



San Vicente Creek was a requested site from our partner agency CDFW. CDFW owns property that is managed as the Canada San Vicente Ecological Preserve. CDFW is concerned about water quality entering the preserve from the upstream portion of San Vicente Creek, as the preserve contains a large population of the federally endangered arroyo toad. The tributary watershed upstream of the preserve contains residential development, a package recycled water treatment plant, and golf course along the stream corridor. Flows at San Vicente Creek have been documented by CDFW to be intermittent.



San Vicente Creek scored poorly, with both benthic macroinvertebrate and algae communities scoring below thresholds. The algae scores were much lower compared to the benthic macroinvertebrate score. Interestingly, physical habitat scored well above the threshold, indicating in-stream habitat degradation is not an issue at this site. Thus, the low scores are likely due to poor chemistry and/or hydrologic (flow) alteration.

Index	Result	Threshold
CSCI	0.75	0.79
d-ASCI	0.57	0.86
h-ASCI	0.58	0.86
IPI	0.93	0.85

Chemistry results indicate possible past nutrient enrichment based on the high benthic AFDM, but the observed low nitrogen, low phosphorous, and low benthic Chl-a indicate enrichment was not present at the time of sampling, and results met relevant aquatic life water quality objectives in the Basin Plan. Chloride and sulfate exceeded Basin plan water quality objectives for non-aquatic life use (drinking water and irrigation), and chloride was above USEPA recommended freshwater criteria for 4-day exposure.

Parameter	Results	Threshold
Temperature	14.3	Narrative (Deg C)
Dissolved Oxygen	9.7	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	8.0	6.5-8.5
Total Nitrogen	ND <sup>+</sup>	1.0 mg/L
Total Phosphorus	0.09	0.1 mg/L
Turbidity	4.7	20 NTU
Chloride	420	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	250	<sup>b</sup> waterbody-specific mg/L
Conductivity	2,342	<sup>a</sup> NA uS/cm
Alkalinity	383	<sup>a</sup> NA mg/L
Silica	34	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	8.5	<sup>a</sup> NA mg/L
Benthic AFDM	167	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	0.9	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	13.0	<sup>a</sup> NA

<sup>+</sup>Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score



#### Taxa

	# taxa	# sensitive taxa
BMI	19	2
Algae	70	1

#### Notable BMI:

- Ephemeroptera: *Baetis*; *Baetis adonis*
- Plecoptera: none
- Trichoptera: none

#### Sensitive algae:

- Diatoms: *Tabellaria flocculosa*
- Cyanobacteria: none
- Other: none

A two-striped garter snake (*Thamnophis hammondi*), California tree frogs (*Pseudacris cadaverina*), and non-native crayfish (*Procambarus clarkii*) were observed when sampling.

Figure 7. California tree frog at San Vicente Creek 4/6/22





#### 5.1.6. 902SCSCRx: Sandia Creek



Sandia Creek was a requested site as part of efforts to quantify nutrient sources and stream condition for the Santa Margarita river and estuary nutrient Total Maximum Daily Loads (TMDLs). This location is sampled for nutrients by MARU on a monthly basis and is co-located at a United State Geologic Survey (USGS) stream flow gage, which shows flows to be perennial. Sandia Creek drains a watershed dominated by agricultural land and rural residential properties.

Sandia Creek scored well for benthic macroinvertebrates but poorly for benthic algae. This is consistent with prior observations, which show that benthic macroinvertebrates are sometimes not as responsive to nutrient enrichment as benthic algae, especially if stream habitat is in good condition. Physical habitat scored well above the threshold, indicating instream habitat degradation is not an issue.

Index	Result	Threshold
CSCI	0.98	0.79
d-ASCI	0.52	0.86
h-ASCI	0.45	0.86
IPI	1.02	0.85

Chemistry results indicate nutrient enrichment based on total nitrogen and benthic AFDM. Chloride and sulfate also exceeded Basin Plan water quality objectives for non-aquatic life uses (drinking water and irrigation). Chloride was slightly above USEPA recommended criteria for 4-day exposure, though no impacts to the BMI community were evident.

