SANTA MARGARITA RIVER
WATERSHED MANAGEMENT AREA

STREAM BIOASSESSMENT MONITORING
ANNUAL REPORT FOR THE MIDDLE SANTA
MARGARITA RIVER SUBWATERSHED AREA

FISCAL YEAR 2017–2018

Prepared for:
Riverside County Santa Margarita River Subwatershed Municipal Separate Storm Sewer System Co-Permittees
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Prepared by:
Wood Environment and Infrastructure Solutions, Inc.
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1.0 INTRODUCTION

On November 18, 2015, the San Diego Regional Water Quality Control Board (Regional Board) adopted National Pollutant Discharge Elimination System (NPDES) Permit Order No. R9-2013-0001, as amended by R9-2015-0100 (Permit), which regulates dischargers of urban runoff from the municipal separate storm sewer systems (MS4s) within the Santa Margarita Region (SMR) Watershed Management Area draining the County of Riverside, the City of Murrieta, the City of Temecula, the City of Wildomar, and the Riverside County Flood Control and Water Conservation District (collectively, Co-Permittees). The Permit includes a monitoring and reporting program that identifies goals and management questions for program design and implementation and provides a basic structure for specific requirements for monitoring and reporting. Wood Environment & Infrastructure Solutions, Inc. (Wood; formerly Amec Foster Wheeler) was contracted to perform the stream assessment monitoring portion of the Permit requirements for the portion of the SMR Watershed located in Riverside County. Complete descriptions of the methods used, and results of the monitoring are presented in this monitoring report.

The stream bioassessment monitoring sites included six sites for compliance with the NPDES MS4 Receiving Water Monitoring Program and two sites that contribute to the Stormwater Monitoring Coalition (SMC) Regional Stream Survey. The SMC program is coordinated by the Southern California Coastal Water Resource Program (SCCWRP), which is the central repository for data analysis and reporting for SMC participating agencies in the South Coast Region. Stream bioassessment sampling and analyses followed the protocols in the Surface Water Ambient Monitoring Program (SWAMP) Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat (Ode et al., 2016), as well as the SMC work plan Bioassessment Survey of the Stormwater Monitoring Coalition (Mazor, 2015a).

Stream bioassessments provide a quantifiable assessment of the resident benthic macroinvertebrates (BMI) and algal communities in wadeable freshwater streams. Because these organisms live in a given water body for extended periods, they provide an integrative direct assessment of the cumulative impacts of water quality over time that other measurements (e.g., water chemistry and toxicity) may not (Karr & Chu, 1999). Using community species composition, taxa-specific ecology, pollution tolerance, and feeding strategies, numerical biometric indices are calculated, allowing for comparison of relative ecological health among monitoring sites and over time.

This report presents the results of sampling and analyses of the BMI and algal communities at the eight stream sites surveyed within the SMR Watershed from May 1 through May 30, 2018. Field sampling for algae and BMI was performed by Thomas Arthur, Stephen Campbell, Bill Isham, Greg McCormick, Cara Nager, and John Rudolph of Wood; laboratory analysis of BMI was performed by Bill Isham (Wood), Thomas Gerlinger (Osprey Marine Management), and Kurt King (Aquatic Assessments, Inc.); and data management and interpretation of BMI and algal data were performed by Bill Isham, John Rudolph, and Corey Sheredy (Wood). Laboratory analyses and compilation of algal taxonomic data were performed by Rosalina Stancheva and Kalina Manoylov, taxonomists with the California Primary Algae Laboratory at the California State University, San Marcos (CSUSM) and the Georgia College and State University, respectively.
2.0 MATERIALS AND METHODS

This section provides a general description of the methods used in the stream bioassessment monitoring program. Wood performed stream bioassessment monitoring in accordance with SWAMP and SMC protocols.

2.1 Stream Monitoring Sites

Six receiving water monitoring sites are identified under the Consolidated Monitoring Program (CMP; Riverside County Flood Control and Water Conservation District, 2014) in accordance with the Receiving Water Monitoring Program requirements of the 2010 Permit (Table 2-1). Moving forward, in accordance with the Transitional requirements of the 2015 Permit, the receiving water monitoring will be conducted in accordance with the old requirements until approval of the watershed-wide Water Quality Improvement Plan; therefore, bioassessment was conducted at the six sites during fiscal year (FY) 2017–2018. Additionally, two other sites are monitored within Riverside County under the current SMC program. Under the SMC probabilistic study design, sites are chosen from a randomized master sample draw of all probabilistic sites throughout the three subwatershed areas of the SMR, provided by the SMC Program Administrator. This procedure requires that the sites on the master list be sequentially screened for suitability, and the first site that passes the SMC site selection criteria (e.g., presence of adequate flow, is safely accessible, and site access is granted) is selected for monitoring. Historically, although desktop and field reconnaissance has been conducted for sites within both the Upper and Middle SMR subwatershed areas, only the Middle subwatershed area has had sites that meet the requirements optimal for conducting bioassessment\(^1\), as outlined in the SWAMP bioassessment methods (Ode et al., 2016) and 2015–2019 SMC work plan. Potential SMC sites screened within the Upper watershed have been reported as dry, and therefore not available for bioassessment, according to current SWAMP bioassessment procedures. Two types of sites are assessed: “condition” and “trend” sites. Condition sites are those that are selected from the SMC randomized list each year. These sites are sampled only once during the current five-year cycle (2015–2019) to discern an overall condition estimate of the health of streams in the region. Trend sites are those that have been randomly selected from the preceding five-year SMC cycle (2009–2013) list and are being sampled each year of the current five-year cycle (2015–2019) to evaluate overall trends in the ecological health of streams in the region.

In the 2017–2018 monitoring year, one trend site (SMC01097 in Sandia Creek) and one condition site (902M18901 in an unnamed tributary to Sandia Creek) were sampled for the SMC program. Five of the six targeted sites under the SMR MS4 Receiving Water Monitoring Program were sampled, with the exception of Redhawk Channel, which had insufficient flow at the time of sampling in May 2018. Table 2-1 lists the locations monitored during the 2017–2018 monitoring year. Figure 2-1 shows the locations of the monitoring sites.

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\(^1\) SMC Stream Requirements: Stream width of ~1 meter. Stream length shall be dependent upon the length of flowing water (11 transects can be stretched to 250 meters maximum or condensed down to 10 meters minimum; therefore, reach lengths may range from 2750 meters (max) to 110 meters (min), typically around 300 meters). Stream depth shall be wadeable (typically <1 meter deep for >50% of reach).
Table 2-1. 2017–2018 Middle SMR Stream Bioassessment Monitoring Site List

<table>
<thead>
<tr>
<th>Program</th>
<th>Water Body/ Site Name</th>
<th>Site Code</th>
<th>Date Sampled</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverside County MS4 Monitoring Program</td>
<td>Lower Temecula Creek</td>
<td>902LTC777</td>
<td>24-May-18</td>
<td>33.47417</td>
<td>-117.13757</td>
</tr>
<tr>
<td></td>
<td>Lower Murrieta Creek</td>
<td>902LMC778</td>
<td>24-May-18</td>
<td>33.47789</td>
<td>-117.14212</td>
</tr>
<tr>
<td></td>
<td>Redhawk Channel</td>
<td>902RDH768</td>
<td>VNS(^1)</td>
<td>33.47710</td>
<td>-117.09675</td>
</tr>
<tr>
<td></td>
<td>Adobe Creek (Reference Site)</td>
<td>902ADB848</td>
<td>16-May-18</td>
<td>33.51302</td>
<td>-117.26858</td>
</tr>
<tr>
<td></td>
<td>Upper Santa Margarita River</td>
<td>902USM828</td>
<td>30-May-18</td>
<td>33.47335</td>
<td>-117.14344</td>
</tr>
<tr>
<td></td>
<td>Sandia Creek (Reference Site)</td>
<td>902SND100</td>
<td>16-May-18</td>
<td>33.49247</td>
<td>-117.24561</td>
</tr>
<tr>
<td>SMC Regional Stream Survey</td>
<td>Tributary to Sandia Creek (Condition Site)</td>
<td>902M18901</td>
<td>1-May-18</td>
<td>33.49625</td>
<td>-117.20414</td>
</tr>
<tr>
<td></td>
<td>Sandia Creek (Trend Site)</td>
<td>SMC01097</td>
<td>1-May-18</td>
<td>33.48724</td>
<td>-117.25558</td>
</tr>
</tbody>
</table>

Notes:
1. Not sampled because of insufficient flow conditions in 2018
VNS = visited not sampled

Figure 2-1. 2017–2018 Stream Bioassessment Monitoring Sites in the Santa Margarita River Watershed Management Area
2.2 Sample Collection

At each stream site, the sampling team delineated a 150-meter stream reach from which to collect BMI and algae samples and to make physical habitat observations. At the Adobe Creek reference site (902ADB848), the reach was compressed to 100 meters because of difficult conditions upstream; this alteration to the standard method is allowable under the SWAMP protocol. Each monitoring reach was divided into 11 main transects at evenly spaced 15-meter intervals (spaced at 10-meter intervals at the Adobe Creek reference site). Transects were established perpendicular to the direction of stream flow (labeled A through K from downstream to upstream) and were marked with flags along the stream bank. Inter-transects were marked at the midpoint of the 11 main transects (i.e., every 7.5 meters). Water quality parameters were measured near Transect A prior to any sampling. In situ measurements included water temperature, pH, dissolved oxygen (DO), specific conductivity, salinity, and turbidity. All parameters were measured in the field using calibrated instruments. Grab samples were then collected at the SMC sites for chemical analyses of the standard SMC suite of water quality constituents (Table 2-2).

