Water Quality Monitoring Plan
For the Russian River Estuary Management Project

Russian River Estuary at Goat Rock State Beach

Prepared by

Sonoma County Water Agency

Sonoma Water

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1.0 INTRODUCTION

The purpose of the Sonoma County Water Agency's (Sonoma Water) Russian River Estuary Management Project is to enhance fish habitat and provide flood protection. The proposed project is located at the Russian River Estuary within Goat Rock State Beach near the town of Jenner, Sonoma County. The proposed project has three main components: 1) form and maintain an outlet channel at the river mouth following barrier beach closure and provide freshwater lagoon habitat for fish from May 15 to October 15; and 2) manage the sandbar at the river mouth following closures when necessary to minimize flooding.

This Water Quality Monitoring Plan is being updated to include monitoring proposed during a TUCP for 2020 in order to have monitoring plans coordinated with the North Coast Regional Water Quality Control Board (NCRWQCB) in a single document. The Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) on 8 June 2020 to temporarily reduce minimum instream flows in the upper and lower reaches of the Russian River to prevent significant depletion of storage in Lake Mendocino due to extreme drought conditions and hydrologic impacts in the Russian River watershed resulting from reduced inter-basin transfers from Pacific Gas & Electric's Potter Valley Project, and in the lower Russian River to protect fishery resources in Dry Creek.

In summary, the Sonoma Water requested the following temporary changes to the Decision 1610 (D1610) instream flow requirements from approximately 1 July 2020 until 27 December 2020 (exact dates to be determined by SWRCB order, if TUCP is approved) to the following:

a) For 1 July through 27 December, the minimum instream flow requirements in the Upper Russian River would be reduced to 50 cfs and in the Lower Russian River would be reduced to 60 cfs;

b) If storage in Lake Mendocino drops more than one percent below the targeted water supply storage level on any day between the date of the SWRCB's order granting the TUCP and 27 December, then, from that date through 27 December, the minimum instream flow requirement on the Upper Russian River be reduced from 50 cfs to 40 cfs and on the Lower Russian River from 60 cfs to 50 cfs.

c) The minimum instream flow requirement shall be implemented as a five-day running average of average daily stream flow measurements, provided that instantaneous flows shall be no less than 40 cfs on the Upper Russian River and no less than 50 cfs on the Lower Russian River, unless storage drops more than one percent below the target water supply storage at Lake Mendocino, then the instantaneous minimum instream flow would be no less than 30 cfs on the Upper Russian River and no less than 40 cfs on the Lower Russian River.

These reduced flows are intended to help conserve stored water in Lake Mendocino so that it can be released for listed Russian River salmonid fisheries present in the Russian River during the fall Chinook salmon migration season. In addition, these reduced flows will help preserve storage in Lake Mendocino as a precaution in case 2021 also is a dry year. It is in the public interest to preserve water supplies for these beneficial uses when hydrologic circumstances cause severe reductions to water supplies.

2.0 BACKGROUND

Under the federal Endangered Species Act (ESA), steelhead, coho salmon and Chinook salmon in the Russian River watershed are listed as threatened or endangered species. Coho salmon is also listed as endangered under the California Endangered Species Act (CESA). In September 2008, National Marine Fisheries Service (NMFS) issued the *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation District in the Russian River Watershed* (Russian River Biological Opinion, NMFS 2008), a culmination of more than a decade of consultation under Section 7 of the ESA among Sonoma Water, U.S. Army Corps of Engineers (Corps), and NMFS regarding the impacts of Sonoma Water's and Corps' water supply and flood control operations in the Russian River watershed on the survival of these listed fish species. The California Department of Fish and Wildlife (CDFW) issued a consistency determination on November 9, 2009, finding that the Russian River Biological Opinion was consistent with the requirements of the CESA and adopting the measures identified in the Biological Opinion.

Studies conducted during the consultation period that ultimately led to this Biological Opinion concluded that artificially elevated inflows to the Estuary and the historical practice of breaching the sandbar that builds up and frequently closes the mouth of the Russian River during the summer and fall have adverse effects on estuarine rearing habitat for juvenile salmonids, particularly steelhead, and that current flood control operations in the Russian River Estuary may adversely affect the listed species and adversely modify their critical habitat. NMFS also concluded in the Biological Opinion that it might be better for juvenile steelhead and salmon if the sandbar is managed during these times, to allow for the formation of a seasonal freshwater lagoon with a low velocity outlet channel in the Russian River Estuary.

Sonoma Water prepared an Environmental Impact Report (EIR) to disclose potential impacts and identify mitigation measures associated with changing the operation of the Estuary to a seasonal freshwater lagoon to satisfy California Environmental Quality Act (CEQA) requirements.

3.0 OBJECTIVES

The objectives of this water quality sampling and analysis plan are to: Integrate existing data being collected under the Russian River Biological Opinion and Temporary Urgency Change (TUC) orders issued by the SWRCB, as well as meeting conditions of permits issued by the NCRWQCB. Another objective of this sampling and analysis plan is to provide a more complete basis for analyzing spatial and temporal water quality trends that may be due to changes in Estuary management. The data collected under this plan will also be utilized in the analysis of potential changes to water quality and aquatic habitat availability that may be due to changes in minimum instream flows in the Russian River, as required in the TUC orders.

4.0 PURPOSE AND NEED

The objectives of the Monitoring Plan are to provide information to evaluate potential changes to water quality and availability of habitat for aquatic resources resulting from the proposed changes to management of the Estuary as a seasonal freshwater lagoon from May 15 to October 15 (lagoon management period) with a low-velocity outlet channel as required by the Biological Opinion. Furthermore, the Monitoring Plan will build upon previous water quality studies that have been conducted in the Estuary as required by the Russian River Biological Opinion TUC Petitions.

Requirements of the TUC Orders from the SWRCB include monitoring and reporting to evaluate potential changes to water quality and availability of habitat for aquatic resources in the freshwater and estuary portions of the Russian River resulting from the proposed changes to minimum instream flows that are also required by the Biological Opinion. As part of that effort, Sonoma Water will conduct nutrient and cyanobacteria-related monitoring and sampling in coordination with the NCRWQCB and as detailed in Appendix F.

In addition, the NCRWQCB issued an Amendment to Clean Water Act (CWA) section 401 water quality certification (Certification) permit number WDID 1B10122WNSO for the Estuary Project on March 14, 2019. The conditions of the permit require a monitoring and reporting plan as well as additional focused water quality sampling related to contact recreation in the Russian River Estuary and maximum backwater area between Jenner and Vacation Beach.

Monitoring will generally be conducted during the spring, summer, and fall to track potential changes to water quality and the availability of aquatic habitat that may be associated with reduced flows in the mainstem Russian River and freshwater lagoon conditions in the Estuary. This will include an assessment of whether a low velocity lagoon outlet channel is successful in contributing to sustained elevated water levels and an increase in the availability of suitable aquatic habitat for juvenile steelhead rearing and potential impacts to contact recreation opportunities.

Estuary monitoring will include continuous hourly monitoring of temperature, dissolved oxygen, pH, and specific conductance at several stations stretching from Monte Rio to Jenner. In addition, the Estuary will be monitored hourly to observe salinity concentration and stratification in the water column; as well as up and downstream migration of the salt water layer associated with tidal exchange, periods of lower instream flows, and periods of barrier beach closure, partial or full lagoon formation, lagoon outlet channel implementation, and sandbar breaching. Vertical and cross-sectional profiles for temperature, dissolved oxygen, pH, specific conductance, and salinity will also be collected at mainstem monitoring stations and the adjacent shallow zones to characterize lagoon backwater areas when the river mouth is closed and a lagoon outlet channel is in place and functioning.

Water samples (grab) will be collected by Sonoma Water staff and analyzed for several constituents by Alpha Labs in Ukiah and the Sonoma County Department of Health Services (DHS) Public Health Division Lab in Santa Rosa.

Regarding water quality monitoring to support the Water Quality Certification for Estuary management, the following questions help to explain the objective of the monitoring plan:

- What are the background levels of nutrients and pathogens in the Estuary under open, tidally-influenced conditions? How do these background levels respond to changes in managing the Estuary as a seasonal freshwater lagoon, considering other contributing factors?
- Do water temperature, dissolved oxygen, and salinity respond to changes managing the Estuary as a seasonal freshwater lagoon?
- Are there secondary biological effects related to changes in water quality from managing the Estuary as a seasonal freshwater lagoon (e.g. stress to fish, plants, invertebrates) and if so, what are they?
- Are there affects to public health/recreation?

In addition, the following questions help to explain the objective of the water quality monitoring requirement in the TUC Orders:

- Are the reduced minimum instream flows authorized by the TUC Order impacting water quality in the Russian River from Ukiah to Jenner, including water quality impacts affecting recreation or the availability of aquatic habitat for salmonids?
- Do biostimulatory conditions exist within the Russian River?

5.0 SAMPLING AND ANALYSIS PLAN

5.1 Russian River Estuary Study

5.1.1 Datasonde Deployment

Water quality monitoring will occur at seven (7) stations in the lower, middle, and upper reaches of the Russian River Estuary, including tributaries and areas upstream from the Estuary that become inundated during lagoon conditions (maximum backwater area). Five stations will be located in the mainstem between Jenner and Monte Rio and two stations will be located in Willow and Austin creeks, in areas that are subject to tidal and/or lagoon inundation. Refer to Figure 1 for a map of Estuary water quality station locations. Locations of water quality monitoring stations within a given reach have changed over the years as more information and a better understanding of the Estuary has been gained and has been done in coordination with resource and regulatory agencies including NMFS, CDFW, SWRCB, DHS, and NCRWQCB. Although it was anticipated that the water quality stations monitored during the 2013 season would continue to be monitored for the duration of the CDP, the identification of cyanobacteria and presence of cyanotoxins in the mainstem water column during the 2015 season by the NCRWQCB and DHS has resulted in the NCRWQCB coordinating with Sonoma Water and inquiring if there was an opportunity for Sonoma Water to assist the NCRWQCB and DHS in gaining a better understanding of cyanobacteria in the mainstem Russian River. In order to accomplish this, Sonoma Water requested that they be allowed to modify this Monitoring Plan to shift additional focus to cyanobacteria to support the NCRWQCB's request. In the event that future coordination with resource and regulatory agencies continues to identify alternative monitoring locations and constituents in subsequent years, Sonoma Water will notify the NCRWQCB of the station location and constituent monitoring changes. The breadth and scale of the overall monitoring effort will essentially remain the same and provide the same degree of monitoring coverage.

Sonoma Water staff will use several Yellow Springs Incorporated (YSI) 6600 series multi-parameter datasondes (sondes) equipped with a YSI 6560 combination conductivity/temperature sensor, a YSI 6561 or YSI 6589Fr hydrogen ion (pH) sensor, and either a YSI 6562 dissolved oxygen sensor or YSI 6150 optical dissolved oxygen sensor to collect water quality parameters at all sites. Sondes will be programmed to record hourly measurements of water temperature (Celsius), dissolved oxygen (milligrams per liter, mg/L), dissolved oxygen (percent saturation, % Sat), specific conductance (microsiemens), salinity (parts per thousand, ppt), and hydrogen ion (pH). Monitoring sites will be accessed by boat or by foot.

All sondes will be recalibrated following the manufacturer's 6-Series User Manual and data downloaded by Sonoma Water staff. The YSI temperature sensor utilizes a thermistor that does not require calibration or maintenance. However, thermistor accuracy will be checked against a National Institute of Standards and Technology (NIST) thermometer during initial deployment, and periodically throughout the monitoring season, to ensure the sensor is functioning properly. The YSI 6560 conductivity sensor will be calibrated using a 10,000 microsiemen (µS/cm) standard. The YSI 6561 pH sensor will be calibrated to two points using buffer solutions of pH 7 and 10. The YSI 6562 dissolved oxygen sensor will be calibrated using the dissolved-oxygen-calibration chamber-in-air method where the calibration chamber is set-up with water and allowed to reach 100-percent saturation prior to calibration. The YSI 6150 optical dissolved oxygen sensor will be calibrated using a one-point dissolved-oxygen-calibration chamber-in-air method where the calibration chamber is set-up with water and allowed to reach 100-percent saturation prior to calibration.

Field calibration and data collection will be conducted using the YSI 650 Multiparameter Display System (MDS) datalogger designed to work with the 6-Series datasondes. Data will be downloaded onto the YSI 650 MDS and then transferred to a PC, where data will undergo analysis by Sonoma Water staff.

Alternately, Sonoma Water staff will utilize newer YSI EXO2 multi-parameter datasondes (sondes) with similar sensors and calibration protocols as the YSI 6600 Series sondes.

Russian River Estuary Management Project Water Quality Monitoring sites (Figure 1) include:

- Russian River at Patty's Rock upstream from Penny Island (2 YSI 6600 Datasondes)
- Willow Creek at the 1st Bridge (1 YSI 6600 Datasonde)
- Russian River at Freezeout Creek downstream of Freezeout Creek (2 YSI 6600 Datasondes)
- Russian River at Brown's Pool downstream of Austin Creek (2 YSI 6600 Datasondes)
- Austin Creek downstream of 1st Steel Bridge (1 YSI 6600 Datasonde)
- Russian River at Patterson Point in Villa Grande (2 YSI 6600 Datasondes)
- Russian River at Monte Rio downstream of Dutch Bill Creek (1 YSI 6600 Datasonde)

The two mainstem stations located in the middle and upper reaches of the Estuary between Jenner and Freezeout Creek will have a vertical array of two datasondes. Monitoring stations will be comprised of a concrete anchor attached to a steel cable suspended from the surface by a large buoy with sondes attached at varying depths along the cable. The rationale for choosing these sites was to locate the deepest pools at various points throughout the Estuary to obtain the fullest vertical profiles possible and to monitor hypoxic or anoxic events and temperature or salinity stratification. The Patty's Rock station in the lower Estuary is predominantly saline and will have sondes placed at the surface (approximately 1-meter depth) and mid-depth portions of the water column. The Freezeout Creek station in the upper Estuary, where water is predominantly fresh, will have sondes located at the mid-depth and bottom of the water column.