Parameter	Results	Threshold
Temperature	16.7	Narrative (Deg C)
Dissolved Oxygen	9.3	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.9	6.5-8.5
Total Nitrogen	1.9	1.0 mg/L
Total Phosphorus	0.02	0.1 mg/L
Turbidity	0.7	20 NTU
Chloride	270	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	350	<sup>b</sup> waterbody-specific mg/L
Conductivity	1,836	<sup>a</sup> NA uS/cm
Alkalinity	181	<sup>a</sup> NA mg/L
Silica	40	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	2.8	<sup>a</sup> NA mg/L
Benthic AFDM	88	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	19.2	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	11.5	<sup>a</sup> NA

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa	# sensitive taxa
BMI	39	14
Algae	45	1

#### Notable BMI:

- Ephemeroptera: Baetidae; *Baetis*; *Baetis adonis*; *Fallceon*; *Tricorythodes*
- Plecoptera: *Malenka*; Nemouridae; *Isoperla denningi*
- Trichoptera: Brachycentridae; *Hydropsyche*; Hydropsychidae; Hydroptilidae; *Micrasema*; *Tinodes*
- Other: *Corbicula* (non-native, perennial flow dependent)

#### Sensitive algae:

- Diatoms: *Karayevia laterostrata*
- Cyanobacteria: none
- Other: none

eDNA metabarcoding at Sandia Creek detected multiple notable aquatic wildlife. Consistent with recent USGS and CDFW surveys, eDNA detected two sensitive native species: steelhead/trout (*Oncorhynchus mykiss*) and arroyo chub (*Gila orcuttii*). Both species were observed in the creek during sampling. It is unknown if the observed steelhead/trout are native or stocked fish, as this eDNA testing does not distinguish subspecies. eDNA also detected two non-native fish: largemouth bass (*Micropterus salmoides*) and fathead minnow (*Pimephales promelas*). Finally, eDNA detected the presence of Anatidae (ducks). Two non-native species, Crayfish (*Procambarus clarkii*) and an Asian clam (*Corbicula fluminea*), were also observed while sampling.