Table 2-2. Chemical Analytes for the Southern California Stormwater Monitoring Coalition’s Regional Bioassessment Monitoring Program

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Reporting Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional and Major Ions</strong></td>
<td></td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>1 mg/L</td>
</tr>
<tr>
<td>Alkalinity as CaCO3</td>
<td>5 mg/L</td>
</tr>
<tr>
<td>Hardness as CaCO3</td>
<td>5 mg/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>1 mg/L</td>
</tr>
<tr>
<td>Sulfate</td>
<td>1 mg/L</td>
</tr>
<tr>
<td><strong>Nutrients</strong></td>
<td></td>
</tr>
<tr>
<td>Ammonia as N</td>
<td>0.1 mg/L</td>
</tr>
<tr>
<td>Nitrogen, Total</td>
<td>0.2 mg/L</td>
</tr>
<tr>
<td>Nitrate + Nitrite as N</td>
<td>0.1 mg/L</td>
</tr>
<tr>
<td>Phosphorus as P</td>
<td>0.05 mg/L</td>
</tr>
<tr>
<td>Orthophosphate as P</td>
<td>0.05 mg/L</td>
</tr>
<tr>
<td><strong>Algal Biomass</strong></td>
<td></td>
</tr>
<tr>
<td>AFDM</td>
<td>1 g/m²</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>10 mg/m²</td>
</tr>
</tbody>
</table>

Notes: AFDM = Ash-Free Dry Mass; CaCO3 = calcium carbonate; g/m² = grams per square meter; mg/L = milligrams per liter; mg/m² = milligrams per square meter; N = nitrogen; P = phosphorus

BMI and algae sampling started at the downstream end of the monitoring reach and progressed upstream to avoid disturbing portions of the creek not yet sampled. BMI and algae samples were collected using the Standard Reach-Wide Benthos (RWB) approach, approximately 1 meter downstream of each main transect, prior to physical habitat parameter assessment, as described below.
Benthic Macroinvertebrate Collection
To collect BMI, a 1-square-foot patch of streambed was sampled at each main transect, rotating locations along each transect between 25 percent (%), 50%, and 75% of the transect width from the bank. Substrates within the delineated patch were agitated so that the associated organisms were dislodged from the substrates. The natural current of the stream carried the dislodged organisms into a 0.5-millimeter (mm) mesh D-frame net positioned immediately downstream of the sampling patch. Samples from all 11 transects were composited and transferred into 1-liter plastic sample jars and preserved with 95% ethanol. The BMI sample was returned to Wood for taxonomic identification.

Benthic Algae Collection
Algae were also collected at each main transect. Algae were removed from substrates using one of three standard area-delimited collection devices, depending on the substrate encountered. The number of times each collection device was used was recorded to quantify the total surface area sampled. In addition to a surface-area-quantified sample, a qualitative sample of soft algae was collected. The qualitative sample consisted of any unique soft algae taxa that were observed within the sampling reach but may have been missed in the transect-limited samples.

The algae sample was processed onsite, creating four subsamples for analysis, including soft-bodied macroalgae, diatoms, ash-free dry mass (AFDM), and chlorophyll-a. The total algae sample composite volume was quantified for calculation of algal biomass per unit area.

2.3 Physical Habitat Quality Assessment
Physical habitat characteristics were assessed once biological sampling was completed. These characteristics are used to document local conditions that may affect the instream biological communities. The primary components of the physical habitat that are assessed include streambed and bank dimensions, substrate composition, stream gradient and sinuosity, riparian vegetation characteristics, flow habitat types, and discharge volume.

To assess the overall riverine wetland habitat quality within the monitoring reach, the California Rapid Assessment Method (CRAM) was also employed (at the SMC sites only). The CRAM protocol assesses 14 separate wetland attributes both instream and stream-side (e.g., in-stream habitat complexity, riparian vegetation, buffer zone width and quality, adjacent land uses, and hydrologic connectivity). CRAM incorporates a broader landscape scope than the SWAMP physical habitat assessment and yields a single score for a site. The range of possible scores is 25 to 100 points, with higher scores representing higher quality wetlands. The scoring system has yet to be calibrated to give categorical ratings such as “Poor” or “Good” that correspond to specific score ranges.

Additional SMC Data Collection
In addition to the standard biological and physical habitat data collected, the SMC work plan calls for assessing several other data types. Analyses of these additional data will be conducted by SCCWRP in the five-year SMC assessment report. Field data sheets were completed for each of these and are included in Appendix A:
- Assessment of Hydrologic States: Flow habitats and the dominant state of discharge in the creek.
- Channel Engineering Checklist: Channel characteristics/substrate and bank composition, and grade control features.
- Hydromodification Physical Habitat Assessment (PHAB) Module: Bank height and angle, median particle size, vertical susceptibility to erosion, and lateral susceptibility to adjustments.
- Vertebrate Observation Reporting Form: Invasive vertebrates and estimated abundance.
- Water Level Loggers: Long-term continuous monitoring of the depth of water within the reach sampled through the dry season for Condition Sites (i.e., until late September/early October), or year-round at Trend sites.

2.4 Laboratory Processing and Analysis

Benthic Macroinvertebrates
Laboratory processing of the BMI samples followed the procedures in the SWAMP Standard Operating Procedures for Laboratory Processing and Identification of Benthic Macroinvertebrates in California (Woodward et al., 2012). Samples were processed so that at least 500 organisms were removed from the sample and the percentage of the sample processed was recorded so that a total abundance for the sample could be estimated. Organisms were identified to standard taxonomic Level II effort, as specified in the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) List of Freshwater Invertebrate Taxa (Richards and Rogers, 2011), using standard taxonomic keys (e.g., Larson et al., 2000; Merritt and Cummins, 1996; Smith, 2001; Thorp and Covich, 2001; Usinger, 1956; Wiggins, 1998).

Benthic Algae
Laboratory processing of the algae samples followed the procedures in the SWAMP Standard Operating Procedures for Laboratory Processing, Identification, and Enumeration of Stream Algae (Stancheva et al., 2015). The procedure includes a standard numerical count of 600 valves per sample for diatoms while macroalgae, microalgae, and epiphytes are quantified as biovolume per unit area.

Algal biomass samples were processed by an analytical laboratory using methods SM10300C (M) and A10200H for AFDM and chlorophyll-a, respectively.

2.5 Data Analysis

Benthic Macroinvertebrates
A taxonomic list of BMI identified from the samples was created using Microsoft Excel and included the designated tolerance value (TV) and functional feeding group (FFG) of each taxon. BMI community-based biological metric values were calculated from the data.

In addition to the individual metric values, two multi-metric community summary indices were calculated: the southern California Index of Biotic Integrity (IBI) and the California Stream Condition Index (CSCI). The IBI is a quantitative scoring system for assessing the quality of benthic macroinvertebrate assemblages (Ode et al., 2005). The multi-metric IBI distills seven key
measures of organism abundance, diversity, and function into a single composite score that varies predictably in response to stressors. The IBI was developed using a multi-year comprehensive assessment of reference and nonreference conditions in southern California to establish an expected range of BMI community structure in the region.

The recently developed CSCI is a California statewide index (Mazor et al., 2016). This index is considered an improvement over the southern California IBI because it incorporates predictors of the natural ecological conditions throughout California that could affect BMI community composition based on natural gradients. These predictors include latitude, elevation, watershed area, mean annual precipitation, and mean annual temperature. CSCI scores are based on a reference stream expectation score of 1.0 (i.e., the mean for all reference sites statewide) and biological condition classes are set statistically from that benchmark. Although no official regulatory benchmarks have been set based on the CSCI, Mazor et al. (2016) considered the top two condition classes (i.e., a CSCI score ≥ 0.79) to be statistically similar to reference condition, with scores below 0.79 to be likely altered from reference.