Three additional mainstem stations were established in the maximum backwater area in 2014, upstream from the Estuary in freshwater habitat that becomes inundated during sandbar closure events. The station at Brown's Pool will have a vertical array of two datasondes placed at the mid-depth and bottom of the pool or thalweg, which is the deepest part of the water column, to track the potential migration of saline water upstream of Freezeout Creek. The Villa Grande area has not previously been observed to become saline when monitored in 2011 and 2012 and the Patterson Point station in Villa Grande has not been observed to become saline since monitoring commenced in 2014; however the Patterson Point station will continue to have a vertical array of two datasondes placed at the mid-depth and bottom of the pool to track the potential for temperature stratification or the migration of saline water upstream of Brown's Pool. The Monte Rio station has not previously been observed to become saline and will have one sonde suspended at approximately mid-depth (during open river mouth conditions) in the thalweg. The two tributary stations in Willow and Austin creeks will each have one sonde that will be suspended at approximately mid-depth (during open river mouth conditions) in their respective thalwegs near the confluences with the Russian River.

Sondes will be located in this manner to track changes to water quality in the water column, vertically and longitudinally, within the Estuary and Maximum Backwater Area during reduced instream flows, tidal fluctuation and partial or full closure events. The placement of sondes in this manner will also allow Sonoma Water staff to track changes to water quality that may be associated with the migration and stratification of the salt water layer within the Estuary, as well as the enhancement of habitat conditions for juvenile salmonids.

When the river mouth closes and a lagoon outlet channel is in place and functioning, vertical and cross-sectional profiles will be collected at the mainstem Russian River monitoring stations and their adjacent

shallow zones to further characterize lagoon backwater areas. Measurements of water temperature, dissolved oxygen, specific conductance, pH, and turbidity will be collected using a YSI 6600 datasonde and YSI 650MDS datalogger, or similarly equipped YSI EXO2. Monitoring sites will be accessed by boat.

5.1.2 River Stage Measurements at Monte Rio

The existing staff gage located on the northern abutment of the Bohemian Highway Bridge in Monte Rio was completely detached during high winter flows in the winter of 2018. To monitor water surface levels during barrier beach closure and inundation of the Maximum Backwater Area between Casini Ranch and Vacation Beach, water surface levels will be recorded at the Jenner staff gauge during weekly grab sample collection. Water surface level data will assist in an evaluation of the potential effect that backwatering may have on water quality conditions in this reach of the Russian River.

5.1.3 Nutrient/Bacterial/Algal Sampling

Water grab samples will be collected from 3 surface-water sites in the Russian River Estuary (Figure 1). All samples will be analyzed for nutrients, *chlorophyll a*, standard bacterial indicators (Total coliforms, *E. coli*, and *Enterococcus*), and dissolved organic carbon (see Table 1). In addition, sampling will be conducted for *Bacteroides* bacteria at the 3 surface-water sites that occur in the maximum backwater area including Patterson Point, Monte Rio, and Vacation Beach (Figure 1).

Sampling methodology and quality assurance protocols including: chain-of-custody procedures, sample labeling, storage and transport protocols, sample containers and sample collection methods, and decontamination will follow the *National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, chapters A1-A9*, available online at http://pubs.water.usgs.gov/twri9A (USGS various) and included as Appendix A, in conjunction with protocols and procedures established by the contract laboratories (Alpha Labs and DHS Lab) and the Sonoma County Water Agency *Quality Assurance Manual, Water Quality Manual*, *July 9, 2013* (SCWA 2013), included as Appendix B. As identified in Table 1, Alpha Labs will be reporting the results at the Method Detection Limit (MDL). However, the data will be subject to their reporting protocols, which will require that they record the results as "Detected but below Reporting Limit; therefore, the result is an estimated concentration, detected but not quantified (DNQ)". The DHS Lab will be reporting the *E. coli* and *Enterococcus* results at the Laboratory Reporting Limit/Practical Quantitation Limit LRL/PQL (Table 1). The DHS lab will also be reporting the *Bacteroides* bacteria results.

Beginning in mid-May of each year, grab samples will be collected weekly for the duration of the lagoon management period (May 15 to October 15). See Figure 1 for a map of surface-water sampling locations. Measurements of water temperature, dissolved oxygen, specific conductance, pH, and turbidity will be collected using a YSI 6600 datasonde and YSI 650MDS datalogger, or similarly equipped YSI EXO2, during water sample collection. The sonde will be calibrated before and after the collection of water samples and is outfitted with a YSI 6136 turbidity sensor that will be calibrated to two points using 0.0 Nephelometric turbidity units (NTU) distilled water, and 126 NTU turbidity standard (YSI 6073G).

Russian River Estuary Management Project Nutrient/Bacterial/*Chlorophyll a* monitoring sites (Figure 1) include:

- Russian River at Patterson Point in Villa Grande
- Russian River at Monte Rio below Dutch Bill Creek

- Russian River at Vacation Beach below summer dam

Additional focused sampling will also occur under certain conditions and following specific river management and operational events, noted below, at the sites listed above.

- Removal of Johnson's Beach and/or Vacation Beach Dam – 3 samples within 10 days after dam removal
- Sandbar Closure at the river mouth – 3 samples within first 10 days (weekly thereafter)
- Sandbar Breach at the river mouth – 3 samples within 10 days after breach
- Lagoon Outlet Channel implementation – 3 samples within 10 days after implementation (weekly thereafter).

Sonoma Water staff will also increase sampling frequency to daily at freshwater beach sites including: Patterson Point, Monte Rio and Vacation Beach, if bacteria indicators exceed NCRWQCB operative standards during the weekly sampling effort and shall continue daily until measurements are below operational standards. After consultation with NCRWQCB staff, it was decided that measurements for *E. coli* (235 MPN/100mL) would be used for a comparison to operational standards (pers. comm. Fitzgerald, 2013).

NCRWQCB staff has indicated, based on guidance from Sonoma County DHS, that *Enterococcus* is not currently being utilized as a fecal indicator bacteria in freshwater conditions due to uncertainty in the validity of the lab analysis to produce accurate results, as well as evidence that *Enterococcus* colonies can be persistent in the water column and therefore its presence at a given site may not always be associated with a fecal source. Sonoma Water staff will continue to collect *Enterococcus* samples and record and report the data, however, *Enterococcus* results will not be relied upon when coordinating with the NCRWQCB and Sonoma County DHS about potentially posting warning signs at freshwater beach sites or to discuss potential adaptive management actions including mechanical breaching of the sandbar to address potential threats to public health.

At the conclusion of any focused grab sampling event, regular weekly sampling will resume, as described above.

Sampling for human-host *Bacteroides* bacteria will be conducted at public freshwater beaches when other bacteria samples are collected. Samples will be filtered, frozen and archived for possible future analyses of human-host *Bacteroides* bacteria. Lab analysis of *Bacteroides* bacteria will be conducted only for those sample dates and locations when operational standards for *E. coli* bacteria are exceeded. The analysis of human-host *Bacteroides* bacteria will help determine whether the source of the high level of *E. coli* bacteria is from human or other sources.

Russian River Estuary *Bacteroides* sites (Figure 1) include:

- Russian River at Patterson Point in Villa Grande
- Russian River at Monte Rio below Dutch Bill Creek
- Russian River at Vacation Beach below summer dam

These analyses will continue Sonoma Water's effort to establish a water-quality baseline for the Russian River Estuary (including the maximum backwater area) from Vacation Beach to the river mouth near Jenner. The baseline established with these analyses will inform the assessment of aquatic habitat availability and public recreational opportunities in the Russian River Estuary and maximum backwater area under open and closed river mouth conditions and during the implementation of a lagoon outlet channel across the river mouth sandbar.

Table 1. List of nutrient, bacterial, and algal indicators to be analyzed in water samples collected for the Russian River Estuary Management Project.

Compound	Test Method	Method Detection Limit (MDL)	Laboratory Reporting Limit (LRL/PQL[1])	Units
Nitrogen, Total	SM4500-N	0.2	0.5	mg/L
Nitrogen, Total Organic	SM4500-N	0.2	0.2	mg/L
Nitrogen, ammonia as N	SM4500NH3C	0.1	0.2	mg/L
Ammonia Unionized	SFBRWQCP	0.00010	0.00050	mg/L
Nitrogen, nitrate as N	EPA300.0	0.050	0.20	mg/L
Organic carbon, dissolved	SM5310C	0.0400	0.300	mg/L
Phosphorus, orthophosphate	SM4500-P E	0.020	0.020	mg/L
Phosphorus, total	SM4500-P E	0.020	0.10	mg/L
Chlorophyll (a)	SM10200H	0.000050	0.010	mg/L
Enterococcus	SM9223 (entro)[3]	2.0	2.0	MPN[2]
E. coli	SM9223 (clert)[4]	2.0	2.0	MPN

- Alpha Labs will be reporting the results at the MDL, however the data will be subject to their reporting protocols which will require that they record the results as "Detected but below Reporting Limit; therefore, result is an estimated concentration, detected but not quantified (DNQ)". The Sonoma County DHS Public Health Division Lab will be conducting the analysis for *E. coli* and *Enterococcus* and will be reporting the results at the LRL/PQL.
- [1] PQL – Practical Quantitation Limit
- [2] MPN – most probable number
- [3]entro – Enterolert Method
- [4]clert – Colilert Method
- [5]NTU – Nephelometric turbidity units

5.1.4 Periphytic and Planktonic Algae and Cyanobacteria

Monitoring of periphytic and planktonic algae will be conducted to document algal response following estuary closure and to establish baseline ecological data for algal populations that are representative of habitats available in the Russian River. Monitoring will be conducted as soon as flows allow a systematic investigation of abundance, cover, and successional processes. Timing of surveys would follow spring draw down and continue from approximately June to October. Photographs will be taken at the transects to document site conditions during each sampling event in each major algal habitat area (including underwater photographs of the condition of periphyton and floating mats of reproductive benthic algae).

Algal Response to Estuary Closure

The sample locations at Patterson Point will be conducted along shallow over-bank habitat in newly flooded shoreline areas that forms after water depths increase during river mouth closure from May 15 to October 15 (Figure 1). Transects will be established to monitor and assess periphytic algal growth, including the potential presence of cyanobacteria, from shoreline to below the photic zone. Transects will be located to sample the range of algae habitat available in these locations. In addition to the estuary closure response monitoring described below, ambient algae conditions at Patterson Point will be monitored every other week (bi-weekly) as described further in Appendix F.

Microalgae/Macroalgae Sampling (Collecting Cover Data)

Sampling methodology to monitor the algal response in newly flooded shoreline areas has been developed based on modification of *Standard Operation Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Assessments in California* (Fetscher, et al. 2009), the *California Watershed Assessment Manual: Volume II, Chapter 4* (Shilling et al., 2005), and the *Rapid Bioassessment Protocols for Use in Wadeable Stream and River: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition* (Barbour, 1999), included as Appendices C, E, and F.

Cover data on algal populations will be conducted to estimate both micro- and macro-algal taxa cover. Point intercept sampling provides an effective method to quickly estimate cover and abundance of microalgae, but since it is a dimensionless sampling method, does not provide clear data on where mats of algae form in relation to different conditions in the littoral zone. Line intercept sampling can be completed quickly and provides additional cover information (size and location of algal mats).

Percent algal cover will be calculated using a point-intercept methodology. Algal cover will be the amount of microalgae coating and macroalgae taken at 2 foot intervals (60 cm) along the transects. The percentage of the points across the transects at each monitoring site will provide an estimate of percent algal cover. Beginning with the downstream transect at each site, water depth and the presence of algae will be recorded at 2 foot (60 cm) intervals along the transect, and identified as microalgae or macroalgae. Microalgae is defined as a “film-like coating” of algae. Measurement of microalgae thickness will follow the method identified in Fetscher, et al. 2009 and an estimate of film-like coating will follow descriptions in Table 2. Thicker microalgae layers will be measured using a ruler or rod with demarcations at 1, 5, and 20 mm. Photographs will be taken to document the periphyton at 10-foot intervals along each transect during point sampling. These photographs will include images taken with underwater cameras and utilizing a 7 X 7 grid marked “viewing bucket”.

Additionally, the presence/absence (distance occupied along transect) of attached macroalgae or unattached, floating macroalgae, emergent vegetation, dried and floating algal mats, and riparian canopy will also be recorded along each transect using the line intercept method. Distance occupied by algal mats divided by total distance of the transect provides an effective measure of instantaneous absolute cover. Cover data on emergent and riparian canopy will be collected along each transect (if present).

Table 2. Microalgal thickness codes and descriptions.

Microalgal thickness codes and descriptions (from Fetscher, et al. 2009 and adapted from Stevenson and Rollins 2006)		
Code	**Thickness**	**Diagnostics**
0	No microalgae present	The surface of the substrate feels rough, not slimy.
1	Present, but not visible	The surface of the substrate feels slimy, but the microalgal layers is too thin to be visible.
2	<1mm	Rubbing fingers on the substrate surface produces a brownish tint on them, and scraping the substrate leaves a visible trail, but the microalgal layers is too thin to measure.
3	1-5mm	
4	5-20mm	
5	>20mm	
UD	Cannot determine if a microalgal layer is present	

Prior to collection of percent algae cover, algae samples will be collected 1 m downstream and adjacent to each point (to avoid trampling on samples during collection of percent algal cover data), beginning at the downstream transect. A multi-habitat sample will be collected at 10 foot (3 meters) intervals along each transect. Each sample will be collected from the substrate that is uppermost within the stream and has highest possibility of sun exposure (i.e. if a thick layer of macroalgae covers the substrate, collection will include the layer). Samples will be placed in a cooler to protect the algae from heat and desiccation and to preserve specimen integrity. Algal species present will be identified to the lowest taxa, preferably species but at least genera. Successional changes in genera over the season should provide a metric to assess species (genera) richness as well as document the stages in development of the periphyton layer.

Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyta (Golden Brown Algae (diatoms)), and Cyanobacteria (Blue Green Algae). In addition, along each transect one sample will be collected at a 1 foot depth in the flowing (in active flowing channel) water column using a plankton net (deployed for five minutes) to assess the presence and abundance of phytoplankton. If cyanobacteria target species are identified (including species of *Anabaena*, *Microcystis*, *Planktothrix*, *Oscillatoria, and Phormidium*), they will be evaluated for changes in cover successionally and the possibility of the presence of cyanotoxins will also be evaluated.

The samples will be combined, homogenized and plated on microscopic slides. The number of cells per volume by genera will be used to evaluate relative abundance of each genera present. Keenan Foster, a

taxonomic botanist and Principal Environmental Specialist with the Water Agency, will be conducting the algae identification and evaluation for the presence of cyanobacteria.

Water chemistry measurements will be recorded near the substrate at each transect point using a YSI 6600 datasonde and YSI 650MDS datalogger, or similarly equipped YSI EXO2. Conditions to be measured include water temperature, dissolved oxygen, specific conductance, pH, and turbidity. Water depth will be taken using a stadia rod or similar device.

Monitoring and sample collection will occur under certain conditions and following specific river management and operational events, noted below, at Patterson Point.

- Transects will be established during open river mouth conditions beginning in June, or at least one month after storm events with sufficient power to mobilize gravels and sand/silt. Monitoring of percent algae cover and collection of samples will be completed with establishment of the transects.
- The next monitoring and sampling event will occur when the river mouth is closed, in an extended perched condition, or with an outlet channel in place and the water surface elevation at the Jenner gage is at or approaching 4.5 feet. Monitoring and sample events will then be repeated with each 2 foot stage change (e.g. 6.5 feet and 8.5 feet) until the river mouth returns to an open condition or at the end of the monitoring period (October 15).

5.2 Reporting

An annual report describing the results of the Sonoma Water Russian River Estuary water quality monitoring and sampling effort will be prepared. The report will provide summaries of data observations recorded for each constituent sampled or monitored (not including the grab sample constituents previously mentioned as not undergoing analysis) and the impacts if any to aquatic habitat availability. Data will be compared to previous years and special attention will be given to the potential for the outlet channel to successfully maintain elevated water levels and improve water quality and the availability of suitable aquatic habitat for salmonid rearing. The report will also address the objectives of the monitoring plan described in Section 3.0, as well as address the purpose and need of the plan described in Section 4.0, including the following questions:

- What are the background levels of nutrients and pathogens in the Estuary under open, tidally-influenced conditions? How do these background levels respond to changes in managing the Estuary as a seasonal freshwater lagoon, considering other contributing factors?
- Do water temperature, dissolved oxygen, and salinity respond to changes managing the Estuary as a seasonal freshwater lagoon?
- Are there secondary biological effects related to changes in water quality from managing the Estuary as a seasonal freshwater lagoon (e.g. stress to fish, plants, invertebrates) and if so, what are they?
- Are there affects to public health/recreation?

Monitoring data is shared with Sonoma Water partners, including the University of California at Davis Bodega Marine Laboratory (BML). BML conducts hydrological analyses of both University-collected and

Sonoma Water-collected data on currents, temperature, salinity, dissolved oxygen, biological oxygen demand (BOD), and water levels in the context of changes in river flow, tide range, wave conditions, and river mouth state, with specific attention to:

- Circulation patterns and statistical description of current speeds associated with tidal flows when mouth open, and wind-driven seiche when mouth closed.
- Salinity intrusion (i.e., landward extent of saline waters).
- Stratification strength and resistance to vertical mixing (i.e., stability) and how stability evolves during long-closure periods.
- Residence times for both low-salinity surface waters and high-salinity bottom waters in the estuary.
- Water budget for the estuary when closed, with a view to better quantifying the loss term due to seepage through the sand barrier at the mouth when closed.
- Salt budget for the estuary when closed, with a view to better quantifying the export of saline waters due to seepage through the sand barrier at the mouth when closed, but also recognizing the role of wave over-wash of seawater into the estuary.
- Quantification of dissolved oxygen levels, BOD levels and de-oxygenation rates in estuary waters during periods of closure, barrier overflow, and immediately after breaching of the mouth.

BML's staff and Principal Investigator, Dr. John Largier, interacts with Sonoma Water staff and other collaborators in relating estuarine hydrology to water quality (specifically concurrent data on nutrient and fecal indicator bacteria levels), ecological productivity (specifically concurrent invertebrate surveys), human uses (specifically salinity intrusion into water sources) and ecosystem functions (specifically quantity and quality of juvenile salmon habitat) in the estuary. BML's data will be included in the annual report, to the extent that data is available.

The report and its evaluation will help guide the adaptive management process and may also provide recommendations for changes to monitoring and sampling efforts to be conducted in subsequent years. The information from this report will also be used in a synthesis report being prepared by Sonoma Water that incorporates other Estuary studies and discusses trends and observations relating to the proposed permanent changes to minimum instream flows and Estuary management during the summer months. Additionally, the NCRWQB has requested that the data be submitted into their California Environmental Data Exchange Network (CEDEN) database for the 303d/305b Integrated Report process.

5.3 Quality Assurance Program

The following section describes applicable standard operating procedures and established monitoring and sampling protocols that Sonoma Water staff, under the guidance of Senior Environmental Specialist Jeff Church, will follow as part of their Quality Assurance (QA) and Quality Control (QC) efforts. Sonoma Water staff will conduct water quality data collection, management, analysis, and evaluation following the Sonoma County Water Agency's *Quality Assurance Manual, Water Quality Manual*, *July 9, 2013* (Appendix B).

All YSI 6600 Datasondes deployed for long-term continuous monitoring will be recalibrated following the manufacturer's 6-Series User Manual and data downloaded by Sonoma Water staff. YSI sondes used for

the collection of water chemistry information during water and algal sample collection will be calibrated daily, before and after use in the field.

- The YSI temperature sensor utilizes a thermistor that does not require calibration or maintenance. However, thermistor accuracy will be checked against a National Institute of Standards and Technology (NIST) thermometer during initial deployment, and periodically throughout the monitoring season, to ensure the sensors are functioning properly.
- The YSI 6560 conductivity sensors will be calibrated using a 10,000 microsiemen (µS/cm) standard.
- The YSI 6561 pH sensors will be calibrated to two points using buffer solutions of pH 7 and 10.
- The YSI 6562 dissolved oxygen sensors will be calibrated using the dissolved-oxygen-calibration chamber-in-air method where the calibration chamber is set-up with water and allowed to reach 100-percent saturation prior to calibration.
- The YSI 6150 optical dissolved oxygen sensors will be calibrated using a one-point dissolved-oxygen-calibration chamber-in-air method where the calibration chamber is set-up with water and allowed to reach 100-percent saturation prior to calibration.
- The YSI 6136 turbidity sensor will be calibrated to two points using 0.0 Nephelometric turbidity units (NTU) distilled water, and 126 NTU turbidity standard (YSI 6073G).

Water grab sampling methodology and quality assurance protocols including: chain-of-custody procedures, sample labeling, storage and transport protocols, sample containers and sample collection methods, and decontamination will follow the USGS *National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapters A1-A9* (Appendix A), in conjunction with protocols and procedures established by Alpha Analytical Laboratories and the Sonoma County Department of Health Services Public Health Division Lab (the Sonoma Water's contract laboratories) and the Sonoma County Water Agency *Quality Assurance Manual, Water Quality Manual*, *July 9, 2013*. Water Agency staff will follow standard operating procedures while collecting water grab samples including:

- Sonoma Water staff will wear non-powdered nitrile gloves during the collection of all water grab samples. New gloves will be used at each sampling site.
- Sample bottles will be labeled with station name, sample date, sample time, sampler identification, constituents being sampled, and preservative used (if any).
- Water grab samples will be collected where the stream depth is approximately 12 to 18 inches.
- Water grab samples will be collected at an approximate depth of 8 inches below the water surface.
- Sonoma Water staff will position bottles at the upstream direction of flow in relation to their body when collecting samples to prevent potential sample bias caused by disturbance to the adjacent substrate when accessing the sample point.
- If substrate is disturbed and cannot be avoided during sampling due to a lack of positive flow, Sonoma Water staff will remain in place until the substrate settles.
- Water grab sample bottle lids will be removed subsurface to allow sample bottles to fill from within the water column and not collect surface detritus.

- Water grab sample bottles will be recapped subsurface to minimize potential sample bias from surface detritus.
- Water grab samples collected (e.g. nutrient, algal, and bacterial samples) have a maximum hold time of six (6) hours between sample collection and receipt by the respective lab.
- Water grab samples will be placed in an ice-filled cooler after collection to keep samples at a temperature below 6 degrees Celsius (<6°C).
- Sonoma Water staff will transport bacterial samples directly to the DHS lab in Santa Rosa.
- Water grab samples that will be analyzed by Alpha Analytical Labs in Ukiah will be returned to Sonoma Water facilities following completion of sample collection and refrigerated to ensure samples remain <6°C and ready for pick-up and transport to Alpha Analytical Labs by the lab courier.
- Chain of custody forms are filled out and signed by Sonoma Water staff for release and transfer of water grab samples to their respective lab for analysis. Chain of custody forms are submitted to laboratory staff at the DHS lab and to the Alpha Analytical Labs courier.
- Paper copies of chain of custody forms are kept on file at Sonoma Water along with lab results and the corresponding lab analysis quality control results (e.g. duplicates, spikes, and blanks). Electronic copies of the chain of custody forms and lab results are also kept on file.

Sampling methodology to address monitoring periphytic algae growth in newly flooded shoreline areas has been developed based on modification of *Standard Operation Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Assessments in California* and *California Watershed Assessment Manual: Volume II Chapter 4*, and the *Rapid Bioassessment Protocols for Use in Wadeable Stream and River: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition* (Barbour, 1999), (Appendices C, E, and F), as described above in Section 5.1.4.

- Monitoring of periphytic and planktonic algae will be conducted to document the algal response following estuary closure and to establish baseline ecological data for algal populations that are representative of habitats available in the Russian River Estuary.
- Monitoring will be conducted as soon as flows allow a systematic investigation of abundance, cover, and successional processes. Timing of surveys will follow spring draw down from May 15 to October 15.
- Transects to monitor and assess periphytic algal growth, including the potential presence of cyanobacteria, will be established at Patterson Point.
- Two transects will be established at the Patterson Point monitoring site.
- Transects will be subjectively placed to collect data from areas with different depths, velocities, substrates, insolation, emergent vegetation, etc. in the littoral zone.
- Photographs will be taken at each transect to document site conditions during each sampling event in each major algal habitat area (including underwater photographs of the condition of periphyton and floating mats of reproductive benthic algae).
- Transects will be located on gravel bars that become inundated during estuary closure on Patterson Point beach. Transect endpoint 0 will be established at a 1 m depth in the mainstem Russian River and extend 12.5 m landward or to a 9 foot elevation.

- Transect locations will avoid locations such as tributaries, outfalls, and man-made structures to minimize influence of algal growth from contributions in nutrients, temperature, or canopy cover from such sources.
- Keenan Foster, a taxonomic botanist and Principal Environmental Specialist with Sonoma Water, will be conducting, and providing oversight to staff that have been trained to conduct, the algae identification and evaluation for the presence of cyanobacteria.
- Water chemistry measurements will be recorded near the substrate at each transect point using a YSI 6600 datasonde and YSI 650MDS datalogger. Conditions to be measured include water temperature, dissolved oxygen, specific conductance, pH, and turbidity. Water depth will be taken using a stadia rod or similar device.

Collecting Cover Data

Identifying Taxa Present (Multi Habitat Algal Sampling)

- Prior to collection of percent algae cover, algae samples will be collected 1 m downstream and adjacent to each point (to avoid trampling on samples during collection of percent algal cover data).
- Multi-habitat sampling will follow the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999).
- A multi-habitat sample will be collected at various points along 10 foot (3 meters) intervals on the transect that are representative of the variety of habitats present (up to a maximum of 5 samples per transect).
- Each sample will be collected from the substrate that is uppermost within the stream and has highest possibility of sun exposure (i.e. if a thick layer of macroalgae covers the substrate, collection will include the layer, or if a thin film on gravel sample will include gravel and the film will be “scrubbed off” for analysis).
- Samples will include all the algae present at the sampling point in a 4 inch (10 cm) radius as collected using a 4.5 inch Pyrex culture dish. Each sample will include all the algae present in the defined area of substrate.
- Samples from each interval will be combined into a common container.
- Samples will be placed in a cooler to protect the algae from heat and desiccation and to preserve specimen integrity.
- Algal species present will be identified to the lowest taxa, preferably species but at least genera.
- Successional changes in genera over the season should provide a metric to assess species (genera) richness as well as document the stages in development of the periphyton layer.
- Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyceae (Golden Brown Algae (diatoms)), and Cyanobacteria (Blue Green Algae).
- Samples will be combined, homogenized, and plated on microscope slides.
- The number of cells per volume by genera can be used to sample relative abundance of each genera present.
- Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyta (Golden Brown Algae [diatoms]), and Cyanobacteria (Blue Green Algae).