## **5.2. Causal Assessment Sites**

None sampled in 2022



## 5.3. Trend Sites

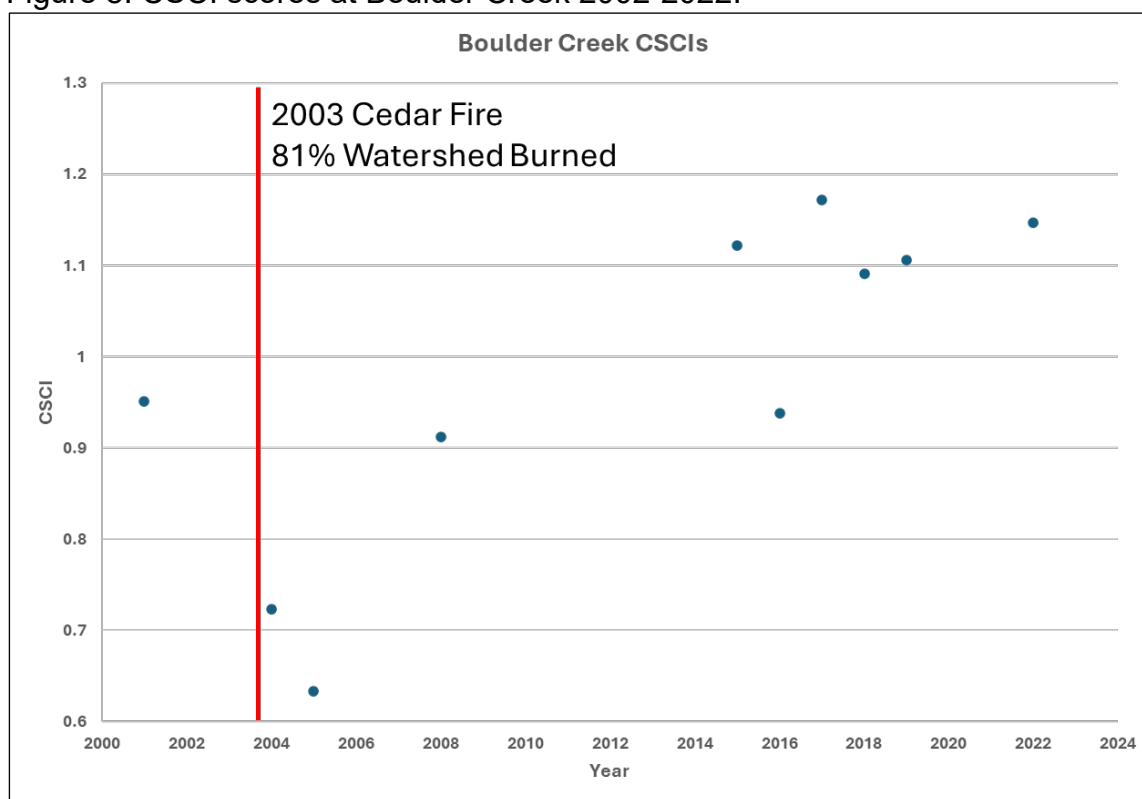
### 5.3.1. 907SDBOC2: Boulder Creek



Boulder Creek is a long-term trend site that has been sampled by the State of California on a semi-regular basis for over 20 years. The site was impacted by the 2003 Cedar fire, which burned over 80 percent of the tributary watershed. The benthic macroinvertebrate community has since recovered from the fire (Figure 8). The Boulder Creek sampling site is currently owned by and sampled in partnership with the San Diego River Park Foundation. Boulder Creek's watershed is largely undeveloped open space but does not meet reference screens as flows are controlled by an upstream reservoir (Lake Cuyamaca) and the watershed contains active producer mines. However, Boulder Creek typically contains benthic invertebrates and algae consistent with reference-quality conditions, as well as high-quality habitat. California newts and southwestern pond turtles, both sensitive native species, have been observed at this site in the past. Boulder Creek exhibits intermittent stream flows.



Figure 8. CSCI scores at Boulder Creek 2002-2022.



Boulder Creek scored well for benthic macroinvertebrates and physical habitat but poorly for benthic algae, with both the d-ASCI and h-ASCI well below the 10<sup>th</sup> percentile threshold. The low ASCI scores are likely attributable to modified flows from Cuyamaca Reservoir. At the time of sampling, flows were higher than usual due to increased water releases from the reservoir. Boulder Creek will be prioritized for monitoring again in the future.

Index	Result	Threshold
CSCI	1.14	0.79
d-ASCI	0.75	0.86
h-ASCI	0.77	0.86
IPI	1.15	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	15.7	Narrative (Deg C)
Dissolved Oxygen	8.5	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.9	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.6	20 NTU
Chloride	21	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	14	<sup>b</sup> waterbody-specific mg/L
Conductivity	343	<sup>a</sup> NA uS/cm
Alkalinity	153	<sup>a</sup> NA mg/L
Silica	26	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	2.7	<sup>a</sup> NA mg/L
Benthic AFDM	48	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	1.3	<sup>d</sup> 44 mg/m <sup>2</sup>

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa	# sensitive taxa
BMI	37	11
Algae	126	11

#### Notable BMI:

- Ephemeroptera: *Baetis*; *Baetis tricaudatus*; *Centroptilum*; *Ecdyonurus criddlei*; *Fallceon*; *Matriella teresa*
- Plecoptera: Capniidae; *Isoperla denningi*
- Trichoptera: Hydroptilidae; *Ochrotrichia*; *Rhyacophila*

#### Sensitive algae:

- Diatoms: *Epithemia adnate*; *E. sorex*; *Meridion circulare*; *Sellaphora bacillum*
- Cyanobacteria: *Calothrix parietina*
- Other: *Chaetophora*; *C. elegans*; *C. incrassate*; *Spirogyra weberi*; *Tribonema affine*; *Zygnema* sp 1