The CSCI score is the mean of two indices of biological condition: (1) a predictive multi-metric index of biotic integrity (pMMI), and (2) a ratio of the observed taxa at a site to the expected taxa at a site (O/E). The multi-metric index incorporates six separate metrics that have a linear response to environmental stressors. The metrics selected decrease in response to impairment of water quality and/or physical habitat. The O/E index is based on the probability of capture of individual organisms in response to stream-specific conditions. Using the combination of a multi-metric index and an O/E index improves the accuracy over using the two individually, because experience has shown that both have limitations when assessing unusual BMI assemblages or sites with unique natural conditions.

**Benthic Algae**
A Microsoft Excel taxonomic list of benthic algae taxa identified from the samples was created to calculate biological metric values and diagnostic metrics for specific ecological conditions. The metrics were recently developed and validated for southern California, as were three algal IBIs specific to the region (Fetscher et al., 2014). The IBIs are presented in three versions: the S2, which assesses soft algae and cyanobacteria; the D18, which assesses diatoms; and the H20, which is a combination of the S2 and the D18 IBIs. The IBI metrics are each on a scale of 0 to 10, while final IBI scores are on a scale of 0 to 100, with higher values representing higher quality algal communities. These algal analysis tools have not yet been integrated into regulatory policy, and therefore care must be taken when interpreting and discussing the results.

### 2.6 SMC Data Submission

Data generated from the field and laboratory efforts will be submitted to the SMC Program Data Manager at SCCWRP in standard format Microsoft Excel spreadsheets created specifically for the program, or through web-based entry interfaces. Physical habitat data will be entered into a Microsoft Access format database and submitted to the SMC Data Manager; CRAM data will be entered into an on-line eCRAM data portal that is accessible by the SMC Data Manager. All applicable SMC data will then be uploaded to the California Environmental Data Exchange Network (CEDEN) state-wide database by the SCCWRP Data Manager.
3.0 RESULTS AND DISCUSSION—BIOASSESSMENT

This section summarizes the results of the 2017–2018 Bioassessment Surveys. Tables listing complete results are provided in Appendix B.

3.1 Benthic Invertebrate Community Summary

A total of 102 distinct taxa representing 3,994 individual organisms were identified from the monitoring sites. The amphipod, *Hyalella* sp., was the most abundant organism across sites, with 370 individuals (9.3%), followed by the midge, *Parametriocnemus* sp., with 346 individuals (8.7%), and Ostracoda (seed shrimp), with 282 individuals (7.1%). Organism abundance, which represents the total number of organisms in 11 square feet (ft²) of stream substrate sampled, ranged from 1,274 organisms at the unnamed tributary to Sandia Creek SMC condition site to 5,000 at the Lower Murrieta Creek site.

3.2 Benthic Macroinvertebrate Community Metrics

The section summarizes the BMI community metrics for the monitored sites.

*Species Diversity and Dominance*

Macroinvertebrate taxa richness ranged from 27 taxa at the Lower Temecula Creek site to 45 taxa at the Sandia Creek SMC site. Dominance by a single taxon was relatively low to moderate at all of the sites, with a maximum of 37.7% at the Lower Murietta Creek site (*Hyalella* sp.), and a minimum of 17.1% at the Sandia Creek reference site (*Simulium* sp.). It is not uncommon for impaired streams to have greater than 80% dominance by a single taxon.

*Ephemeroptera, Plecoptera, and Trichoptera Taxa*

Most insects in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) are considered sensitive, and do not tolerate poor water quality conditions, but some from this group are moderately tolerant to impairment (e.g., the mayfly *Baetis adonis*). The presence of EPT taxa ranged from one taxon at the Lower Temecula Creek site (*Baetis* sp.) to 12 taxa at the Sandia Creek reference site.

*Tolerance Measures*

For most of the stream BMI, a TV has been determined for each taxon through prior research on the animals’ life history (e.g., Hilsenhoff, 1987). These TVs rank BMI taxa on a scale of 0 to 10 in terms of their sensitivity to impairment, with a TV of 0 given to taxa that are highly sensitive to habitat or water quality impairment and a TV of 10 given to those that are very tolerant. While organisms with a high TV can be found in streams with good water and habitat quality, they tend to be a smaller proportion of the community. Conversely, taxa with low TVs (i.e., sensitive organisms) will very rarely be found at sites with poor water or habitat quality.

The Hilsenhoff Biotic Index (an abundance-weighted mean community TV) ranged from 5.52 at the Upper Santa Margarita River site to 6.97 at the Lower Murrieta Creek site. Highly intolerant (i.e., sensitive) organisms (TV of 0–2) were present at all sites except the Lower Temecula Creek
site, but were not abundant at any site, with a maximum of 3.7% of the community at the Sandia Creek SMC trend site. Every site had substantial numbers of organisms with moderate TVs (TV of 4–6), which indicated that none of the sites receive high levels of pollutants.

**Functional Feeding Groups**
As with TV, FFG designations have been determined through prior research of life history for each taxon. A healthy assemblage will typically contain a more even distribution of FFG, while dominance of the community by a single FFG, particularly collector taxa, suggests that the stream may not support a diversity of ecological niches and may be a general indicator of poor community health. Collector-gatherers dominated every site monitored with percentages that ranged from 64.0% at Adobe Creek to 87.2% at Lower Temecula Creek. Collector-gatherers feed on fine particulate organic detritus, algae, and various micro-organisms (Smith, 2001; Usinger, 1956) and are often associated with high levels of urbanization and runoff (Lenat and Crawford, 1994).

### 3.3 Physical Habitat Quality Assessment

Section 5 discusses the physical habitat characteristics of each monitoring site individually. The monitoring sites were all in natural stream channels with riparian zones ranging from moderately to minimally altered. Summaries of the habitat characteristics at the monitoring sites are provided in Appendix B. The SWAMP field data sheets containing physical habitat observations, as well as the CRAM field data sheets for the SMC sites, are provided in Appendix A. Densiometer readings were converted to percent vegetative cover according to the procedures outlined in Strickler (1959).

### 3.4 Water Quality

In situ water quality measurements taken in the field at the time of sampling are presented in Table 3-1, and analytical results for the chemistry samples for the SMC sites are provided in Appendix B. The chemistry results were elevated for several constituents at the SMC Sandia Creek trend site and the SMC tributary to the Sandia condition site, including specific conductivity (1,842 and 1,655 microSiemens per centimeter [µS/cm], respectively), chloride (280 and 240 milligrams per liter [mg/L], respectively) and sulfate (350 and 310 mg/L, respectively). Total nitrogen concentrations were also somewhat elevated at these two sites. These constituents may not have impacted BMI community quality, but there was likely an effect on algal community composition (see discussion in Section 5). In addition, the Lower Temecula Creek and the Sandia Creek reference MS4 sites exhibited specific conductivity measurements of 2,040 and 1,967 µS/cm, respectively, which may have limited some of the more sensitive BMI. Lower Temecula Creek also had a relatively low dissolved oxygen content at the time of sampling (2.1 mg/L), which could be the result of flow this site at the time of sampling consisting of 100% groundwater seepage (see Section 5.1).
Table 3-1. Summary of 2017–2018 Physical Water Quality Parameter Measurements

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Lower Temecula Creek</th>
<th>Lower Murrieta Creek</th>
<th>Redhawk Channel</th>
<th>Adobe Creek (Reference)</th>
<th>Upper Santa Margarita River</th>
<th>Sandia Creek (Reference)</th>
<th>Upper Sandia Creek (SMC Condition)</th>
<th>Sandia Creek (SMC Trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Code</td>
<td>902LTC777</td>
<td>902LMC778</td>
<td>902RDH768</td>
<td>902ADB848</td>
<td>902USM828</td>
<td>902SND100</td>
<td>902M18</td>
<td>SMC01097</td>
</tr>
<tr>
<td>Water Temperature (°C)</td>
<td>16.0</td>
<td>19.7</td>
<td>NS</td>
<td>13.9</td>
<td>21.2</td>
<td>18.3</td>
<td>13.2</td>
<td>13.7</td>
</tr>
<tr>
<td>pH</td>
<td>6.96</td>
<td>7.77</td>
<td>NS</td>
<td>7.40</td>
<td>8.75</td>
<td>8.06</td>
<td>7.76</td>
<td>8.34</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>2.1</td>
<td>7.7</td>
<td>NS</td>
<td>4.4</td>
<td>8.4</td>
<td>9.1</td>
<td>8.9</td>
<td>10.9</td>
</tr>
<tr>
<td>Specific Conductivity (μS/cm)</td>
<td>2040</td>
<td>1013</td>
<td>NS</td>
<td>455</td>
<td>973</td>
<td>1967</td>
<td>1655</td>
<td>1842</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>0.6</td>
<td>1.2</td>
<td>NS</td>
<td>1.7</td>
<td>1.3</td>
<td>2.0</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>1.05</td>
<td>0.50</td>
<td>NS</td>
<td>0.22</td>
<td>0.48</td>
<td>1.01</td>
<td>0.84</td>
<td>.94</td>
</tr>
</tbody>
</table>

Notes:
°C = degrees Celsius; μS/cm = microSiemens per centimeter; mg/L = milligrams per liter; NS = insufficient flow, not sampled; NTU = nephelometric turbidity unit; ppt = parts per thousand; SMC = Stormwater Monitoring Coalition
3.5 BMI Community Summary Indices

Two indices were used to assess the overall quality of the BMI communities at the bioassessment monitoring sites: the southern California IBI and the CSCI. The results of these calculations are presented below.