- If cyanobacterial target species are identified (including species of *Anabaena*, *Microcystis*, *Planktothrix*, *Oscillatoria,* or *Phormidium*), they will be evaluated for seasonal changes in cover and the possibility of the presence of cyanotoxins will also be evaluated.
- Sampling will follow the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999) and incorporate the steps below:
    - Visual estimates or quantitative transect-based assessments can be used to determine the percent coverage of each substrate type and the estimated relative abundance of macrophytes, macroscopic filamentous algae, diatoms and other microscopic algal accumulations (periphyton), and other biota.
    - Collect algae from all available substrates and habitats. The objective is to collect a single composite sample that is representative of the periphyton assemblage present in the reach.
    - Sample all substrates and habitats (riffles, runs, shallow pools, nearshore areas) roughly in proportion to their areal coverage in the reach. A composite sample will be collected randomly from 5 points (selected from a table of random numbers) along the transect. Each sample will include all the algae present in a 5X5 cm square area of substrate. Changes in species composition of algae among habitats are often evident as changes in color and texture of the periphyton. Small amounts (about 5 mL or less) of sample from each habitat are usually sufficient. Pick specimens of macroalgae by hand in proportion to their relative abundance in the reach. Combine all samples into a common container.
        - Collection methods include:
            - Removable substrates (hard): gravel, pebbles. Remove representative substrates from water; brush cobble and woody debris or scrape representative area of algae from surface and rinse into sample jar.
            - Removable substrates (soft): mosses, macroalgae. Place a portion of the plant in a sample container with some water. Shake it vigorously and rub it gently to remove algae. Remove plant from sample container.
            - Loose sediments: (sand, silt, fine particulate organic matter). Invert petri dish over sediments. Trap sediments in petri dish by inserting spatula under dish. Remove sediments from stream and rinse into sampling container. Algal samples from depositional habitats can also be collected with spoons, forceps, or pipette.
            - Place all samples into a single water-tight, unbreakable, wide-mouth container. A composite sample measuring four 4 ounces (ca. 125 ml) is sufficient. Add recommended amount of Lugol's (IKI) solution, "M3" fixative, buffered 4% formalin, 2% glutaraldehyde, or other preservative.
            - Label the outside of the sample container with the following information: waterbody name, sampling location, transect, date, name of collector, and type of preservative. Record this information and relevant ecological information in a field notebook. Place another label with the same information inside the sample container.

- Transport samples back to the laboratory in a cooler with ice (keep them cold and dark) and store preserved samples in the dark until they are processed. Be sure to stow samples in a way so that transport and shifting does not allow samples to leak. When preserved, check preservative every few weeks and replenish as necessary until taxonomic evaluation is completed.
- Record sample identification code, date, stream name, sampling location, transect, collector's name, sampling method, and area sampled.

Estimating Taxa Richness and Abundance

- An assessment of the relative abundances of algal taxa will be conducted for “soft" (non-diatom) algae and diatoms using a modified version of the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999).
- Five samples will be collected at each transect by collecting all the algae present at the sampling point in a 4 inch (10 cm) radius as collected using a 4.5 inch Pyrex culture dish.
- All the algae present will be removed from the substrate and all five samples will be combined into a common container.
- Algal samples will be homogenized in a blender and pipetted into a “Palmer” counting cell.
- Cell densities will be adjusted by diluting (with known volumes) with distilled water to optimize cell counts (20-40 cells per 400X microscope field).
- Relative abundances of "soft" algae will be determined by dividing the number of cells (cell units) counted for each taxon by the total number of cells counted.
- 300 algal cell units will be counted per site for each field event.
    - Homogenize algal samples with a tissue homogenizer or blender.
    - Thoroughly mix the homogenized sample and pipette into a Palmer counting cell. Algal suspensions that produce between 10 and 20 cells in a field provide good densities for counting and identifying cells. . Lower densities slow counting.
    - Dilute samples if cells overlap too much for counting.
    - Identify and count 300 algal "cell units" to the lowest possible taxonomic level at 400X magnification. Distinguishing cells of coenocytic algae and filaments of blue-green algae as 10 mm sections of the thallus or filament.
    - For diatoms, only count live diatoms and do not identify to lower taxonomic levels.
    - Record numbers of cells or cell units observed for each taxon.
    - Make taxonomic notes and drawings of important specimens.
- Palmer counting cells will be utilized to identify and count soft-algae.
- Relative abundances of "soft" algae are determined by dividing the number of cells (cell units) counted for each taxon by the total number of cells counted (e.g., 300).
- Estimate total taxa richness by adding the number of "soft" algal taxa and diatom taxa.

Data on algal populations will be collected using both point and line intercept sampling methods. Percent algal cover will be calculated as an algal indicator of productivity measured as algal abundance using a point-intercept collection methodology. Algal cover will be the amount of microalgae coating and macroalgae taken at 2 foot intervals (60 cm) along each transect. The percentage of the points across the transects will provide an estimate of percent algal cover. Line intercept methodology will be used to further characterize macro-algal and riparian conditions. The presence/absence (distance occupied along transect) of attached macroalgae or unattached, floating macroalgae, emergent vegetation, dried and floating algal mats, and riparian canopy will also be recorded along each transect.

Point-Intercept Sampling

- Beginning with the downstream transect at each site, for each point along the transect, the presence of algae will be recorded and identified as microalgae or macroalgae. Microalgae is defined as a "film-like coating" of algae.
- Sample periphyton at 2 foot (60 cm intervals).
- Characterize microalgal cover. Measurement of microalgae thickness will follow the method identified in Fetscher, et al. 2009 and an estimate of film-like coating will follow descriptions in Table 2. Thicker microalgae layers will be measured using a ruler or rod with demarcations at 1, 5, and 20 mm.
- The presence/absence of attached macroalgae or unattached, floating macroalgae will also be recorded at each point.
- Photograph transect condition (from both endpoints).
- Photograph benthic conditions at 10 foot intervals using an underwater camera and viewing bucket marked with a 7 X 7 grid.
- Measure water depth at each sampling location.
- Characterize macroalgal biomass. Record the species and length of macroalgae. If two or more genera of macroalgae are present, measure and record information for each type of macroalgae separately.

Line-Intercept Sampling

- Cover along transects occupied by floating and attached algal mats will be recorded using the line-intercept method. Distance occupied by algal mats divided by total distance of the transect provides an effective measure of instantaneous absolute cover.
- Where individual cyanobacterial colonies can be visually differentiated in the periphyton, distances for these colonies will be recorded.
- Data on emergent and riparian canopy cover will be collected along each transect (if present)

Periphytic algal monitoring and sample collection will occur under certain conditions and following specific river management and operational events, noted below, at the sites described above.

- Transects will be established beginning in mid-May, or at least one month after storm events with sufficient power to mobilize gravels and sand/silt. Monitoring of percent algae cover and collection of samples will be completed with establishment of the transects.
- The next monitoring and sampling event will occur when the river mouth is closed, in an extended perched condition, or with an outlet channel in place and the water surface elevation

at the Jenner gage is at or approaching 4.5 feet. Monitoring and sample events will be repeated as needed with each 2 foot stage change (e.g. 6.5 feet and 8.5 feet) until the river mouth returns to an open condition or at the end of the monitoring period (October 15).

Datasonde data management will include downloading datasets from the YSI 6600 datasondes to YSI 650MDS hand units in the field.

- The datasets are downloaded from the 650 MDS to a Sonoma Water personal computer (PC) and are converted to excel files.
- Individual electronic files for each downloaded dataset are kept in project files on the Sonoma Water computer network in .dat, .cdf, and .xls format.
- The data is stored on a water quality database and maintained by Sonoma Water staff under the supervision of Jeff Church.
- Datasonde data is analyzed by Jeff Church for accuracy and to ensure datasondes were operating properly during data collection. Calibration logs are utilized in the process of identifying valid and invalid data.
- Invalid data is flagged and a separate electronic file of the QC'd dataset is created for analysis, evaluation and reporting purposes. The invalid data is removed from the QC'd dataset for the purposes of statistical analysis to generate seasonal minimum, mean, and maximum values for each dataset.

Grab sample data management will include receiving laboratory results from the two contract laboratories: the Sonoma County DHS lab and Alpha Labs in Ukiah.

- Grab sample laboratory results for bacteria are received from the Sonoma County DHS lab in electronic pdf format.
- Grab sample laboratory results for nutrients and *chlorophyll a* are received from Alpha Labs of Ukiah in electronic (.xls and .pdf) and hard copy format.
- Hard copies of grab sample data are kept in project folders at the Sonoma Water offices.
- Electronic copies are stored in project files on the Sonoma Water computer network, and data is entered into the water quality database under the supervision of Jeff Church.

All data is analyzed for validity by Sonoma Water staff under the supervision of Jeff Church and all data undergoes a final QA/QC review by Jeff Church prior to analysis, evaluation, and reporting.

As described in Section 5.2, Reporting, data collected under this WQMP will be evaluated and provided in an annual report describing the results of the Sonoma Water Russian River Estuary water quality monitoring and sampling effort. The report will provide summaries of data observations recorded for each constituent sampled or monitored (not including the grab sample constituents previously mentioned as not undergoing analysis) and the impacts if any to aquatic habitat availability. Lab results will be provided as appendices to the annual report, as well as shared with the NCRWQCB and DHS, as they are QA/QC'd by Sonoma Water Senior Environmental Specialist Jeff Church. The report will also address the objectives of the monitoring plan described in Section 3.0, as well as address the purpose

and need of the plan described in Section 4. As described in Section 5.2, the report and its evaluation will help guide the adaptive management process and may also provide recommendations for changes to monitoring and sampling efforts to be conducted in subsequent years. The information from this report will also be used in a synthesis report being prepared by Sonoma Water that incorporates other Estuary studies and discusses trends and observations relating to the proposed permanent changes to minimum instream flows and Estuary management during the summer months.

5.4 Adaptive Management Approach

The Russian River Biological Opinion provides for an adaptive management approach to changes in Estuary management. Each year in coordination with NMFS, CDFW, and the Corps, Sonoma Water prepares an annual barrier beach outlet plan by April 1 for their review and input. Water quality results will be considered if any revisions to the adaptive management approach are considered for recommendation.

The Biological Opinion's Incidental Take Statement allows for artificially breaching the lagoon using methods that do not create a perched lagoon twice per year between May 15 and October 15 (the lagoon management period) during the first three years covered by the Biological Opinion, and once per year during years 4-15. NMFS assumes that experience gained during years 1-3 and remediative steps associated with modification of the jetty or flood management options will improve the proficiency of Sonoma Water at maintaining a closed or perched lagoon. If the estuary is breached using methods that create a deep channel through the bar more than the number of times indicated above, or biological monitoring indicates periods of adverse water quality throughout the estuary longer than 3 to 4 weeks, then incidental take may be exceeded. As described in the Biological Opinion, NMFS anticipates 3 to 4 weeks of adverse water quality conditions after the sandbar closes the mouth of the estuary. A longer period of adverse water quality conditions may indicate that the formation of a closed lagoon or the creation of a perched lagoon by adaptive bar management has resulted in unanticipated water quality degradation (for example, dramatic reductions in invertebrate prey items, or temperatures over 23 degrees Celsius throughout the water column, or dissolved oxygen levels near zero throughout the water column) (NMFS 2008).