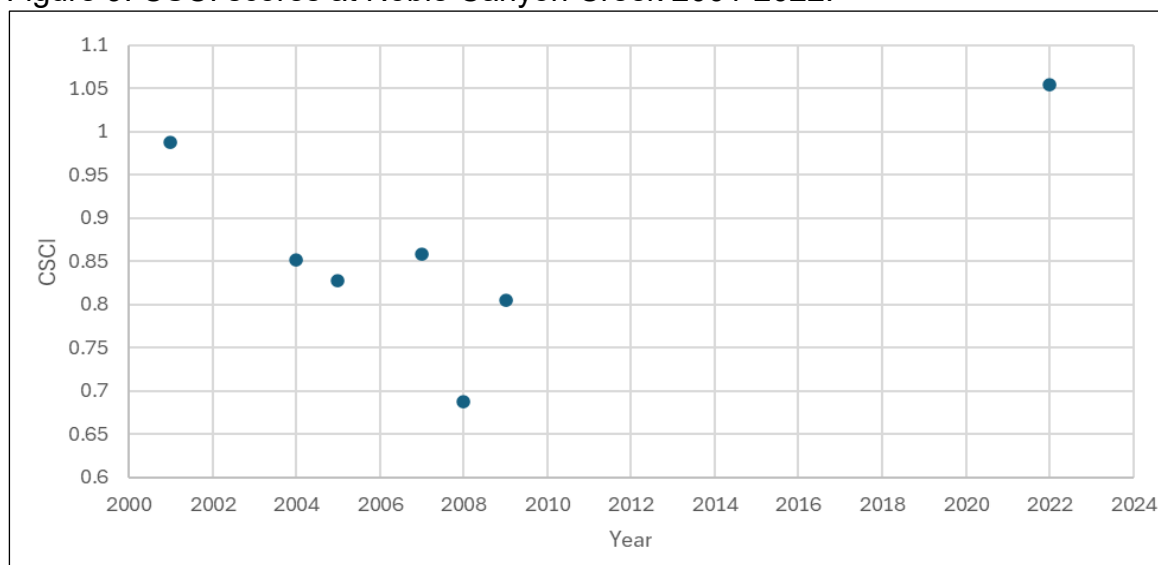
A two-striped garter snake (*Thamnophis hammondi*) and a California newt (*Taricha torosa*) were observed when sampling.

### 5.3.2. 911NCPCR<sub>x</sub>: Noble Canyon Creek



Noble Canyon Creek was a historic trend site that was monitored from 2001-2009 ( $n = 7$  events). CSCI scores during that time ranged from 0.68 to 0.98, with only one score below 0.79 (Figure 9). Noble Canyon was selected for sampling due to the extended time since prior sampling (over 10 years), in addition to its identification as quality habitat for sensitive species by partners at USGS and CDFW. Southwestern pond turtle and arroyo toad were historically observed in Noble Canyon Creek. The Noble Canyon Creek sampling site and tributary watershed is largely Cleveland National Forest open space, but the watershed has potential impacts associated with upstream mining, as well as heavy stock grazing in the Laguna Meadow area, which drains into Noble Canyon. Noble Canyon Creek is an intermittent stream, though it may flow year-round during high precipitation years.

Figure 9. CSCI scores at Noble Canyon Creek 2001-2022.



Noble Canyon Creek scored as expected, with biologically intact benthic macro-invertebrate and algae communities, as well as intact physical habitat.