Southern California Index of Biotic Integrity
Table 3-2 shows the seven metrics used to calculate the IBI scores in accordance with Ode et al. (2005) The table also provides the scoring ranges for each metric and the qualitative ratings (i.e., Very Poor, Poor, Fair, Good, and Very Good). Each of the seven metric values is given a score from 0 to 10, and the scores are added to give the total IBI score. The cumulative total is then standardized to a scale of 0–100 by multiplying the raw score by 1.43. Each final score is then classified into the five quality rating categories.

<table>
<thead>
<tr>
<th>Metric Score</th>
<th>Number Coleoptera Taxa</th>
<th>Number EPT Taxa</th>
<th>Number Predator Taxa</th>
<th>Percent CF+CG Individuals</th>
<th>Percent Intolerant Individuals</th>
<th>Percent Non-Insect Taxa</th>
<th>Percent Tolerant Taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>&gt;5</td>
<td>&gt;17</td>
<td>&gt;12</td>
<td>0–59</td>
<td>25–100</td>
<td>0–8</td>
<td>0–4</td>
</tr>
<tr>
<td>9</td>
<td>16–17</td>
<td>12</td>
<td>60–63</td>
<td>23–24</td>
<td>9–12</td>
<td>5–8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>15</td>
<td>64–67</td>
<td>21–22</td>
<td>13–17</td>
<td>9–12</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>13–14</td>
<td>68–71</td>
<td>19–20</td>
<td>18–21</td>
<td>13–16</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>11–12</td>
<td>9</td>
<td>72–75</td>
<td>16–18</td>
<td>22–25</td>
<td>17–19</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>9–10</td>
<td>76–80</td>
<td>13–15</td>
<td>26–29</td>
<td>20–22</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7–8</td>
<td>8</td>
<td>81–84</td>
<td>10–12</td>
<td>30–34</td>
<td>23–25</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5–6</td>
<td>6</td>
<td>85–88</td>
<td>7–9</td>
<td>35–38</td>
<td>26–29</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>5</td>
<td>89–92</td>
<td>4–6</td>
<td>39–42</td>
<td>30–33</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2–3</td>
<td>4</td>
<td>93–96</td>
<td>1–3</td>
<td>43–46</td>
<td>34–37</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–3</td>
<td>97–100</td>
<td>0</td>
<td>47–100</td>
<td>38–100</td>
</tr>
</tbody>
</table>

Notes:
Total IBI Score Quality Ratings (source: Ode et al., 2005):
- Very Poor: 0–19
- Poor: 20–39
- Fair: 40–59
- Good: 60–79
- Very Good: 80–100

CF+CG = collector filterers plus collector gatherers; EPT = Ephemeroptera, Plecoptera, and Trichoptera

The IBI is quite accurate at broadly identifying stream impairment, which is defined as the cutoff between the Poor and Fair categories (score of ≤39). Small differences in IBI scores are not significant and may be due to natural biological variability within a stream reach. Ode et al. (2005) determined that the “minimum detectable difference” between scores is approximately 13 points; therefore, a site score must be at least 13 points higher or lower to be considered of significantly higher or lower quality than another. The total IBI scores and community quality ratings for each site are presented in Table 3-3 and the complete results, including individual metric values and scores, are presented in Appendix B.
The IBI rated two of the bioassessment monitoring sites above the impairment threshold of 39 points and five sites as impaired (Table 3-3). The IBI scores ranged from 9 (Very Poor) at the Lower Murrieta Creek site to 54 (Fair) at the Sandia Creek SMC trend site. The Adobe Creek reference site was also above the impairment threshold with an IBI score of 41. The Sandia Creek reference site was at the margin of the impairment threshold with a score of 39.

Table 3-3. Summary of 2017–2018 SMR Watershed Southern California IBI Scores

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Code</th>
<th>Overall SoCal IBI Score</th>
<th>Categorical Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Temecula Creek</td>
<td>902LTC777</td>
<td>14</td>
<td>Very Poor</td>
</tr>
<tr>
<td>Lower Murrieta Creek</td>
<td>902LMC778</td>
<td>9</td>
<td>Very Poor</td>
</tr>
<tr>
<td>Redhawk Channel</td>
<td>902RDH768</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Adobe Creek (Reference)</td>
<td>902ADB848</td>
<td>41</td>
<td>Fair</td>
</tr>
<tr>
<td>Upper Santa Margarita River</td>
<td>902USM828</td>
<td>21</td>
<td>Poor</td>
</tr>
<tr>
<td>Sandia Creek (Reference)</td>
<td>902SND100</td>
<td>39</td>
<td>Poor</td>
</tr>
<tr>
<td>Tributary to Sandia Creek</td>
<td>902M18901</td>
<td>34</td>
<td>Poor</td>
</tr>
<tr>
<td>(SMC Condition)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandia Creek (SMC Trend)</td>
<td>SMC01097</td>
<td>54</td>
<td>Fair</td>
</tr>
</tbody>
</table>

Notes:
1. Sum of individual SoCAL IBI metric scores multiplied by 1.43 and rounded to the nearest whole number to convert to a 100-point scale.
NS = not sampled; SMC = Stormwater Monitoring Coalition

California Stream Condition Index

BMI condition categories for the CSCI set statistically from the 1.0 reference benchmark are presented in Table 3-4. Summary CSCI scores are presented in Table 3-5 and more complete documentation of the CSCI calculation results is presented in Appendix B. The results contrasted with the southern California IBI ratings for several sites, with the CSCI rating the sites in better condition than the IBI did. For the Upper Santa Margarita River site, the Sandia Creek reference site, and the SMC tributary to Sandia Creek condition site, the CSCI rated these as statistically similar to reference (i.e., Likely Intact or Possibly Altered) while the IBI rated the sites below reference (i.e., Poor). The CSCI categorized Adobe Creek as likely impaired, while the IBI rated it as similar to reference (i.e., Fair). The remaining sites had both indices in agreement as Likely Impaired (Lower Murrietta and Lower Temecula Creeks) or Likely Unimpaired (Sandia Creek trend site).
Table 3-4. Condition Category Thresholds for the California Stream Condition Index

<table>
<thead>
<tr>
<th>Condition Category</th>
<th>CSCI Scoring Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely Intact</td>
<td>≥0.92</td>
</tr>
<tr>
<td>Possibly Altered</td>
<td>0.79 to 0.91</td>
</tr>
<tr>
<td>Likely Altered</td>
<td>0.63 to 0.78</td>
</tr>
<tr>
<td>Very Likely Altered</td>
<td>0.00 to 0.62</td>
</tr>
</tbody>
</table>

Notes:
Source: Mazor et al., 2016
CSCI = California Stream Condition Index

Table 3-5. Summary of 2017–2018 California Stream Condition Index Scores

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Code</th>
<th>Condition Category</th>
<th>Final CSCI Score</th>
<th>O/E Score</th>
<th>pMMI Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Temecula Creek</td>
<td>902LTC777</td>
<td>Likely Altered</td>
<td>0.74</td>
<td>1.11</td>
<td>0.36</td>
</tr>
<tr>
<td>Lower Murrieta Creek</td>
<td>902LMC778</td>
<td>Very Likely Altered</td>
<td>0.57</td>
<td>0.58</td>
<td>0.55</td>
</tr>
<tr>
<td>Redhawk Channel</td>
<td>902RDH768</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Adobe Creek (Reference)</td>
<td>902ADB848</td>
<td>Likely Altered</td>
<td>0.74</td>
<td>0.79</td>
<td>0.68</td>
</tr>
<tr>
<td>Upper Santa Margarita River</td>
<td>902USM828</td>
<td>Possibly Altered</td>
<td>0.88</td>
<td>1.08</td>
<td>0.67</td>
</tr>
<tr>
<td>Sandia Creek (Reference)</td>
<td>902SND100</td>
<td>Likely Intact</td>
<td>1.13</td>
<td>1.30</td>
<td>0.97</td>
</tr>
<tr>
<td>Tributary to Sandia Creek (SMC</td>
<td>902M18901</td>
<td>Likely Intact</td>
<td>1.03</td>
<td>1.14</td>
<td>0.93</td>
</tr>
<tr>
<td>Condition)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandia Creek (SMC Trend)</td>
<td>SMC01097</td>
<td>Likely Intact</td>
<td>1.02</td>
<td>1.10</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Notes:
1 - Final CSCI scores are the average of the O/E and pMMI scores.
CSCI = California Stream Condition Index; NS = not sampled because of insufficient flow conditions; O/E = ratio of observed to expected taxa; pMMI = predictive multi-metric index.