6.0 References

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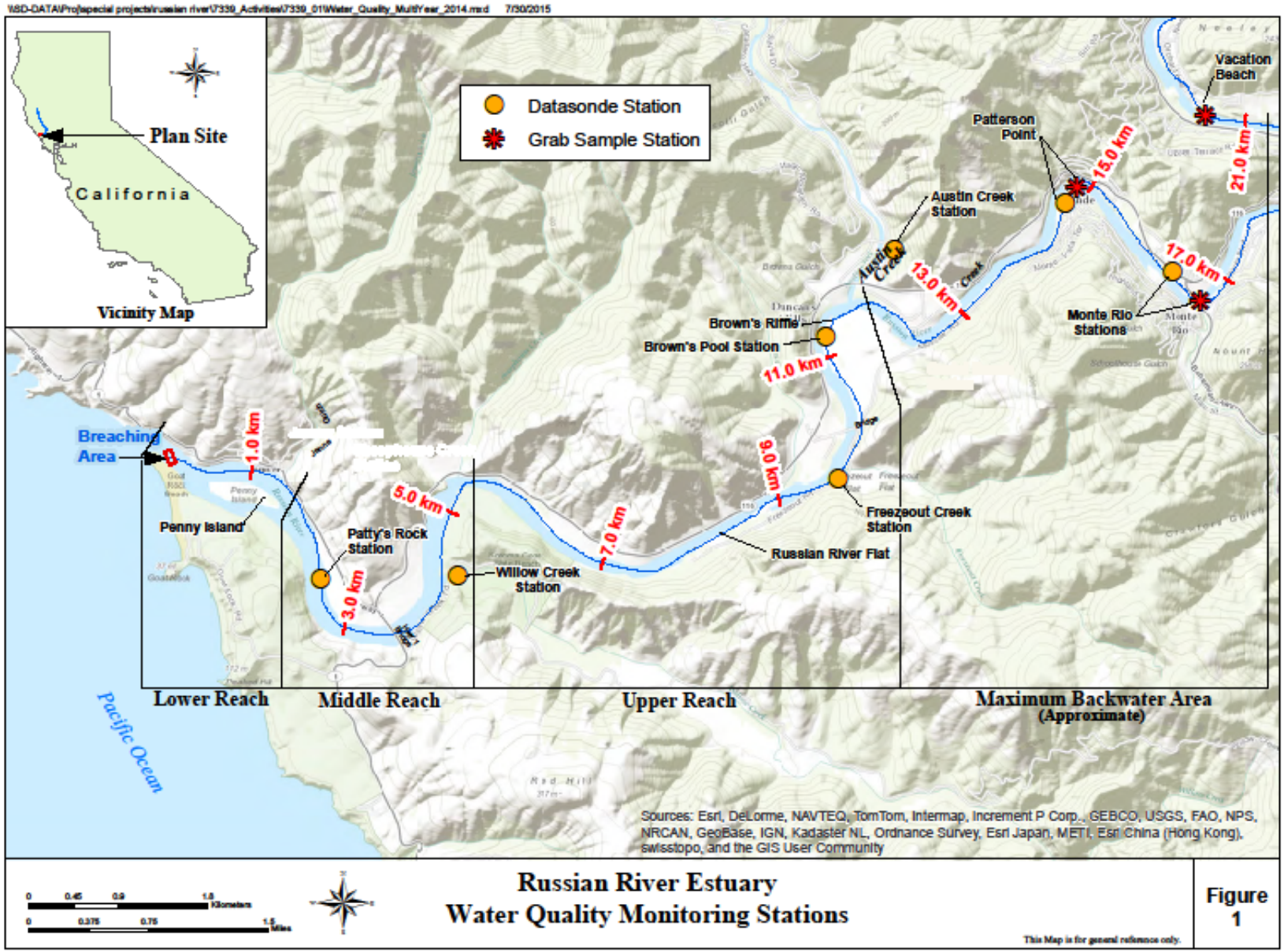
Datasonde Station
Grab Sample Station
Plan Site
California
Vicinity Map
Vacation Beach
Patterson Point
15.0 km
21.0 km
Austin Creek Station
Austin Creek
13.0 km
17.0 km
Monte Rio Stations
Brown's Riffle
Brown's Pool Station
11.0 km
Breaching Area
1.0 km
9.0 km
5.0 km
7.0 km
Freezeout Creek Station
Penny Island
Patty's Rock Station
Willow Creek Station
3.0 km
Russian River Flat
Lower Reach
Middle Reach
Upper Reach
Maximum Backwater Area (Approximate)
Pacific Ocean
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Russian River Estuary
Water Quality Monitoring Stations
This Map is for general reference only.
Figure 1

APPENDIX A. National Field Manual for the Collection of Water Quality Data: U.S. Geological Survey Techniques of Water Resources Investigations, Book 9, Chapters A1-A9

There are multiple documents associated with the National Field Manual that are available online at http://pubs.water.usgs.gov/twri9A

APPENDIX B. Sonoma County Water Agency Quality Assurance Manual, Water Quality Manual

SONOMA COUNTY WATER AGENCY

QUALITY ASSURANCE MANUAL

WATER QUALITY MANUAL

July 9, 2013

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I. ORGANIZATIONAL STRUCTURE OF THE WATER QUALITY LABORATORY

A. Qualifications and Background of Laboratory Personnel

1. ***Qualifications for the Laboratory Coordinator:***

   a. **Education:** Any combination of education and training which would provide the opportunity to acquire the knowledge and abilities to conduct a variety of chemical, biochemical physical and bacteriological tests; use laboratory equipment and materials skillfully and safely; draw sound conclusions from laboratory analyses and, as necessary, make appropriate recommendations regarding treatment processes and water quality; plan, direct, and evaluate the work of others; interpret complex water quality regulation and develop procedures to comply; deal effectively with those contracted in the course of work; prepare clear and concise records, reports, and correspondence; develop and implement procedures to catalog and store records.

   b. **Experience:** Any combination of experience, which would provide the opportunity to acquire the knowledge and abilities listed above. Normally, three years of experience making chemical and bacteriological analyses and tests, preferably in a water or wastewater treatment plant. One year of supervisory experience is highly desirable.

   c. Possession of a valid California Driver's License.

   d. Possession of or have the ability to obtain within two years, a Grade III Laboratory Analyst/Water Quality Analyst Certificate issued by the California Water Environment Association or the California-Nevada section of the American Water Works Association.

2. ***Qualifications for the Water Agency Chemist:***

   a. **Education:** Any combination of education and training which would provide the opportunity to acquire the knowledge and abilities to perform chemical analyses and related laboratory work using sophisticated laboratory equipment and instrumentation; analyze test and evaluate results; keep records and prepare reports; plan, organize and coordinate laboratory activities; and lead and train other workers. Normally, graduation from a four year college or university with major in chemistry, bacteriology, chemical engineering, sanitary engineering or a closely related field.

   b. **Experience:** Any combination of experience, which would provide the opportunity to acquire the knowledge and abilities, listed above. Normally, one year of experience performing chemical and bacteriological analyses and tests, preferably in a water and wastewater treatment plant.

   c. Possession of a valid California Driver's License.

   d. Possession of a Grade II CWEA Laboratory Analyst certificate.

   e. Possession of a California Water Treatment Plant Operator License - Grade T2 required within two years of employment.

II. QUALITY ASSURANCE (QA) OBJECTIVES FOR MEASUREMENT OF DATA

The analytical methods in use at the Sonoma Valley Treatment Plant and the Russian River Treatment Plant laboratories are from Standard Methods For the Examination of Water and Wastewater (*Standard Methods*), the Environmental Protection Agency (EPA) published methods, from instrumentation handbooks, and from methods developed by laboratory staff (used for process control only). No method will be used for regulatory reporting unless it is approved by the California Department of Public Health (CDPH) or by the USEPA for the National Pollutant Discharge Elimination System (NPDES) Monitoring and Reporting Program. Quality control (QC) measures differ with each analytical method, therefore, each method contains its own QC procedures. Since many of the terms employed in the QC procedures are not fully described elsewhere in this document, some brief definitions are shown in section B. below.

A. Quality Assurance Objectives

The Sonoma County Water Agency Water Quality Laboratory Quality Assurance Program (QAP) is designed to meet the following objectives:

1. Provide a true assessment of water and wastewater quality and maintain quality control of the water and wastewater purification processes.
2. Ensure compliance with monitoring requirements of federal, State, and local authorities.
3. Provide accurate data for management to use as a basis for process control decisions.
4. Obtain and ensure continuation of relevant certifications and accreditation to validate the laboratory's training program.
5. Ensure the defensibility of analytical results.
6. Provide documentation of all QC data generated by the laboratory for a period of at least five years.

The Chemist (or designee when unavailable) reviews all data reported by the laboratory before it is used to make decisions. The Laboratory Coordinator also reviews data produced by the Sonoma County Water Quality Lab and by contract laboratories to ensure that data quality objectives are met.

B. Definitions of QA/QC Terminology

1. **Accuracy**: A combination of bias and precision of an analytical procedure, which reflects the closeness of a measured value to a true value.

2. **Bias**: A consistent deviation of measured value from the true value cause by systemic errors in a procedure.

3. **Blanks**:
    a. "**Travel**": Analyte free water brought to the sample site in sealed containers and then brought back to the laboratory as a sample.
    b. "**Equipment**": Trip blanks opened in the field, poured over or through the collection device, collected in a sample container, and returned to the laboratory as a sample.
    c. "**Method**": Method blanks approximate the matrix of the sample. They are spiked with surrogates and internal standards (if necessary) prior to being put through the analytical procedure.

4. **Calibration Check Standard**: A standard used to verify instrument calibration between periodic recalibrations.

5. **Confidence Coefficient**: The probability, % that a measured result will lay within the confidence limits.

6. **Confidence Interval**: A set of possible values within which a value will lie with a specified level of probability.

7. **Confidence Limit**: One of the boundary values defining the confidence interval.

8. **Detection Limits**:

   a. "**Instrumental**" - (IDL): The constituent concentration that produces a signal greater than five times the signal to noise ratio of the instrument. This is similar in many respects, to "Critical level" and "Criterion of detection". The latter limit is stated as 1.645 times the standard deviation (SD) of blank analyses.

   b. "**Lower Limit of Detection**" - (LLD): The constituent concentration in reagent water that produces a signal 2 x 1.645 x SD above the mean of blank analyses. These sets both type I and type II errors at 5%. Other names for this limit are "Detection Limit (DL)" and "Limit of Detection (LOD)".

   c. "**Method**" - (MDL): The constituent concentration that, when processed through the complete method, produces a signal with a 99% probability that it is different from the blank. For seven replicates of the sample, the mean must be 3.14 x SD above the blank where SD is the standard deviation of the mean for seven replicates.

   d. "**Reporting Limit**" - (RL): The lowest concentration of analyte, which will be reported by the laboratory. This concentration is typically 3-5 times the MDL or equivalent to the PQL.

   e. "**Limit of Quantification**" - (LOQ) or "Practical Quantitation Limit"-(PQL): The constituent concentration that produces a signal sufficiently greater than the blank can be detected within specified limits by good laboratory practices during routine operations. Typically, it is the concentration that produces a signal 10 times the SD, where SD is the standard deviation of the mean for seven water blank replicates.

9. **Duplicate**: Two repeat samples collected at the same time and location.

10. **Laboratory Control Standard**: A standard, usually certified by an outside agency, used to measure the bias in a procedure. For certain constituents and matrices, use National Institute of Standards and Technology (NIST) standard reference materials or other reputable reference materials.

11. **Precision**: A measure of the degree of agreement among replicate analyses of a sample, usually expressed as the relative percent difference (RPD).

12. **Quality Assessment**: A procedure for determining the quality of laboratory measurements by use of data from internal and external quality control measures.

13. **Quality Assurance (QA)**: A definitive plan for laboratory operations that specifies the measure used to produce of known precision and bias.

14. **Quality Control**: A set of measures within a sample analysis methodology to assure that the process is in control.

15. **Random Error**: The deviation in any step in an analytical procedure that can be treated by standard statistical techniques.

16. **Replicate**: A repeated operation occurring within an analytical procedure. Two or more analyses for the same constituent in an extract of a single sample.

17. **Standard Curve**: A series of three or more standards containing the analyte of interest. Each standard is composed of different concentrations of the analyte: from near the Reporting Limit to a higher level to bracket the expected concentration of the sample analyte. The resulting data is statistically processed to provide a means to quantify the amount of the analyte in the samples.

18. **Surrogate Standard**: A pure compound added to a sample in the laboratory just before processing so that the overall efficiency of a method can be determined.

19. **Type I Error**: (Also called an "Alpha" error): is the probability of detecting a constituent when it actually is absent.

20. **Type II Error**: (Also called a "Beta" error): is the probability of not detecting a constituent when it actually is present.

III. SAMPLING PROCEDURES

A. Sampling Program Objectives

1. Regulatory:

   a. Sampling and analysis of municipal water and wastewater is required by the following regulatory agencies: California Department of Public Health (CDPH), California Regional Water Quality Control Board (CRWQCB) and the Environmental Protection Agency (EPA).

   b. Frequency requirements are determined by the regulatory agencies.

2. Process Control:
   Sampling for process control purposes is conducted for both the water and wastewater treatment plants.

3. Research and Development:
   Special needs projects are conducted from time to time. The sampling objectives for each project will vary depending on information needed.

B. Sample Volumes, Preservation, and Holding Times

1. Use TABLE 1 to observe collection, preservation, and holding time requirements for constituents of water and wastewater.

2. The sample holding times will be those prescribed in Standard Methods, 20th Edition when applicable. However, most samples analyzed by Water Quality Laboratory staff are 24-hour composite or grab samples that are tested immediately after collection.

TABLE 1: COLLECTION, PRESERVATION, AND MAXIMUM HOLDING TIMES

Analysis	Volume of Sample-Container Required	Preservation	Holding Time
Alkalinity	250 ml - P, G	≤ 6.0°C	14 days
Biochemical Oxygen Demand (BOD)	100-500 ml - P, G	≤ 6.0°C	48 hours
Chlorine Residual	200 ml - P, G	≤ 6.0°C	Analyze ASAP
Coliform (Total and Fecal)	100 ml - P, G (sterile)	≤ 6.0°C	6 hrs waste water 8 hrs source water 30 hrs drinking water
Fish Bioassay (acute or chronic)	20 L - carboy	≤ 6.0°C	36 hours
Hardness	100 ml - P, G	HNO_3 to pH<2	6 months
Oxygen, Dissolved (Winkler)	300 ml BOD Bottle	Chemicals, 4°C	8 hours
pH	100 ml - P, G	≤ 6.0°C	15 minutes
Settleable Solids	2000 ml - P,G	≤ 6.0°C	7 days
Specific Conductance	100 ml - P,G	≤ 6.0°C	28 days
Temperature	measure at collection	Not applicable	Not applicable
Total Dissolved Solids (TDS)	500 ml - P, G	≤ 6.0°C	7 days
Total Suspended Solids (TSS)	1000 ml - P, G	≤ 6.0°C	7 days
Turbidity	100 ml - P, G	≤ 6.0°C	48 hours

C. Sampling Quality Control Procedures

Sampling procedures for both water and wastewater collection will be reviewed periodically, and corrected or revised when necessary.

D. Sample Point Collection

Sample point collection will be determined by regulatory agencies or will be predetermined by operators of the treatment plant facilities.

IV. CUSTODY, HANDLING, and DISPOSAL OF SAMPLES

A. Chain of Custody

A Chain of Custody (COC) form is used to document sample testing information from sampler to courier to lab receipt. A COC serves as a work order and a communication tool. A COC contains sampling information: date and time of collection and receipt, number and type of sample containers, preservative(s) added, analyses requested, sample handling precautions, and transition information.