Index	Result	Threshold
CSCI	1.05	0.79
d-ASCI	1.11	0.86
h-ASCI	1.07	0.86
IPI	1.2	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	9.8	Narrative (Deg C)
Dissolved Oxygen	9.1	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.7	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.3	20 NTU
Chloride	44	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	52	<sup>b</sup> waterbody-specific mg/L
Conductivity	532	<sup>a</sup> NA uS/cm
Alkalinity	158	<sup>a</sup> NA mg/L
Silica	34	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	4.3	<sup>a</sup> NA mg/L
Benthic AFDM	68	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	4.1	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	15.6	<sup>a</sup> NA

<sup>a</sup>Non-detect <sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score



#### Taxa

	# taxa recorded	# sensitive taxa
BMI	40	13
Algae	86	12

#### Notable BMI:

- Ephemeroptera: *Baetis*; *Centroptilum*; *Ephemerellidae*
- Plecoptera: *Isoperla*; *I. adunca*; *I. denningi*; *Taeniopterygidae*
- Trichoptera: *Hydroptila*; *Micrasema*; *Ochrotrichia*; *Rhyacophila*; *R. sibirica* group; *Wormaldia*

#### Sensitive algae:

- Diatoms: *Epithemia adnate*; *E. sorex*; *E. turgida*; *Fragilariforma virescens*; *Meridion circulare*
- Cyanobacteria: *Tolypothrix distorta*
- Other: *Chaetophora*; *C. incrassate*; *Paralemanea catenata*; *Spirogyra varians*; *Tribonema affine*; *Zygnema* sp 1

Noble Canyon Creek was sampled for algae again on April 25 and June 16.

For the April 25 sample, d-ASCI and h-ASCI scores were 1.00 and 1.05, respectively. A total of 95 taxa and 12 sensitive taxa were present. Sensitive taxa present were those above minus *Meridion circulare*, *Chaetophora*, *Paralemanea catenata*, and *Spirogyra varians*, and plus *Gomphonema americobtusatum* (Diatom), *Tolypothrix lanata* (Cyanobacteria), *Chaetophora elegans* and *Zygnema* sp 2 (Other).

Chemical and physical water quality results s (4/25) met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	16.0	Narrative (Deg C)
Dissolved Oxygen	8.9	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.8	6.5-8.5
Turbidity	0.2	20 NTU
Conductivity	541	<sup>a</sup> NA uS/cm
Alkalinity	155	<sup>a</sup> NA mg/L
Benthic AFDM	142	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	1.4	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	15.2	<sup>a</sup> NA

For the June 16 sample, d-ASCI and h-ASCI scores were 0.97 and 1.01, respectively. A total of 99 taxa and 13 sensitive taxa were present. Sensitive taxa present were those above minus *Paralemanea catenata* and *Spirogyra varians*, and plus *Gomphonema americobtusatum*, *Tabellaria flocculosa* (Diatoms), and *Calothrix parietina* (Cyanobacteria).

Chemical and physical water quality results (6/16) met relevant aquatic life water quality objectives in the Basin Plan

Parameter	Results	Threshold
Temperature	18.9	Narrative (Deg C)
Dissolved Oxygen	6.7	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.2	6.5-8.5
Turbidity	0.9	20 NTU
Conductivity	690	<sup>a</sup> NA uS/cm
Alkalinity	190	<sup>a</sup> NA mg/L
Benthic AFDM	169	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	2.3	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	-	<sup>a</sup> NA

eDNA metabarcoding at Noble Canyon Creek did not detect any notable higher-trophic level aquatic wildlife, and no arroyo toads or southwestern pond turtles were observed during sampling. A two-striped garter snake (*Thamnophis hammondi*) and Pacific tree frog (*Pseudacris regilla*) were observed when sampling.

Figure 10. Baby two-striped garter snake at Noble Canyon Creek 4/25/22.





## 5.4. Coverage Expansion Sites

### 5.4.1. 907TEMREF: Temescal Creek



Temescal Creek was selected for sampling after identification as a priority by partners at the San Diego River Park Foundation. The stream is on property that was historically used for cattle ranching and was purchased by the San Diego River Park Foundation, who is doing active restoration on-site. Temescal Creek is a small intermittent stream in the headwaters of the San Diego River, and the property purchased largely encompasses the entire upstream watershed of the site. The site was originally selected because it meets GIS reference screens. However, the site would not be used by the RCMP in its current state due to on-site observed impacts (trampling and defecation) from cattle associated with a neighboring property.