Similar to the 2017 results, the CSCI scores for all sites had an O/E index score higher than the pMMI score. This result is particularly notable for the Lower Temecula Creek and the Upper Santa Margarita River sites, which had O/E scores that were above the mean of reference (1.0), while the pMMI scores for these two sites were below the 0.79 CSCI threshold of Likely Altered with scores of 0.36 and 0.67 for the Lower Temecula Creek and Upper Santa Margarita River sites, respectively.
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4.0 BENTHIC ALGAE

Analytical results for the seven benthic algae samples collected for the SMC and MS4 Receiving Water Monitoring programs are presented below. Full taxa lists of both soft algae and diatoms are provided in Appendix B.

Algae are good indicators of water quality conditions, notably nutrient and organic enrichment, and also indicate major ion, dissolved oxygen, and stream microhabitat conditions. The autecology (i.e., the physiological optima and tolerance of algal species for various water quality contaminants and conditions) is relatively well understood for certain groups of freshwater algae, particularly diatoms. These algal characteristics are used to help understand the condition of a river or stream, particularly in association with other stream health indicators.

Algal IBIs specific to the South Coast Region were calculated to assess the biotic integrity of the algal communities (Fetscher et al., 2014). Table 4-1 summarizes the algal IBI scores for the sites sampled. Algal IBI scores have not yet been calibrated to provide qualitative rankings or impairment thresholds, and a statewide algal IBI is currently under development by SCCWRP.

The S2 soft algal community IBI scores ranged from 33 at the SMC condition site to 87 at the Adobe Creek reference site. The Sandia Creek reference site did not have sufficient taxonomic diversity of soft algae to calculate the S2 IBI. Based on the taxa list at the Sandia Creek reference site, three of the four soft algae identified in 2018 were in the qualitative fraction, which is ignored in the calculation of the S2 index. The remaining taxa, Heteroleibleinia sp 1, is not recognized by the algae IBI calculator because it is a new morphospecies. Hence, the calculator was unable to assign trait attributes to any of the taxa in the list and therefore unable to calculate the S2 index score.

In contrast, the calculator was able to determine a combined overall IBI H20 score because the H20 score does include the qualitative fraction in its calculations. The diatom D18 IBI scores ranged from 24 at the Lower Temecula Creek site to 72 at the Lower Murrieta Creek site. Overall combined H20 algal IBI scores ranged from 38 at the Sandia Creek reference site to 75 at the Adobe Creek site.
Table 4-1. Summary of 2017–2018 Algal IBI Scores

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Lower Temecula Creek</th>
<th>Lower Murrieta Creek</th>
<th>Redhawk Channel</th>
<th>Adobe Creek (Reference)</th>
<th>Upper Santa Margarita River</th>
<th>Sandia Creek (Reference)</th>
<th>Tributary to Sandia Creek SMC Condition</th>
<th>Sandia Creek SMC Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Code</td>
<td>902LTC777</td>
<td>902LMC778</td>
<td>902RDH768</td>
<td>902ADB848</td>
<td>902USM828</td>
<td>902SND100</td>
<td>902M18901</td>
<td>SMC01097</td>
</tr>
<tr>
<td>Soft Algae and Cyanobacteria IBI: S2</td>
<td>62</td>
<td>45</td>
<td>NS</td>
<td>87</td>
<td>40</td>
<td>UTC</td>
<td>33</td>
<td>52</td>
</tr>
<tr>
<td>Diatoms IBI: D18</td>
<td>24</td>
<td>72</td>
<td>NS</td>
<td>68</td>
<td>62</td>
<td>60</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>Combined Overall IBI: H20</td>
<td>44</td>
<td>68</td>
<td>NS</td>
<td>75</td>
<td>56</td>
<td>38</td>
<td>53</td>
<td>64</td>
</tr>
</tbody>
</table>

Notes:
IBI = South Coast Index of Biotic Integrity; NS = not sampled; UTC = unable to calculate, insufficient taxa for calculations
Individual algal biotic metric values that compose the algal IBI scores are presented in Appendix B. These values are on a 0- to 10-point scale from the raw metric values (which may increase or decrease in response to impairment), with higher values representing healthier algal ecological conditions.

Basic algal community summary metrics are presented in Table 4-2. The Sandia Creek reference site had the fewest number of unique taxa (33), and the Lower Temecula Creek site had the highest (65). The SMC condition site had the highest taxa richness for diatoms, while the Lower Temecula Creek site had the highest taxa richness for soft algae. Diatom taxa richness and soft algae taxa richness were both lowest at the Sandia Creek reference site.

Total soft algal biovolume, a measure of the estimated mass of soft algae in the entire sampling reach, was much lower at the Adobe Creek reference site than at any other site monitored. The Upper Santa Margarita River site had the greatest total algal biovolume. At most sites, *Cladophora glomerata* was the dominant soft alga by volume, with the exception of the Adobe Creek reference site, where pollutant-intolerant *Vaucheria* sp 1 was the dominant taxon, and the Sandia Creek Reference site, where *Heteroleibleinia* sp 1 was the dominant taxon.
Table 4-2. Summary of 2017–2018 Algal Community Metrics

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Lower Temecula Creek</th>
<th>Lower Murrieta Creek</th>
<th>Redhawk Channel¹</th>
<th>Adobe Creek (Reference)</th>
<th>Upper Santa Margarita River</th>
<th>Sandia Creek (Reference)</th>
<th>Tributary to Sandia Creek SMC Condition</th>
<th>Sandia Creek SMC Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Code</td>
<td>902LTC777</td>
<td>902LMC778</td>
<td>902RDH768</td>
<td>902ADB848</td>
<td>902USM828</td>
<td>902SND100</td>
<td>902M18901</td>
<td>SMC01097</td>
</tr>
<tr>
<td><strong>All Algae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Taxa Richness</td>
<td>65</td>
<td>63</td>
<td>NS</td>
<td>63</td>
<td>47</td>
<td>33</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td><strong>Diatoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxa Richness</td>
<td>30</td>
<td>37</td>
<td>NS</td>
<td>38</td>
<td>32</td>
<td>29</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Dominant Taxon</td>
<td><em>Navicula gregaria</em></td>
<td><em>Cocconeis placentula</em></td>
<td>NS</td>
<td><em>Planothidium frequentissimum</em></td>
<td><em>Cocconeis placentula</em></td>
<td><em>Cocconeis placentula var euglypta</em></td>
<td><em>Cocconeis placentula</em></td>
<td><em>Cocconeis placentula</em></td>
</tr>
<tr>
<td>Dominant Taxon Abundance</td>
<td>176</td>
<td>102</td>
<td>NS</td>
<td>116</td>
<td>102</td>
<td>198</td>
<td>111</td>
<td>177</td>
</tr>
<tr>
<td>Dominant Taxon Percent</td>
<td>29.3</td>
<td>17.0</td>
<td>NS</td>
<td>19.3</td>
<td>17.0</td>
<td>33.0</td>
<td>18.5</td>
<td>29.5</td>
</tr>
<tr>
<td><strong>Soft Algae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxa Richness</td>
<td>35</td>
<td>26</td>
<td>NS</td>
<td>25</td>
<td>15</td>
<td>4</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Dominant Taxon by Volume</td>
<td><em>Cladophora glomerata</em></td>
<td><em>Cladophora glomerata</em></td>
<td>NS</td>
<td><em>Vaucheria sp 1</em></td>
<td><em>Cladophora glomerata</em></td>
<td><em>Heteroleibleinia sp 1</em></td>
<td><em>Cladophora glomerata</em></td>
<td><em>Cladophora glomerata</em></td>
</tr>
<tr>
<td>Dominant Taxon Volume Percent</td>
<td>57.5</td>
<td>85</td>
<td>NS</td>
<td>49</td>
<td>99.9</td>
<td>100</td>
<td>82.7</td>
<td>98.7</td>
</tr>
<tr>
<td>Total Biovolume (µm³/cm²) / 10,000,000</td>
<td>1,732</td>
<td>9,143</td>
<td>NS</td>
<td>41.1</td>
<td>132,067</td>
<td>529</td>
<td>11,611</td>
<td>75,767</td>
</tr>
</tbody>
</table>

Notes:
1. Not sampled because of insufficient flow conditions.