B. Sample Labeling

1. Sample containers will be labeled by number and the number will correspond to specific locations. When locations do not correspond to a number, then a label with the following information will be placed on the sample bottle:

    a. Sample point - address or location at which sample is taken.
    b. Sample source - Source water description.
    c. Time and date sample is taken.
    d. Name of the sample collector.
    e. Preservative (if any)
    f. Analyses to be performed on the sample.

2. The above information, in addition to the time and date the sample arrived at the laboratory, shall be written in the Sample Receiving Logbook, which shall also contain other information gathered at the time of collection (i.e., Cl_2 residual).

3. To document information gathered at the time of collection, a Chain of Custody (COC) document is required to be filled out by the sampler for each sample collected. If possession of the samples changes hands (i.e., sent to the laboratory), the COC must be signed by both sender and receiver of the samples.

4. Wastewater samples will be labeled according to sample point and logged in the Sample Receiving Logbook.

C. Logbooks

Logbooks / Worksheets are maintained for:

1. Total Alkalinity as CaCO3
2. Mettler Balance Calibration (2)
3. Bioassay Instrumentation Calibration
4. Biochemical Oxygen Demand (BOD)
5. Dissolved Oxygen Meter Calibration / Temperature
6. Conductivity
7. Equipment Maintenance
8. Field Worksheets (Receiving Water Collection)
9. Settleability
10. pH
11. Standards / Reagents Preparation Log
12. Total Residual Chlorine
13. Settleable Solids
14. Total Dissolved Solids
15. Temperature Log (Incubators, Ovens, Refrigerators, Water Baths)
16. Temperature Log for Chronic Bioassay
17. Thermometer Calibration Log
18. Total Suspended Solids
19. Turbidity
20. Ground Water Field Data
21. Media Preparation
22. Sample Receiving Logbook

These logbooks contain the above label information mentioned above, date analyzed, analyst, calculations, and results or maintenance information.

D. Sample Disposal

1. Non-hazardous samples

Samples are disposed after all analyses have been completed and data report generated. Samples that are not hazardous waste are disposed into the sewer system. pH neutralization is practiced for large quantities of acidic or basic waste.

2. Hazardous waste

Reagents containing hazardous waste are segregated and stored until sent to a commercial hazardous waste disposal facility, as required by law.

V. INSTRUMENTATION

A. Microbiological Examination Apparatus

1. Autoclave
2. Balance, Top Loading (to 0.01 gram)
3. Incubator for Total Coliform
4. Magnetic Hot/Stir Plate
5. Vortex Mixer
6. Water bath for Fecal Coliform

B. General Chemistry and Physical Properties Apparatus

1. Amperometric Titrator
2. Analytical Balance (to 0.0001 gram)
3. Balance, Top-Loading (to 0.01 gram)
4. BOD Incubator
5. Conductivity Bridge
6. Dissolved Oxygen Meters
7. Fume Hoods
8. Magnetic Hot/Stir Plates
9. Muffle Furnace
10. Ovens
11. pH Meter and Ion Selective Electrodes
12. Turbidimeter
13. Water Baths

C. Additional Equipment

1. Automatic Glassware Washer
2. Bioassay Tanks: Flow-Through, Water-Incubated
3. Pipettors and Dispensers
4. Refrigerators

D. Personnel Training on the Instruments

Staff is trained on the instruments either by equipment representatives and/or by experienced technicians with the aid of the manufacturers' instrument manuals.

E. Instrument Manuals

The manufacturers' instrument manuals are used for training and for reference. They are kept on file in the laboratory library and online in the laboratory directory.

VI. INSTRUMENT INSPECTION, CALIBRATION, AND SERVICE

A. TABLE 2: Instrument Inspection, Calibration, and Service Frequencies - General

Instrument	Inspection / Instrument Check	Calibration	Service Frequency
Autoclave Max Temperature Sterility Check Timer Check	Each Use Weekly Per use Quarterly	As Needed	As Needed
Balances	Each Use	Monthly	Annually
Conductivity Meter	Each Use	Each Use	As Needed
BOD Incubator	Daily	Annually	As Needed
Coliform Incubator	Twice a Day	Annually	As Needed
TDS Oven	Each Use	Annually	As Needed
TSS Oven	Daily	Annually	As Needed
pH Meter	Each Use	Each Use	As Needed
Refrigerator	Daily	Annually	As Needed
Tubidimeter	Each Use	Quarterly	As Needed
Water Bath (Fecal coliform)	Twice a Day when in use.	Annually	As Needed

1. Prior to use each instrument is inspected for proper and safe operation by the technician. Before analysis is begun, each instrument is calibrated until an acceptable calibration limit is reached. The manufacturer's manual is referenced for trouble-shooting the instrument. All thermometers are calibrated annually against NIST thermometer.

2. Ovens and refrigerators temperatures are checked and recorded daily with necessary corrections noted in the Laboratory Temperatures Logbook.

3. Microbiological incubator and water bath temperatures are logged twice a day with at least 4 hours in between readings. Any corrections made are recorded in the Laboratory Temperatures Logbook. Weekends exempted.

B. Calibration Procedures

1. The calibration for each instrument is made in accordance with the manufacturer's instrument manual or by Standard Method / EPA specification. For each calibration performed there is a limit of acceptance to ensure accuracy of the equipment.

2. Thermometers for each instrument are calibrated against a National Institute of Standards Testing (NIST) certified thermometer at least annually. Temperature adjustments are made on each instrument when they do not fall within the following temperature range limits. Any adjustment made is recorded in the Instrumentation Calibration Logbook by the analyst.

C. TABLE 3: TEMPERATURE SETTINGS FOR HEATING / COOLING EQUIPMENT

Instrument	Temperature ± Range (°C)
Autoclave	121.0 ± 1.0 (@ 15PSI)
BOD Incubator	20.0 ± 1.0
Incubator - Bacteriological	35.0 ± 0.5
Oven - Total Dissolved Solids (VWR)	180 ± 2
Oven - Total Suspended Solids (VWR)	103 - 105
Refrigerators	≤ 6.0
Water Bath - Fecal Coliform	44.5 ± 0.2

1. Balances: An internal balance calibration is performed prior to each use. The calibrations of all balances are checked against certified Class "S1" weights monthly.

2. pH Meter: A daily standardization using three buffers is performed daily. An Internal Calibration Verification Standard (ICVS) is performed prior to any analysis to check for drift. The slope must fall within a slope range of 92 - 102 (theoretical slope 100). Recalibration or maintenance is performed if the slope is outside of this range.

3. Conductivity Meter: The conductivity meter is equipped with an electrode used to measure conductivity and also has an internal temperature sensor used for automatic temperature compensation. A standard KCL solution is measured and the result is used to calibrate the meter by setting the internal cell constant. The calibration of the conductivity meter is checked daily against a NIST-traceable reference standard. Recoveries must meet the control criteria and/or be between 90 – 110 %.

4. Turbidimeter: The Nephelometer is calibrated quarterly against primary standards. A calibration check with secondary standards is performed with each analysis and must be within ± 2% of the true value. If the measurement(s) do not fall in this range, the instrument is recalibrated with primary standards.

D. Calibration Frequencies

For regulatory samples, all analyses with more than ten samples in the run will be interrupted to analyze a calibration check standard and calibration blank after every tenth determination. Recalibration will be done if the check sample is not within ±10% of the original standard.

E. Service of Instruments

The balances will be serviced at least annually according to the instrument manufacturers' recommendations. Other instruments will be serviced according to manufacturers' instructions as need requires.

F. Preventive Maintenance

1. Preventive maintenance will be done on each instrument as it is used or when needed. Each instrument has a logbook in which maintenance records are logged. Log entries contain the following information: date, problem, corrective action, name of the person who performed the work, and the date the instrument was placed back in service.

2. A replacement parts inventory is maintained for each instrument so that backup parts exist for each expected failure.

3. Laboratory Analysts service the majority of the instruments in the lab after a malfunction is discovered. Usually, the service requires a solution renewal, electrode or bulb replacement, temperature or volume calibration, etc. If the instrument requires manufacturer service, the instrument is scheduled for maintenance with the manufacturer or authorized service representative.

VII. ANALYTICAL PROCEDURES

A. Standard Methods and EPA methods

1. Standard Methods (20th edition) will be used for the following Microbiology of Drinking Water and Wastewater analyses. Analytes and methods used are shown below (TABLE 4):

TABLE 4

Microbiology of Wastewater Methods	Standard Method, 20th Ed. (or other)
Total Coliforms, by Multiple Tube Fermentation	SM 9221 B.
Fecal Coliforms, by Multiple Tube Fermentation	SM 9221 C, E.

2. For the analysis of acute fish bioassays the following reference will be used: "Methods For Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", 5th Edition, EPA-821-R-012. The methods to be used are listed in the reference below (TABLE 5):

TABLE 5

Acute Toxicity Methods	EPA Reference
Freshwater Acute Toxicity	EPA-821-R-012

3. Standard Methods or EPA methods will be used for the analysis of Wastewater Inorganic Chemistry, Nutrients and Demand. The analytes and methods to be used are listed below (TABLE 6):

TABLE 6

Inorganic Chemistry of Wastewater Methods	Method
Alkalinity	SM 2320 A, B
Biochemical Oxygen Demand	SM 5210 B
Chlorine Residual, Total	SM 4500-Cl D
Hardness, Total	SM 2340 C
Oxygen, Dissolved	SM 4500-O C, G
pH	SM 4500-H+ B
Residue, Filterable (Total Dissolved Solids)	SM 2540 C
Residue, Nonfilterable (Total Suspended Solids)	SM 2540 D
Settleable Solids	SM 2540 F
Specific Conductance	SM 2510 B
Turbidity	SM 2130 B

B. Other Methods

Analytical procedures other than those listed in this manual will be used for process control purposes only and will not be used for monitoring requirements. When new methods are developed, they must be approved by the EPA and the CDPH before routine application to meet monitoring requirements. Modifications of a Standard Method or EPA Method (i.e., change in chemistry of test) may be made with Alternative Test Protocol or other approval from EPA and/or per CDPH approval through the Environmental Laboratory Accreditation Program (ELAP).

VIII. DATA ACQUISITION AND REDUCTION

A. Significant figures

All digits in a reported result are expected to be known definitely, except for the last digit, which may be in doubt. If more than a single doubtful digit is in a result, the extra digit(s) is (are) not significant *and should not be reported*.

Reported figures will be justified by the accuracy of the work. Rounding off will be done by dropping digits that are not significant. If the digit 6, 7, 8, or 9 is dropped, increase the preceding digit by one unit. If the digit 0,1,2,3 or 4 is dropped, do not alter the preceding digit.

If the digit 5 is to be dropped and it is followed by other non-zero digits, increase the preceding digit by one unit; but if the digit 5 is to be dropped and there are no figures other than zero beyond it, round off the preceding digit to the nearest even number. The digit 0 may record a measured value, or it may serve as a spacer to locate a decimal point.

B. Units

TABLE 7: Concentration units will be expressed as indicated below

COMMON NAME OF UNIT	ABBREVIATION OF UNIT
Degrees Celsius	°C
Degrees Fahrenheit	°F
Microgram per liter	µg/L
Micromhos per centimeter	µmhos/cm
Milligram per liter (water)	mg/L
Milligram per kilogram (solids)	mg/kg
Milliliters per liter per hour	ml/L/hr
Most Probable Number	MPN
Nephelometric Turbidity Units	NTU
Survival	%

The International System of units (SI) will be used as a general rule; however, terms like ppm and acre-feet will occasionally be used. When these terms are used, they will be used with equivalent SI values shown parenthetically when requested.

C. Data Reduction

1. The data system will process raw data and develop finished data. The data system may be a hand-written logbook or a printout from analytical instrumentation. Hard copy logbooks are used primarily for recording raw analytical data. Spreadsheet data reports are generated from the raw data.

2. Quality Control tests are performed for each analytical test to ensure the data is accurate and defensible. Common QC parameters are:

    - Matrix spike percent recovery
    - Duplicate analysis RPD
    - Average of Duplicates
    - Reference Standard percent recovery
    - Means QC charts (optional, used when test bias is an issue)

3. Raw data includes handwritten and printed measured values, dilution and concentration factors, sample treatment and calculations. Some instrumentation produces raw data printouts.

4. Finished data includes spreadsheet data reports, standard curve analysis, and computer generated printouts.

IX. DATA VALIDATION and REPORTING

A. Data Validation

All analytical results are passed through the review process. The review process will include but not be limited to:

1. Assuring proper documentation
2. Checking sample data against historical values
3. Adherence to preservation and holding times
4. Adherence to established Standard Operating Procedures (SOPs)
5. Verifying calculations
6. Verify applicable reference standard(s), calibration, precision and matrix spike recovery criteria are acceptable
7. Comparison of new quality control data against established control charts

All data that does not pass the data validation step will not be reported. Affected samples will be re-run if the sample is still within holding time. If the sample can is not within hold time for the affected analysis or the sample has been discarded, the affected sample data will be invalidated**.**

B. Data Reporting

1. Final Data Reports

Final reports will be submitted only when all relevant data has been reduced and validated.

2. Compliance Monitoring Reports

All Self-Monitoring Reports submitted for compliance will be completed and delivered to the applicable Regional Water Quality Control Board (North Coast or San Francisco) and CA DPH by their permit required due dates. Completion of compliance monitoring reports will take priority over all other reports. Analytical results are issued in report formats that are intended to satisfy the permitting agencies requirements. A variety of report formats are available to meet specific needs. Some agencies require printed reports, some require uploading of data into computer databases or exporting of report data to spreadsheets.