Temescal Creek scored well for benthic macroinvertebrates, but scores for benthic algae and physical habitat were below expected. The IPI is likely slightly skewed by the predominance of bedrock, which reduces habitat diversity metrics. [The IPI is being updated to better represent this stream type.] There was evidence of cattle presence throughout the reach (trampling, feces) which likely contributed to the lower-than-expected scores. In addition, flows during the time of sampling were marginal.

The results and cattle observations were shared with the San Diego River Park Foundation, who stated the cattle were trespassing and they would be working with the neighbor to implement control measures. As a result, this site will be prioritized for resampling in the future.

Index	Result	Threshold
CSCI	0.90	0.79
d-ASCI	0.83	0.86
h-ASCI	0.76	0.86
IPI	0.76	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	12.3	Narrative (Deg C)
Dissolved Oxygen	8.5	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.3	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	0.04	0.1 mg/L
Turbidity	4.8	20 NTU
Chloride	46	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	84	<sup>b</sup> waterbody-specific mg/L
Conductivity	534	<sup>a</sup> NA uS/cm
Alkalinity	101	<sup>a</sup> NA mg/L
Silica	39.5	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	3.5	<sup>a</sup> NA mg/L
Benthic AFDM	32	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	0.6	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	13.9	<sup>a</sup> NA

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa recorded	# sensitive taxa
BMI	46	10
Algae	105	8

#### Notable BMI:

- Ephemeroptera: Baetidae; *Baetis tricaudatus*; *Centroptilum*; Leptophlebiidae; Paraleptophlebia
- Plecoptera: Perlodidae; Plecoptera; Taeniopterygidae
- Trichoptera: Hydroptilidae; *Ochrotrichia*



Sensitive algae:

- Diatoms: *Cymbella affinis*; *Epithemia sorex*; *Meridion circulare*
- Cyanobacteria: none
- Other: *Klebsormidium rivulare*; *Paralemanea*; *Spirogyra varians*; *Zygnema* sp 1:  
*Zygnema* sp 2

eDNA metabarcoding at Temescal Creek did not detect any notable aquatic wildlife. A very large red diamond rattlesnake was observed in the riparian zone along the sampling reach.

#### 5.4.2. 911GSCAPV: Granite Spring Creek



Granite Spring Creek was selected for sampling after San Diego Water Board identification as 1) meeting reference screens, and 2) having never been sampled. Granite Spring Creek is a likely intermittent stream tributary to Pine Valley Creek whose watershed is entirely within the Cleveland National Forest and Cuyamaca Rancho State Park. No known development exists in the tributary watershed.

Granite Spring Creek scored as expected, with biologically intact benthic macroinvertebrate and algae communities, as well as intact physical habitat. While scoring above the 10<sup>th</sup> percentile of the reference distribution, the IPI was lower than expected. This is likely because the IPI score is likely slightly skewed by the predominance of bedrock, which reduces habitat diversity metrics. The IPI is being updated to better represent this stream type.

Index	Result	Threshold
CSCI	0.92	0.79
d-ASCI	1.05	0.86
h-ASCI	1.08	0.86
IPI	0.87	0.85

Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	14.2	Narrative (Deg C)
Dissolved Oxygen	9.8	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.3	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.4	20 NTU
Chloride	24	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	43	<sup>b</sup> waterbody-specific mg/L
Conductivity	353	<sup>a</sup> NA uS/cm
Alkalinity	110	<sup>a</sup> NA mg/L
Silica	36	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	4	<sup>a</sup> NA mg/L
Benthic AFDM	56	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	1.4	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	12.3	<sup>a</sup> NA

\*Non-detect <sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazor et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa recorded	# sensitive taxa
BMI	43	9
Algae	83	12

#### Notable BMI:

- Ephemeroptera: *Baetis*; *Baetis tricaudatus*; *Callibaetis*; *Cloeodes excogitatus*
- Plecoptera: *Isoperla adunca*
- Trichoptera: Hydroptilidae; *Ochrotrichia*; *Rhyacophila angelita* group; *Wormaldia*