µm³/cm² = cubic micrometers per square centimeter; NS = not sampled
Diatom Autecology Indicators

Algal species considered pollution-tolerant (e.g., polysaprobous and α-mesosaprobous) are often found in higher abundance in streams with poor water and habitat quality; however, these taxa can also be found in higher-quality streams. Conversely, taxa considered sensitive or pollution-intolerant (e.g., oligosaprobous and β-mesosaprobous taxa) will very rarely be found at sites with poor water or habitat quality.

The Lower Temecula Creek site and Adobe Creek reference site contained a significantly lower proportion of pollution-intolerant algae taxa (oligosaprobous and β-mesosaprobous taxa) than other sites monitored (metric score range 0 and 2, respectively). The two dominant diatom taxa at these sites, *Navicula gregaria* and *Planothidium frequentissimum*, respectively, also display many of the same diagnostic characteristics as high nitrogen indicators, are moderately tolerant to pollutants, and are eutraphentic (indicative of eutrophic conditions). However, pollution-intolerant taxa composed a much higher proportion of the communities at the other sites (metric score range 6 to 9), indicating good water quality conditions. The proportion of non-reference soft algae indicator taxa at Adobe Creek was low (metric score of 10).

*Cocconeis pediculus*, a β-mesosaprobous (pollution-intolerant) taxa, was the dominant diatom taxon at all other sites, indicating good water quality. These organisms are generally found in increased abundance at higher-quality sites. This taxon is considered a low total nitrogen indicator that is somewhat intolerant to nutrient and organic enrichment.

Algal Biomass

Algal biomass measures of chlorophyll-a and AFDM exhibited a moderate range of conditions. Chlorophyll-a concentrations ranged from 30.3 milligrams per square meter (mg/m²) at the Adobe Creek reference site to 173.5 mg/m² at the Sandia Creek reference site, while AFDM ranged from 30.7 grams per square meter (g/m²) at the Lower Murrieta Creek site to 72.5 g/m² at the Adobe Creek reference site. This condition of Adobe Creek exhibiting the highest AFDM, while also exhibiting the lowest Chlorophyll-a concentration, has been observed in previous monitoring years at this site. The large amount of leaf litter within the streambed at this site accounts for its high AFDM, because AFDM measures all organic matter, whether it is algae or not. These two measures together indicate high organic matter, but lower algal biomass.
<table>
<thead>
<tr>
<th>Site Name</th>
<th>Lower Temecula Creek</th>
<th>Lower Murrieta Creek</th>
<th>Redhawk Channel (Reference)</th>
<th>Adobe Creek (Reference)</th>
<th>Upper Santa Margarita River</th>
<th>Sandia Creek (Reference)</th>
<th>Tributary to Santa Margarita River (SMC Condition)</th>
<th>Sandia Creek (SMC Trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Code</td>
<td>902LTC777 902LMC778</td>
<td>902RDH768 902ADB848</td>
<td>902USM828 902SND100 902M18</td>
<td>SMC01097</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorophyll-a (mg/m²)</td>
<td>119.9</td>
<td>136.7</td>
<td>NS</td>
<td>30.3</td>
<td>112.8</td>
<td>173.5</td>
<td>129.9</td>
<td>165.9</td>
</tr>
<tr>
<td>Ash-free Dry Mass (g/m²)</td>
<td>33.2</td>
<td>30.7</td>
<td>NS</td>
<td>72.5</td>
<td>31.8</td>
<td>41.3</td>
<td>41.5</td>
<td>69.7</td>
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</table>

Notes:
g/m² = grams per square meter; mg/m² = milligrams per square meter; NS = not sampled; SMC = Stormwater Monitoring Coalition
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5.0 INDIVIDUAL MONITORING SITE RESULTS

This section presents the major findings from each individual site that was sampled.

5.1 Lower Temecula Creek Site, 902LTC777

The source of dry weather flows at the Lower Temecula Creek mass loading station (MLS) was observed to be rising groundwater. Although flows in Redhawk Channel, which is tributary to Lower Temecula Creek, were observed to be derived from MS4 discharges (see below), they infiltrated or evaporated prior to reaching Lower Temecula Creek.

Lower Temecula Creek is a sand-dominated stream with low-quality instream habitat. Sparse patches of filamentous algae, aquatic macrophytes (primarily cattails [Typha sp.] and bulrush [Scirpus sp.]), small woody debris, and some fine willow tree roots were found throughout the reach. The stream had a relatively straight flow path that was dominated by glides (shallow, slow water). In contrast to previous years, there was some new pool (>0.5-meter, slow flow) habitat at the downstream end of the sampling reach. The upper riparian canopy was heavy throughout the reach; the lower canopy and ground cover vegetation exhibited moderate to heavy coverage. Observed human influences near the creek included a golf course within 50 meters of the left bank and a bridge abutment 50 meters downstream of Transect A. The reach appeared to have some regular human visitation, as evidenced by a well-used path along the north stream bank.
The BMI community was rated Very Poor by the IBI and had a CSCI rating of Likely Altered. The community was dominated by midges in the family Chironomidae; however, baetid mayflies, common at the site in historical surveys, were rare. The community was likely limited by the unconsolidated sandy substrates (85% of the reach) and lack of cobble, woody debris, or other instream habitat types. Specific conductivity, with a concentration of 2,040 micrograms per liter (µg/L), may also have limited taxa sensitive to high ionic strength.

The algae community exhibited IBI scores of 62 (soft algae), 24 (diatoms), and 44 (combined overall) (Table 4-1). The diatom IBI value was the lowest of all the monitoring sites. Individual metrics of the algal community indicated that there were few taxa present that indicate low nitrogen and phosphorus levels, and few pollution-intolerant taxa or those indicative of high dissolved oxygen conditions.

Several notable habitat changes were observed relative to the previous monitoring year:

- Flow volume decreased from 0.12 cubic foot per second (ft³/sec) to 0.01 ft³/sec.
- Coarse particulate organic matter increased from 35.2% of the reach to 61.9%.
- Macroalgal coverage increased from 1% of the reach to 22.9%.
- The soft algae IBI increased from 33 to 62.
The source of dry weather flows at the Lower Murrieta Creek MLS was observed to be rising groundwater; there was no evidence of flow contribution from the MS4 during sampling activities. A large section of dry creek bed was observed just upstream of the sampled reach.

Lower Murrieta Creek is dominated by bedrock in the sampling reach, with very little cobble or interstitial niche space. The instream habitat included areas of floating filamentous algae, some willow tree roots, and several dense patches of aquatic macrophytes (primarily the bulrush, *Scirpus* sp.). The sinuosity ratio was 1.07, indicating low sinuosity (i.e., stream meandering). The water path does tend to change direction regularly within the bankfull contours; however, it is following small depressions in the bedrock and does not exhibit the typical meandering pattern of a typical stream system. The creek flow was dominated by glides (shallow, slow) and deep pools, with low flow volume (0.197 ft³/sec). Overhead and upper riparian canopy was sparse (9.5% of the reach) and was generally well away from the wetted area. Lower canopy and ground cover vegetation exhibited moderate coverage along the banks.

Observed human influences included a cleared lot within 50 meters of the left bank, an unpaved road within 50 meters of the right bank, a small transient encampment within 50 meters of Transect A on the left bank, and several pieces of trash throughout the reach.
The BMI community was rated Very Poor by the IBI and had a CSCI rating of Very Likely Altered. The BMI community may have been limited by the predominance of slow, deep water and lack of riffle habitat and layered cobble. The community was dominated by the collector taxa *Hyalella* sp. and ostracods, which can indicate a high amount of fine particulate organic matter. The most notable taxon collected was the sensitive caddisfly, *Tinodes* sp.

The algae community had IBI scores of 45 (soft algae), 72 (diatoms), and 68 (combined overall) (Table 4-1). The diatom IBI value was the highest of the monitoring sites. Individual metrics of the IBI indicated moderate to good water quality conditions for most of the metrics, with the exception of low total Phosphorus indicator taxa and some soft algae metrics.

Relative to the 2017 monitoring year:

- Macroalgal coverage increased from 63.8% to 87.6%.
- The soft algae IBI decreased from 62 to 45.
5.3 Redhawk Channel Site, 902RDH768

In spring 2018, Redhawk Channel had insufficient flow at the time of the scheduled bioassessment. A small amount of water was observed to be ponded, but there was no observable surface flow. The site was also had insufficient flow in 2016 and 2017 at the time of the site visits.