C. Compliance with Drinking Water Standards

1. Physical Constituents

a. Turbidity:

i. If a daily sample of filtered water exceeds 0.5 NTU, a resample shall be taken within one hour.
ii. If the average of the resample plus the original sample exceeds 0.5 NTU, California Department of Public Health (CDPH) will be notified within 48 hours.
iii. The repeat sample shall be the same sample used for the purpose of calculating the monthly average.
iv. If the monthly average of the daily samples exceeds 0.5 NTU, or if the average of two samples taken on consecutive days exceeds 2.0 NTU, California Department of Public Health (CDPH) will be notified.
v. The public shall be notified if the following occurs:
- Monthly average of all daily samples exceeds 1.0 NTU.
- Average of two samples taken on two consecutive days exceeds 5.0 NTU.

2. Microbiological Examinations

a. Total Coliform:

i. If more than 5.0% of the distribution or treated water samples collected during a month are total coliform positive, then the system is not in compliance.

ii. Any positive fecal-coliform, E. coli, or total-coliform repeat sample following a fecal-coliform-positive or E. coli-positive routine sample, constitutes a violation of the MCL for total coliform and will initiate public notification.

iii. Additional actions initiated after the positive test result will include prompt review of operating practices and current bacteriological data.

- Immediate efforts to be taken within 24 hours of the positive test result shall include sampling, media preparation and handling checks, and technique review to identify possible causes of the positive test result.

- Daily follow-up samples from 5 upstream and 5 downstream locations plus the positive sample location will be taken until the results from 3 consecutive samples from the original sample location are total-coliform negative.

b. Fecal Coliforms:

i. If any routine or repeat sample is total coliform-positive in the system, the laboratory must analyze that total coliform-positive culture to determine if fecal coliform is present. Testing for E. coli may be substituted for fecal coliform testing. If fecal coliform or E. coli is detected, public notification procedures go into effect before the end of the same business day. If any repeat sample was fecal coliform-positive or E. coli-positive is followed by a total coliform-positive sample and the original total coliform-positive sample is not invalidated, then the system is in acute violation of the MCL.

ii. Any indication of gross contamination of the water supply or any substantiated report of waterborne illness will be forwarded immediately to the Department of Public Health.

iii. All action taken to eliminate questionable conditions shall be documented and available to the Department of Health Services.

3. Public Notification:

a. If public notification is necessary, the following agencies shall be contacted: the California Department of Public Health, Sonoma County Health Department and the public.

b. The State and County Health Departments will be notified by phone and confirmed by letter.

c. The public will be notified by radio, TV, newspapers and any other means of rapid communication. The means of notification and the wording will be selected together by County and City management and the Health Departments.

D. Compliance With NPDES Wastewater Discharge Requirements

Reports to the California Regional Water Quality Control Boards for noncompliance are made by telephone or email within 24 hours. A follow-up written report is submitted within two weeks (or with the monthly report whichever the Board prefers). The written report includes a statement of the incident, and immediate and future actions undertaken or proposed which bring the discharge into full compliance.

E. Record Retention

The Agency's record retention policy is as follows:

All hard copies/original documents pertaining to laboratory results, plant and laboratory operations are kept by or accessible to the laboratory for at least 5 years and a maximum of 10 years.

X. INTERNAL QUALITY CONTROL

Internal quality control checks are employed with all analyses to ensure accurate data is being reported and to ensure data is defensible.

Commonly employed internal QC checks are:

1. Method Blank (MB) *Also referred to as Laboratory Reagent Blank (LRB)*
2. Laboratory Control Sample (LCS) *Also referred to as a spiked blank or a Laboratory Fortified Blank (LFB)*
3. Duplicate sample analyses (D or DUP)
4. Matrix Spike (MS) and Matrix Spike Duplicate (MSD) *Also referred to as a Laboratory Fortified Matrix (LFM) and LFM Duplicate*
5. Initial and Continuing Calibration Verification Standards (ICV & CCV)
6. Reference standard (REF) = "second source standard" or "external standard"

XI. ASSESSMENT OF PRECISION and ACCURACY

A. General Quality Control Acceptance Limits based on EPA CLP Criteria

When a Quality Control chart is not available for comparison, general QC acceptance limits shall apply (based on generally accepted QC limits – EPA CLP Protocol):

1. Spike recovery limits: 80-120% recovery for drinking water; 75-125% for wastewater matrices.
2. Precision limits: < 20% Relative Percent Difference is acceptable
3. Reference Standard: 90-110% of true value for standard (or per stated acceptable limits).

B. Establishing Acceptance Limits: Control Charts

Quality Control worksheets using Microsoft Excel are established after 35 samples have been analyzed per analyte for the following QC: (1) Replicates, (2) Matrix Spikes, and (3) External Reference Samples (i.e., Laboratory Control Samples). Control charts are maintained for most analytes and include acceptance/rejection limits

Some analytes, such as pH and alkalinity, cannot be spiked, so matrix spike QC charts do not exist for such analytes.

Control limits are calculated as follows:

- Calculate the mean of the data set
- Calculate the standard deviation of the data set
- Lower warning limit = mean – 2 standard deviations
- Upper Warning Limit = mean + 2 standard deviations
- Lower control limit = mean – 3 standard deviations
- Upper control limit = mean + 3 standard deviations

C. Replicate ("Duplicate") Samples

Replicate (commonly called "Duplicate") samples, prepared by splitting a sample into two or more aliquots, shall be analyzed with a minimum frequency of 10% per matrix batch of samples, or per sample if a single sample is analyzed.

A control chart for replicate samples and data sheets shall be maintained for each analyte. Prior to the establishment of control charts a relative percent difference (RPD) of 20% between replicates at a level greater than or equal to the Reporting Limit is acceptable.

D. Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Analyses

1. Spiked samples shall be analyzed at a minimum frequency of 10% of the samples analyzed per matrix, per batch of samples. If there are less than 10 samples per batch, at least one spiked sample per matrix, per batch must be analyzed. Samples shall be spiked at the lowest concentration corresponding to one of the following levels:

    a. Sample concentration (if greater than $1/5^{th}$ of the MCL)

    b. Mid-range concentration on calibration curve

    c. Maximum Contaminant Level of the analyte

2. Matrix spike duplicates (MS/MSD) analysis may substitute for replicate sample analysis. MS/MSD analysis is required for spiking samples when analyte(s) is below detection level(s).

3. Secondary source standards (different from calibration source) are employed for matrix spiking, if the method specifies to do so. Otherwise, calibration source standards are employed as the source of spikes.

4. Control charts and data sheets shall be maintained which include acceptance/rejection limits.

5. General acceptance/rejection criteria for matrix spikes are 80% to 120% recovery of the spiked analyte.

6. After 20 or more matrix spike analyses have been conducted per analyte, Means control charts shall be generated and used for control limits.

E. Limit of Detection Spikes

1. Acceptance / rejection criteria for detection limit spikes is 70% to 130% recovery for a spike level equal to the Reporting Limit.

F. External Reference Samples

1. Certified external reference samples shall be analyzed on at least a quarterly basis. The concentration of the samples shall be within the working range of the method with no pretreatment, dilution or concentration of the sample. External reference samples will not substitute for matrix spike samples.

2. Control charts, including acceptance/rejection limits, and data sheets shall be maintained for each analyte. Acceptance / rejection criteria for external reference samples may be the same criteria recommended by the supplier of the reference sample. If these criteria are not available, then the criteria for matrix spike samples may be substituted.

G. Method Blanks

A method blank shall be processed along with samples if the analytical method requires sample pretreatment, which is not applied to calibration standards. Method blanks shall be analyzed with a minimum frequency of 10% of the samples per matrix, per batch of samples. If there are less than ten (10), samples per batch, at least one blank per batch shall be analyzed.

H. Method-Specific Quality Control

The QA/QC requirements are defined in each SOP. Please refer to each SOP for review and acceptance criteria.

I. Sources of Standards and Reagents

1. Stock standards and reagents are purchased from reputable companies. ACS-grade or special-grade chemicals are preferentially purchased over other grades of chemicals.

2. Reference samples are purchased from ERA, Wibby, NSI, and HACH Co. EPA DMRQA, WP Study reference standards results are also used in evaluating the Water Quality Laboratory QA program.

XII. PERFORMANCE TESTING AND QUALITY ASSURANCE REPORTS

A. Quality Assurance Reports

In order to ensure that the QA Program maintains a high profile, the Laboratory Coordinator routinely conveys QA information to Water Agency Management, Treatment Plant Coordinators, and operations staff. The information communicated includes but is not limited to: Internal System Audits, Performance Testing Study summaries, External Audit findings, non-conformances, and any corrective actions to be initiated.

B. Performance Testing (PT) and DMRQA Studies

PT and DMRQA Studies are administered by CDPH-ELAP and USEPA to check the performance of accredited laboratories. The Sonoma County Quality Lab conducts Water Pollution (WP) and DMRQA Studies annually. In the event of an external PT sample failure, the Laboratory Coordinator is responsible for submitting a corrective action letter to the certifying agency explaining the cause of the failure as well as the corrective action taken.

C. Laboratory Audit Review (Internal or External)

All deficiencies and corrective actions discovered during a Laboratory audit shall be documented and brought to the attention of management as well as operations and laboratory personnel. All deficiencies, improvements, corrective actions, goals and comments of the evaluator shall be addressed and documented. The Laboratory Coordinator is responsible for submitting a corrective action letter to CDPH-ELAP in response to deficiencies noted during external audits. The corrective action letter will describe corrective action measures taken to prevent recurrence of any deficiencies noted during the external audit.

D. Review of Documentation

Logbooks are reviewed as analyses are completed to verify documentation is adequate to support data. Emphasis of this review is on:

1. Instrument calibration checks
2. Verifying the proper amount of QC was performed for batch analyses.
3. Holding times were observed
4. Sample preservation was employed

XIII. CORRECTIVE ACTIONS

All corrective actions shall be taken as soon as possible after discovery of a deficiency. Any deficiency that has resulted in invalidated sample results is documented in the logbook(s) for the affected analyses, which explains what the problem was, what samples were affected, when it happened, how it was corrected, and who corrected it, so that this information may be available for performance and system audits.

XIV. GOOD LABORATORY PRACTICES

Accepted good laboratory practices shall be adhered to at all times.

These include, but are not limited to:

1. Use of proper cleaning procedures for sample containers and laboratory glassware;
2. Use of highest quality grades of reagents and ASTM Type II laboratory pure water.
3. Compliance with existing health, fire and safety codes.
4. Maintenance of instruments with documentation.
5. Documentation of standard sources and preparation of media, solutions, and working standards.
6. Continual review process of all aspects of laboratory operation.

XV. EDUCATION OF PERSONNEL

A. Training

All laboratory personnel are trained in proper laboratory procedures. The training consists of formal instruction, reading, watching a procedure, performing the procedure until competency is proved, and bi-annual reviews. Chemist training is documented and available for review.

B. Conferences and Seminars

Lab personnel attend professional development training conferences and seminars whenever time and subject matter is appropriate. Additional training on specific instrumentation is provided by the manufacturer at the site and / or at the manufacturer's site as needed.

C. Improvement of laboratory dialogue

Lab dialogue occurs on an informal, basis in which discussions on Quality Assurance / Quality Control and testing procedures occur. Meetings which focuses on improvement of lab performance as it relates to plant activities are scheduled as needed.

D. Maintenance of a library

Libraries are located at each treatment plant in the laboratory and in the main operations building. These libraries contain books and journals on safety, microbiology, chemistry, ecology, bacteriology, biochemistry, water analysis, wastewater analysis, pretreatment sludge analysis and distribution.

XVI. LABORATORY SAFETY

A. Inventory of chemicals

An inventory of chemicals and supplies will be kept on file in the laboratory. Whenever any chemical or supply becomes low, it will be reordered. An effort will be made to order most chemicals and supplies on a "standing order" basis, since this method of purchasing reduces the probability of shortages.

B. Labeling of chemicals

All dangerous chemicals will be labeled according to the particular danger expressed. Right-To-Know (RTK) International hazard stickers (HMIS) will be used.

C. Material Safety Data Sheets

Material Safety Data Sheets (MSDS) are maintained for each chemical used and are on file in the laboratory in three-ring loose-leaf binders.

D. Training of Laboratory Personnel

Laboratory personnel are trained in safe laboratory practices through demonstrations, reading materials, hands-on training and meetings. The Laboratory's Chemical Hygiene Plan (CHP) is an additional training tool that is employed to detail specific laboratory safety issues.

E. Safety Meetings

Safety meetings are held on a regular basis. The meetings focus on a wide range of safety topics, from safe handling of chemicals and apparatus, toxicology, ergonomics, spill response, etc. Safety is emphasized in daily lab dialogues. Films are occasionally shown. Records of the meetings are kept on file.

APPENDIX C. Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California

There are multiple documents associated with Standard Operating Procedures that are available online at https://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/sops.html

APPENDIX D. California Watershed Assessment Manual: Volume II, Chapter 4

There are multiple documents associated with the California Watershed Assessment Manual that are available online at http://cwam.ucdavis.edu

APPENDIX E. Rapid Bioassessment Protocols for Use in Wadeable Stream and River: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition

Documents associated with the Rapid Bioassessment Protocols are available online at https://archive.epa.gov/water/archive/web/html/index-14.html

APPENDIX F. Addendum to the Water Quality Monitoring Plan for The Russian River Estuary Management Project to address Mainstem Russian River Ambient Algae Monitoring

APPENDIX F

Mainstem Russian River Ambient Algae Monitoring

Introduction

Monitoring of periphytic and planktonic algae will be conducted to gather ecological data for algal populations that are representative of habitats available in the Russian River under a variety of dry season flows. This effort is intended to identify the composition, abundance, cover and change over time of algal periphytic and planktonic taxa in the Russian River. Monitoring is also being conducted to gain a better understanding of how and what ecological conditions influence periphytic and planktonic algae populations in the Russian River. Green (Family Chlorophyta) taxa will be identified to the level of genus. Golden-Brown (Family Chrysophyceae) represented overwhelmingly by diatom taxa, will be grouped as Bacillariophyta. Blue-Green algae (Phylum Cyanophyta), or Cyanobacteria, will be identified to taxonomic level of genus where possible depending on visible diagnostic features present during sampling and monitoring.