#### Sensitive algae:

- Diatoms: *Cymbella affinis*; *Epithemia adnata*; *E. turgida*; *Fragilariforma virescens*
- Cyanobacteria: *Calothrix parietina*; *Tolypothrix distorta*
- Other: *Chaetophora*; *C. elegans*; *C. incrassate*; *Tribonema affine*; *Zygnema aplanosporum*; *Zygnema* sp 1

A rosy boa (*Lichanura orcutti*) was observed in the riparian zone. A two-striped garter snake (*Thamnophis hammondi*) and California tree frogs (*Pseudacris cadaverine*) were also observed when sampling.



#### 5.4.3. 911PS0794: Upper Pine Valley Creek



Upper Pine Valley Creek is a coverage expansion site originally intended for sampling by the SWAMP perennial stream assessment program in 2016. MARU identified this site as a priority for sampling to better assess the upper Pine Valley Creek drainage, which was unsampled except for a single tributary (Indian Creek). The sampling site and tributary watershed is almost entirely open space within the Cleveland National Forest and Cuyamaca Rancho State Park. However, the site does not meet reference screens due to upstream mining. Upper Pine Valley Creek exhibits intermittent stream flows.

Upper Pine Valley Creek scores indicate biologically intact benthic macroinvertebrate and algae communities, as well as intact physical habitat. All scores for the site exceeded expectations for similar reference sites.

Index	Result	Threshold
CSCI	1.07	0.79
d-ASCI	1.06	0.86
h-ASCI	1.08	0.86
IPI	1.14	0.85



Chemical and physical water quality results met relevant aquatic life water quality objectives in the Basin Plan.

Parameter	Results	Threshold
Temperature	11.9	Narrative (Deg C)
Dissolved Oxygen	9.2	5.0 (WARM BU) or 6.0 (COLD BU) mg/L
pH	7.5	6.5-8.5
Total Nitrogen	ND <sup>a</sup>	1.0 mg/L
Total Phosphorus	ND <sup>a</sup>	0.1 mg/L
Turbidity	0.7	20 NTU
Chloride	36	<sup>b</sup> waterbody-specific mg/L; <sup>c</sup> 230 & 860 mg/L
Sulfate	87	<sup>b</sup> waterbody-specific mg/L
Conductivity	499	<sup>a</sup> NA uS/cm
Alkalinity	98	<sup>a</sup> NA mg/L
Silica	30	<sup>a</sup> NA mg/L
Dissolved Organic Carbon	3.1	<sup>a</sup> NA mg/L
Benthic AFDM	98	<sup>d</sup> 25 g/m <sup>2</sup>
Benthic Chl-a	2.0	<sup>d</sup> 44 mg/m <sup>2</sup>
Benthic C:N	15.8	<sup>a</sup> NA

\*Non-detect

<sup>a</sup> Informational

<sup>b</sup> Basin Plan criteria are specific to non-aquatic use

<sup>c</sup> USEPA recommended freshwater criteria for 4-day and 1-hour exposure, respectively.

<sup>d</sup> Mazon et al. 2022 threshold for obtaining 10<sup>th</sup> percentile ASCI score

#### Taxa

	# taxa recorded	# sensitive taxa
BMI	44	9
Algae	107	16

#### Notable BMI:

- Ephemeroptera: *Baetis*; *Baetis tricaudatus*
- Plecoptera: *Isoperla*; *Isoperla adunca*; Taeniopterygidae
- Trichoptera: Hydroptilidae; *Ochrotrichia*; *Rhyacophila angelita* group; *Wormaldia*

#### Sensitive algae:

- Diatoms: *Cymbella affinis*; *Epithemia adnata*; *E. turgida*; *Fragilariforma virescens*; *Gomphonema americobtusatum*; *G. subclavatum*; *Meridion circulare*; *Reimeria sinuata*
- Cyanobacteria: *Calothrix parietina*; *Tolypothrix distorta*; *T. lanata*
- Other: *Chaetophora incrassate*; *Klebsormidium rivulare*; *Spirogyra weberi*; *Tribonema affine*; *Zygnema* sp 1

eDNA metabarcoding at Upper Pine Valley Creek did not detect any notable aquatic wildlife. California tree frogs (*Pseudacris cadaverina*) were observed when sampling.