Redhawk Channel (902RDH768) visited 4/30/2018
5.4 Adobe Creek Reference Site, 902ADB848

The Adobe Creek reference site is located within the Santa Rosa Plateau Ecological Reserve at an elevation of approximately 1,800 feet, west of the City of Murrieta. Dry weather flows at this reference site were observed to be from rising groundwater; there was no evidence of any other contributing flows. As a reference site, Adobe Creek was chosen to represent conditions that have little to no anthropogenic influence.

In-stream conditions in Adobe Creek were similar to those observed during the previous year of sampling, with a moderate amount of oak leaf litter and fallen branches in the streambed. The substrate in Adobe Creek was composed of a variety of substrate types, including fines, sand, gravel, cobble, and boulders. Instream habitat complexity was high and was composed of a mixture of patch types, including macrophytes, filamentous algae, small and large woody debris, live tree roots, undercut banks, and overhanging vegetation. The stream path was minimally sinuous (sinuosity ratio of 1.06) and consisted of flow habitats dominated by glides (shallow, slow). Flow
volume at the Adobe Creek reference site was very low and could not be measured accurately. Overhead and upper riparian canopy cover was moderate (73% of the reach), with moderate coverage of lower vegetative layers.

The BMI community was rated Fair by the IBI and Likely Altered by the CSCI; thus, the creek was within the reference range for the IBI, but just below reference range for the CSCI. Habitat and water quality were not limiting factors in BMI community quality. The community was dominated by the mayfly, *Paraleptophlebia* sp. (37% of the community) and the pollution-tolerant snail, *Physa* sp. (21% of the community), an opportunistic organism that was well suited to the slow currents and rocky substrates. Strong signals of a high-quality BMI community included a low percentage of collector taxa and high diversities of beetles and predators. The community had four different BMI taxa that are considered highly sensitive to impairment, although none were present in high abundance.

The algae community had IBI scores of 87 (soft algae), 68 (diatoms), and 75 (combined overall) (Table 4-1). These values indicated the highest quality algal community relative to other sites monitored. Most of the individual metrics of the IBI signaled good water quality conditions, with the exception of the proportion of *Achnanthes minutissima* (a nutrient sensitive taxa), oligo- and beta-mesosaprobic taxa, and taxa requiring high DO saturation.

Relative to the 2017 monitoring period:

- The number of sensitive BMI taxa decreased from eight to four taxa.
- Coarse particulate organic matter increased from 63.8% to 84.8%.
- The soft algae IBI increased from 55 to 87 and the combined IBI increased from 59 to 75.
5.5 Upper Santa Margarita River Site, 902USM828

Dry weather flows at the Upper Santa Margarita River monitoring site were observed to be the result of the confluence of Murrieta Creek and Temecula Creek waters and an imported water delivery discharge just upstream of the monitoring station. This imported water is continuously discharged at approximately 10 ft³/sec, and this water was observed to compose virtually all of the flow in the Upper Santa Margarita River. Very little water input was observed from Murrieta Creek and Temecula Creek. As described above, there were no observed contributions of MS4 discharge to the lower reaches of Murrieta Creek and Temecula Creek. Based on these observations, the water quality measured at the Upper Santa Margarita River monitoring site does not appear to represent MS4 discharges.

The substrate in the Upper Santa Margarita River is primarily composed of bedrock and boulder, with some sand deposits and root mats of emergent vegetation along the banks. Instream habitat complexity was observed to be a mixture of patch types, including sparse to moderate coverage of filamentous algae, macrophytes, small woody debris, live tree roots, and boulders. The river course was a fairly straight path (sinuosity ratio of 1.01), with a relatively even mix of three flow habitat types (riffles, runs, and glides), with occasional pools and rapids. Mean overhead and upper riparian canopy was sparse throughout the reach; lower canopy and groundcover vegetation were
moderate. Human influence was limited to sparse trash, and with no obvious signs of regular human visitation.

The BMI community was rated Poor by the IBI and had a CSCI rating of Possibly Altered (i.e., the CSCI score was within reference range). The BMI community may have been limited somewhat by the lack of layered cobble, because many sensitive BMI organisms prefer this type of substrate. The community was dominated by collector taxa, including the mayflies, *Tricorythodes* sp. (32.0% of the community) and *Baetis* sp. (20.4%), and the amphipod *Hyalella* sp. (17.3% of the community). There was one sensitive taxon collected, the caddisfly, *Tinodes* sp., which indicated that water quality was relatively good, although only one individual was collected.

The algae community had IBI scores of 40 (soft algae), 62 (diatoms), and 56 (combined overall) (Table 4-1). These values were moderate, relative to the other sites monitored. Most of the individual metrics of the algal IBI had scores in the middle to high end of the scale. A few metrics scores were low, including the metric for algal taxa, which indicates nonreference conditions, and the metric for percentage of green macroalgae. However, the dominant diatoms at this site were *Cocconeis pediculus* and *C. placentula*, indicators of good water quality and low total nitrogen.

There were no substantial changes noted from the 2017 monitoring period.
5.6 **Sandia Creek Reference Site, 902SND100**

The Sandia Creek reference site is at an elevation of approximately 1,100 feet and is about 6 miles west of the City of Temecula. Although the stream flows parallel and very close to De Luz Road, riparian and in-stream habitat conditions were relatively good. Dry weather flows at the Sandia Creek reference site were observed to be primarily from rising groundwater; there are no MS4 facilities that are tributary to this monitoring site, but there is a considerable amount of agriculture in the watershed above the reach (citrus and avocado) that likely contributes to the groundwater.

The creek bed was observed to be composed of a variety of substrate types, primarily sand, gravel, and cobble. Instream habitat was moderately complex, including a mix of woody debris, aquatic macrophytes, live tree roots, undercut banks, and overhanging vegetation. The sinuosity was relatively low (sinuosity ratio of 1.10) and flow habitats across the reach were composed primarily of glides and riffles, with a couple of small pools. Human influences observed at the Sandia Creek reference site included a chain link fence within 50 meters of the right bank, De Luz Road and
some culverts within 10 meters of the left bank, and occasional trash throughout. Agricultural activities were within 50 meters of the right bank at the upstream end of the reach, and some limited vegetation management was evident.

The BMI community was rated Poor by the IBI and Likely Intact by the CSCI; thus, the creek was well within the reference range for the CSCI. The IBI score was only one point below the impairment threshold, and the site has been rated above the IBI threshold in previous surveys. The BMI community was weakly dominated by the black fly, *Simulium* sp. (17.1% of the community), followed by the midge *Rheotanytarsus* sp. (12.1%), and there were four sensitive BMI taxa collected.

The algae community had IBI scores of 60 (diatoms) and 38 (combined overall) (Table 4-1). The soft algal IBI was unable to be calculated because of insufficient taxonomic diversity. The combined IBI was the lowest relative to the other sites monitored. As was observed in 2017, individual metrics of the algal IBI showed mixed signals of water quality conditions, with most metrics scoring either at the high or low end of the scale (or unable to be calculated) and there were no metric scores in the scaled range of 1–6. The high percentage of oligosaprobous and β-mesosaprobous taxa indicated overall good water quality; however, metrics based on nutrient indicator taxa and green macroalgae indicated an algal community response to nutrient levels. For comparison, the site had an elevated total nitrogen concentration of 6.1 mg/L, compared with the SMC Program 2009–2013 five-year mean of all reference sites of 0.43 mg/L (Mazor, 2015b). Algal community composition was also likely affected by the relatively high concentrations of sulfate (390 mg/L), which is a known stressor for many diatom and soft algae taxa (Porter, 2008).

While this site is being used as a comparator reference site within the SMR bioassessment monitoring program, this site is not considered “true reference” in the sense that it meets the statewide SWAMP standard of a reference stream (i.e., minimal to no anthropogenic influence). Sandia Creek (902SND100) was selected as a comparator reference site during the 2013–2014 monitoring year after an extensive survey of sites within the SMR Watershed failed to identify any “true reference” sites that flowed long enough into the index period to warrant sampling. The FY 2013–2014 Monitoring Annual Report (Section 2.1.6) describes the process that was undertaken through conversations with SCCWRP and the San Diego Regional Water Quality Control Board to relax reference criteria to locate a site within the SMR Watershed that would serve as a relative reference site.

Relative to the 2017 monitoring period:

- Macroalgal cover decreased from 62.9% to 26.7%.
- The number of sensitive BMI taxa decreased from seven taxa to four.
5.7 Tributary to Sandia Creek SMC Condition Site, 902M18901

The unnamed tributary SMC condition site was located approximately 3.1 miles upstream of its confluence with Sandia Creek. The stream was in close proximity to citrus and avocado groves and a mixture of irrigation runoff and groundwater was the likely water source for stream flow. The substrate was dominated by coarse gravel and cobble in the riffle sections, with sand and fines in the pools. The stream gradient was moderate, and the stream banks showed evidence of incision and erosion, particularly at the downstream end of the reach. Canopy coverage was 92.9% of the reach, while instream macrophyte and algal cover was relatively sparse. A CRAM score of 66 was obtained at this site.

The BMI community was rated Poor by the IBI and Likely Intact by the CSCI (i.e., within the reference range for the CSCI). The BMI community was dominated by midges, including Rheotanytarsus sp. (20.1% of the community) and Parametrocnemus sp. (16.3% of the community). Indicators of good water quality included the stoneflies, Isoperla sp. and Malenka sp., and the caddisflies, Helicopsyche sp. and Wormaldia sp.

The algae community had IBI scores of 33 (soft algae), 54 (diatoms), and 53 (combined overall) (Table 4-1). These values indicated the lowest quality soft algal community compared with the other sites monitored. Most of the individual metrics of the IBI indicated a moderate to poor algal community, although metrics based on the proportion of oligosaprobus, and β-mesosaprobus taxa, nitrogen heterotrophic taxa, and low total phosphorus indicator taxa scored high on the scale.
5.8 Sandia Creek SMC Trend Site, SMC01097

The Sandia Creek SMC trend site is located approximately 0.9 mile downstream of the Sandia Creek reference site at an elevation of approximately 885 feet. The site also has similar water sources. The monitoring site was located within private property and was next to De Luz Road, passing beneath the road just upstream of the sampling reach. Riparian vegetative habitat was somewhat dissimilar from that of the upstream Sandia Creek reference reach, in that this location had a lower mean overhead canopy, but substantially greater low canopy and herbaceous/grass ground cover. In-stream conditions were relatively similar at the two sites. CRAM was not performed at this site in 2018, as the SMC work plan specifies that trend sites are assessed only every third year, or if a major hydrologic disturbance has occurred (CRAM was performed at this site in 2017).

The creek was composed of a variety of substrate types and was dominated by sand, gravel, and cobble. Instream habitat was moderately complex, including a mix of woody debris, aquatic macrophytes, live tree roots, undercut banks, and overhanging vegetation. The gradient and flow volume were relatively low (1.3% and 0.01 ft³/sec, respectively) and flow habitats across the reach were composed entirely of shallow water glides (63.5% of the reach) and riffles (36.5%).

The BMI community was rated Fair by the IBI and Likely Intact by the CSCI, which were within the reference ranges of both indices. The BMI community was dominated by ostracods (22.4% of the community), followed by the chironomid midge, *Rheotanytarsus* sp. (15.0%). There were three highly sensitive BMI taxa collected, including the stonefly, *Isoperla* sp., the dobsonfly, *Neohermes* sp., and the caddisfly, *Micrasema* sp. Other signals of a high-quality BMI community included
low percentages of non-insect taxa, low dominance by any single organism, and a relatively high diversity of predators and beetles.

The algae community had IBI scores of 52 (soft algae), 60 (diatoms), and 64 (combined overall) (Table 4-1). These values indicated moderate algal community conditions. Most of diatom metrics showed signals of moderate to good water quality conditions, and although many of the soft algae metrics had very low scores, metrics for non-reference indicator taxa and low total phosphorus indicator taxa scored high.

Relative to the 2017 monitoring period:

- Macroalgal coverage decreased from 72.4% to 35.2%.
- Flow volume decreased from 0.16 ft³/sec to 0.01 ft³/sec.
6.0 SMC SPECIAL STUDY PRELIMINARY RESULTS

This section provides the preliminary results of the SMC special studies conducted at the two SMC stream bioassessment sites. Copies of the field checklists and data sheets are provided in Appendix A. The results will be incorporated into the regional SCCWRP SMC database and will be included in reports to be released by the SMC Program Manager as data are analyzed and relevant conclusions are made.

Assessment of Hydrologic States: The dominant state of discharge in both of the creeks was classified as “Eurheic” (base flow), defined as follows: “Water always below banks. Discharge is high enough to allow access to most of the streambed.” The flow at the unnamed tributary SMC condition site consisted of fast shallow riffle habitat (35% of the reach), slow shallow glide habitat (51% of the reach), and slow deep pool habitat (14% of the reach). The Sandia Creek SMC trend site had less flow variability, and the reach consisted of 36.5% riffle habitat and 73.5% glide habitat.

Channel Engineering Checklist: Both channels were recorded as natural, and grade control features were absent within 10 meters upstream or downstream of the sampling reach.

Hydromodification PHAB Module: Because the channels were noted to be natural, particle size and bank angle were quantified.

The channel and banks at the SMC condition site were dominated by cobble with variable bank angles that ranged from 10 to 90 degrees and were assessed to be highly susceptible to vertical and lateral adjustments (i.e., erosion).

The Sandia Creek SMC trend site was considered to be susceptible to lateral adjustments on both banks with moderately well consolidated banks. Bank angles ranged from 10 to 43 degrees. Vertical susceptibility and lateral susceptibility were assessed to be intermediate with effective grade controls greater than 100 meters apart, with a road crossing approximately 50 meters upstream of the sampling reach.

Vertebrate Observation Reporting Form: At the SMC condition site, vertebrates observed within the monitoring reach included the Pacific tree frog, with more than 50 larvae and 11 to 50 adults observed. No invasive amphibians, invasive invertebrates, or fish were observed.

At the Sandia Creek SMC trend site, 11 to 50 Pacific tree frog larvae were observed.
7.0 SUMMARY AND CONCLUSIONS

Eight stream sites in the Santa Margarita Watershed Management Area were monitored for BMI and algae in May 2018, and the seven sites that had flowing water were sampled. Five of the sites were part of the NPDES MS4 Receiving Water Monitoring Program and two sites were part of the SMC Regional Stream Survey program. Sampling and analysis followed the work plan of the SMC and standardized SWAMP field and laboratory procedures. This stream bioassessment study fulfills the District’s NPDES Permit requirements and the data derived from this effort will be provided to the SMC program and/or to the SWAMP statewide, publicly available CEDEN database.

All of the sites sampled were in natural stream channels with riparian vegetation and flowing water at the time of monitoring. Physical habitat quality ranged from moderate to good, with the Lower Temecula Creek site rating poor for BMI and algae colonization likely a result of unconsolidated sandy substrates, and the Lower Murrieta Creek site rating somewhat limited for BMI (but not algae) because of the poor in-stream habitat quality.

Analyses of the BMI communities used two separate indices: the southern California IBI and the statewide CSCI. These indices were in agreement for three of the seven sites with regard to overall comparison with reference condition (Table 7-1). The Sandia Creek trend site was rated as equivalent to reference for both indices. Sites rated as impaired by both indices included the Lower Temecula Creek and Lower Murrieta Creek sites. The Upper Santa Margarita River, Sandia Creek reference, and the SMC condition site were all categorized below the impairment threshold of the IBI but were rated as equivalent to reference by the CSCI. The Adobe Creek reference site was rated within the IBI reference range, but slightly below the CSCI reference range.

Algae respond somewhat differently to stream ecological conditions than do BMI and the results of this study were no exception. For example, the Lower Murrieta Creek site, which was rated as Impaired (below reference condition) for the BMI community, was the second highest rated site by the H20 combined algal IBI, and the Sandia Creek trend site had the highest rated BMI community, but its algal IBI scores were moderate relative to those of the other sites (Table 7-1). The Sandia Creek reference site showed mixed signals for algal community quality (very low IBI for soft algae; moderate IBI for diatoms) but had the highest overall CSCI score for the BMI community.
Table 7-1. Summary of 2017–2018 Biotic Community Index Scores

<table>
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<tr>
<th>Site Name</th>
<th>Lower Temecula Creek</th>
<th>Lower Murrieta Creek</th>
<th>Redhawk Channel</th>
<th>Adobe Creek (Reference)</th>
<th>Upper Santa Margarita River</th>
<th>Sandia Creek (Reference)</th>
<th>Sandia Creek Condition</th>
<th>Sandia Creek Trend</th>
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<td>41 21 39 34 54</td>
<td>41 21 39 34 54</td>
<td>41 21 39 34 54</td>
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<td>SoCal BMI IBI Ranking</td>
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<td>CSCI Score</td>
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</tbody>
</table>

Notes:
BMI = benthic macroinvertebrate; CSCI = California Stream Condition Index; IBI = Index of Biotic Integrity; SMC = Stormwater Monitoring Coalition; UTC = unable to calculate
8.0 REFERENCES