## 6. Summary

- 2022 marked the 27th year of State of California bioassessment monitoring in Region 9. To date, over 550 sites in the region have been bioassessed at least once, and more than 1,700 bioassessments have been done.
- The 2022 bioassessment sites comprised four reference, two program, two trend, and three coverage expansion sites. With a few exceptions, indices showed intact macroinvertebrate and algal communities, and intact physical habitat among the sites sampled.
  - **CSCI scores were above the threshold at all but one site.** The one site below the threshold (San Vicente Creek) has potential sources of macroinvertebrate stressors in its watershed.
  - **ASCI scores were above the threshold at all but four sites.** The four sites below the threshold (San Vicente, Sandia, Boulder, and Temescal Creeks) likely experience various types of algal stressors such as, for example, upstream development at San Vicente, agricultural impacts at Sandia, flow modification at Boulder, and cattle activity at Temescal.
  - **IPI scores were above the threshold at all but one site.** The one site below the threshold (Temescal Creek) is likely somewhat degraded due to on-site cattle grazing and low-flow conditions during sampling.
  - **Where sites were sampled more than once, index scores were consistent and above the threshold, except in one case.** At Agua Caliente Creek, the field duplicate's d-ASCI was slightly below the threshold. The lower d-ASCI score is explained by the fact that four species of sensitive diatoms were not found in that sample. Otherwise, the BMI field duplicates gave similar results (Bell Canyon Creek), as did the repeat algal samples (Kitchen and Noble Creeks).
- **Chemistry results met Basin Plan objectives for aquatic life at all but one site;** total nitrogen at Sandia Creek (1.9 mg/L) was slightly above the objective (1.0 mg/L). Chloride levels at San Vicente Creek (420 mg/L) and Sandia Creek (270 mg/L) were above the USEPA recommended freshwater aquatic life criteria for 4-day exposure (230 mg/L). [This USEPA criterion assumes an association with sodium.] San Vicente Creek also stood out as having relatively high specific conductivity (2,342 uS/cm) and alkalinity (383 mg/L) compared to the other sites. Benthic AFDM results at eight sites were above a published threshold for California, but this parameter is documented to have a high degree of variability.
- The greatest number of BMI taxa found in a sample was 52 (Bell Canyon Creek), and the greatest number of algal taxa was 126 (Kitchen Creek, Boulder Creek). Microscopic algae contribute in large part to the high number of algal taxa.  
**Overall, pooling taxonomic data from the 11 streams, 140 BMI taxa and 387 algal taxa were recorded in Region 9 in 2022.**

- Of the six sites where Jonah Ventures eDNA metabarcoding kits were used, **Sandia Creek was the only site where notable aquatic wildlife was detected using eDNA.** eDNA was detected from two sensitive native fish species and two non-native fish species. The native species were steelhead/trout (*Oncorhynchus mykiss*) and arroyo chub (*Gila orcuttii*), both of which were observed during sampling, and the non-native species were largemouth bass (*Micropterus salmoides*) and fathead minnow (*Pimephales promelas*). eDNA sampling at more sites is planned for 2023.
- **Carbon:Nitrogen ratios were between 8 and 16 at all but two sites**, indicating that most of the streams had a mix of carbon-rich (leaves) and nitrogen-rich (algae, animal waste) sources. The slightly higher ratios at Bell Creek (16.1) and Kitchen Creek (17.2) suggest these two have a slight predominance of terrestrial carbon sources. Continued sampling of particulate carbon and nitrogen is planned for 2023.
- MARU plans to do future bioassessment sampling at Temescal Creek and Boulder Creek during normal baseflow to better document stream condition.

## 7. References

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