Monitoring will be conducted every other week (bi-weekly) as soon as stream flows allow a systematic investigation of abundance, cover, and successional processes. Timing of surveys will follow spring draw down, approximately from June to October (or later in the season depending on weather and streamflow conditions), and target representative areas in the upper, middle, and lower Russian River. Transects to monitor and assess periphytic algal growth, including the potential presence of cyanobacteria, will be established at four surface water locations selected to represent the range of algal habitats available in the Russian River. Locations for sampling include establishing monitoring sites at Patterson Point, Syar Vineyards, Jimtown Bridge in Alexander Valley, and near Hopland (Figure 1).

Methodology

Sampling methodology has been developed based on modification of *Standard Operation Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Assessments in California* (Fetscher, et al. 2009), the *California Watershed Assessment Manual: Volume II, Chapter 4* (Shilling et al., 2005), and the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999).

The monitoring approach is summarized in the sections below and the sampling and monitoring methodology are discussed in further detail in the QAPP.

Transect Establishment

Transects to monitor and assess periphytic algal growth, including the potential presence of cyanobacteria, will be established at the four surface water sites selected to represent the range of algal habitats available in the Russian River. Monitoring sites in the Russian River will be located at: Patterson Point, located in the lower river in Villa Grande; at Syar Vineyards, located south of Healdsburg; at Jimtown Bridge, located in Alexander Valley, and in Hopland at the USGS gauging station (Figure 1).

Transects will be subjectively placed to collect data from areas with different habitat features including but not limited to depths, velocities, substrates, insolation, and emergent vegetation in the littoral zone. Transects will be placed to capture algal habitat variation in the littoral zone (riffles, runs, backwaters, boulders, gravel, sand, mud, sun, shade, etc.). As a result, transects will vary in length based on the habitat composition, but will typically be between 100 and 150 feet in length.

Photographs will be taken at each transect to document site conditions during each sampling event in each major algal habitat area (including underwater photographs of the condition of periphyton and floating mats of reproductive benthic algae). Transect locations will avoid locations such as tributaries, outfalls, and man-made structures to minimize influence of algal growth from contributions in nutrients, temperature, or canopy cover from such sources.

Collecting Cover Data

Identifying Taxa Present (Multi Habitat Algal Sampling)

Prior to collection of percent algae cover, algae samples will be collected 1 m downstream and adjacent to each point (to avoid trampling on samples during collection of percent algal cover data), beginning at the downstream transect. A multi-habitat sample will be collected at various points along 10 foot (3 meters) intervals on the transect that are representative of the variety of habitats present (up to a maximum of 5 samples per transect). Algal species present will be identified to the lowest taxa, preferably species but at least genera. Successional changes in genera over the season should provide a metric to assess species (genera) richness as well as document the stages in development of the periphyton layer. Each sample will be collected from the substrate that is uppermost within the stream and has highest possibility of sun exposure (i.e. if a thick layer of macroalgae covers the substrate, collection will include the layer). Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyta (Golden Brown Algae [diatoms]), and Cyanobacteria (Blue Green Algae). If cyanobacterial target species are identified (including species of *Anabaena*, *Microcystis*, *Planktothrix*, *Oscillatoria,* or *Phormidium*), they will be evaluated for seasonal changes in cover and the possibility of the presence of cyanotoxins will also be evaluated.

Estimating Taxa Richness and Abundance and Metrics Based on Species Composition

Estimates of species abundance will developed from 50 dot viewing bucket sampling, line intercept data, and the relative frequency of occurrence of each genera and species in the multi-habitat sample. Metrics will be calculated based on presence/absence data or on relative abundances of taxa. Percent community similarity will be calculated between sample locations. It will be calculated as the percent of species that are the same by making all relative abundances greater than 0 equal to 1. Metrics of biotic integrity evaluated will include species richness, total number of genera, and total number of taxonomic divisions (green, golden brown, red, blue-greens) present. The following metrics will also be calculated with presence/absence data (as feasible based on known algal indexes): % sensitive taxa, % motile taxa, % acidobiontic, % alkalibiontic, % halobiontic, % saprobiontic, % eutrophic, simple autecological indices, and change in inferred ecological conditions.

Figure 1. Mainstem Russian River Ambient Algae Monitoring Stations.

Cover data on algal populations will be conducted to estimate cover by both micro- and macro-algal taxa. Point intercept sampling provides an effective method to quickly estimate cover and abundance of micro-algae, but since it is a dimensionless sampling method, does not provide clear data on where mats of algae form in relation to different conditions in the littoral zone. Line intercept sampling can be completed quickly and provides additional cover information (size and location of algal mats).

Point Intercept Sampling

Percent algal cover will be calculated as an algal indicator of productivity measured as algal abundance using a point-intercept collection methodology. Algal cover will be the amount of microalgae coating and macroalgae taken at 2 foot intervals (60 cm) along each transect. The percentage of the points across the transects at each monitoring site will provide an estimate of percent algal cover.

Beginning with the downstream transect at each site, at every 2-foot (60 cm) interval along the transect, water depth and the presence of algae will be recorded and identified as microalgae or macroalgae. Microalgae is defined as a "film-like coating" of algae. Measurement of microalgae thickness will follow the method identified in SCWA, 2019 and an estimate of film-like coating will follow descriptions in Table 1. Thicker microalgae layers will be measured using a ruler or rod with demarcations at 1, 5, and 20 mm.

Line Intercept Sampling

Line intercept methodology will be used to further characterize macro-algal and riparian cover conditions. The presence and absence (distance occupied along transect) of attached macroalgae or unattached, floating macroalgae, emergent vegetation, dried and floating algal mats, and riparian canopy will also be recorded along each transect. Cover along transects occupied by floating and attached algal mats will be recorded using the line intercept method. Distance occupied by algal mats (or other cover category) divided by total distance of the transect provides an effective measure of instantaneous absolute cover. Where individual cyanobacterial colonies can be visually differentiated in the periphyton, relative distances along the transect for these colonies will be recorded. Data on emergent vegetation and riparian canopy cover will be collected along each transect. Cover data on emergent and riparian canopy will be collected along each transect (if present).

Viewing Bucket Sampling

Semi-quantitative assessments of benthic algal biomass and taxonomic composition will be made rapidly with a viewing bucket marked with a grid and a biomass scoring system. This technique enables rapid assessment of algal biomass over large spatial scales. Coarse-level taxonomic characterization of communities is also possible with this technique. This technique is a survey of the natural substrate and requires no laboratory processing beyond verifying identification.

A viewing bucket marked with a 50-dot grid will be utilized to characterize algae biomass. Three samples will be collected along each transect at approximately 10-30 foot intervals to represent the right bank littoral zone, river center littoral zone, and left bank littoral zone. Using the dots, observations are made to determine thickness of microalgae, length of macroalgae, as well as, occupied and unoccupied substrate.

Sampling Phytoplankton

One sample will be collected along each transect at a 1-foot depth in the flowing (in active flowing channel) water column using a plankton net (deployed for five minutes) to assess the presence and abundance of phytoplankton.

Qualitative Visual Assessment

Staff will conduct a qualitative visual assessment of overall site conditions at a reach-like scale (conditions and access allowing) and coordinate with NCRWQCB staff on a bi-weekly basis to discuss the potential for cyanobacterial harmful algal blooms (cyanoHABs) or potential presence of cyanotoxins in the water column and/or substrate (e.g. algal mats or floating scum).

Water Chemistry and Nutrient Sampling

Water chemistry measurements will be recorded near the substrate at each transect point using a YSI 6600 datasonde and YSI 650MDS datalogger, or similarly equipped YSI EXO2. Conditions to be measured include water temperature, dissolved oxygen, specific conductance, pH, and turbidity. Water depth will be taken using a stadia rod or similar device. Water grab samples will be collected from the four ambient algae monitoring sites during algal monitoring activities. Water chemistry and grab sampling will also be conducted at Cloverdale River Park in Cloverdale (Figure 1). All samples will be analyzed for nutrients and *chlorophyll a* (Table 2).

Reporting

An annual report describing the results of the Sonoma Water Mainstem Russian River Ambient Algae Monitoring effort will be prepared. The report will provide summaries of data observations recorded for each constituent sampled or monitored and the impacts if any to aquatic habitat availability or public health associated with contact recreation. The report will also address the objectives of the monitoring plan described above and answer the following questions:

- What is the composition, abundance, cover and change over time of algal periphytic and planktonic taxa in the Russian River?
- What ecological conditions, including instream flows, influence periphytic and planktonic algae populations in the Russian River?

Quality Assurance Project Plan (QAPP)

Transect Establishment

- Transects to monitor and assess periphytic algal growth, including the potential presence of cyanobacteria, will be established and sampled bi-weekly at the four surface water sites selected to represent the range of algal habitats available in the Russian River.
- Monitoring sites in the Russian River will be located at: Patterson Point, located in the lower river in Villa Grande; Syar Vineyards, located south of Healdsburg; at Jimtown Bridge, located in Alexander Valley, and in Hopland at the USGS gauging station (Figure 1).

- Transects will be subjectively placed to collect data from areas with different habitat features including but not limited to depths, velocities, substrates, insolation, and emergent vegetation in the littoral zone Establish the reach for multihabitat sampling.
- Transect location will be subjectively placed to incorporate range of the substrate, flow, depth, and light exposure available in aquatic habitats in the Russian River.
- Transects will vary in length based on the habitat composition, but will typically be between 100 and 150 feet in length.
- Photographs will be taken at each transect to document site conditions during each sampling event in each major algal habitat area (including underwater photographs of the condition of periphyton and floating mats of reproductive benthic algae).
- Transect locations will avoid locations such as tributaries, outfalls, and man-made structures to minimize influence of algal growth from contributions in nutrients, temperature, or canopy cover from such sources.

Collecting Cover Data

Identifying Taxa Present (Multi Habitat Algal Sampling)

- Prior to collection of percent algae cover, algae samples will be collected 1 m downstream and adjacent to each point (to avoid trampling on samples during collection of percent algal cover data).
- Multi-habitat sampling will follow the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999).
- A multi-habitat sample will be collected at various points along 10 foot (3 meters) intervals on the transect that are representative of the variety of habitats present (up to a maximum of 5 samples per transect).
- Each sample will be collected from the substrate that is uppermost within the stream and has highest possibility of sun exposure (i.e. if a thick layer of macroalgae covers the substrate, collection will include the layer, or if a thin film on gravel sample will include gravel and the film will be “scrubbed off” for analysis).
- Samples will include all the algae present at the sampling point in a 4 inch (10 cm) radius as collected using a 4.5 inch Pyrex culture dish. Each sample will include all the algae present in the defined area of substrate.
- Samples from each interval will be combined into a common container.
- Samples will be placed in a cooler to protect the algae from heat and desiccation and to preserve specimen integrity.
- Algal species present will be identified to the lowest taxa, preferably species but at least genera.
- Successional changes in genera over the season should provide a metric to assess species (genera) richness as well as document the stages in development of the periphyton layer.
- Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyceae (Golden Brown Algae (diatoms)), and Cyanobacteria (Blue Green Algae).
- Samples will be evaluated for presence of Chlorophyta (Green Algae), Chrysophyta (Golden Brown Algae [diatoms]), and Cyanobacteria (Blue Green Algae).

- If cyanobacterial target species are identified (including species of *Anabaena*, *Microcystis*, *Planktothrix*, *Oscillatoria,* or *Phormidium*), they will be evaluated for seasonal changes in cover and the possibility of the presence of cyanotoxins will also be evaluated.
- Metrics of Biotic Integrity will be evaluated, including species richness, total number of genera, and total number of algal taxonomic divisions.
- Sampling will follow the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999) and incorporate the steps below:
    - Visual estimates or quantitative transect-based assessments will be used to determine the percent coverage of each substrate type and the estimated relative abundance of macrophytes, macroscopic filamentous algae, diatoms and other microscopic algal accumulations (periphyton), and other biota.
    - Collect algae from all available substrates and habitats. The objective is to collect a single composite sample that is representative of the periphyton assemblage present in the reach.
    - Sample all substrates and habitats (riffles, runs, shallow pools, nearshore areas) roughly in proportion to their areal coverage in the reach. A composite sample will be collected randomly from 5 points selected from a table of random numbers along the transect. Each sample will include all the algae present in a 5X5 cm square area of substrate. Changes in species composition of algae among habitats are often evident as changes in color and texture of the periphyton. Small amounts (about 5 mL or less) of sample from each habitat are usually sufficient. Pick specimens of macroalgae by hand in proportion to their relative abundance in the reach. Combine all samples into a common container.
        - Collection methods include:
            - Removable substrates (hard): gravel, pebbles. Remove representative substrates from water; brush cobble and woody debris or scrape representative area of algae from surface and rinse into sample jar.
            - Removable substrates (soft): mosses, macroalgae. Place a portion of the plant in a sample container with some water. Shake it vigorously and rub it gently to remove algae. Remove plant from sample container.
            - Loose sediments: (sand, silt, fine particulate organic matter). Invert petri dish over sediments. Trap sediments in petri dish by inserting spatula under dish. Remove sediments from stream and rinse into sampling container. Algal samples from depositional habitats can also be collected with spoons, forceps, or pipette.
            - Place all samples into a single water-tight, unbreakable, wide-mouth container. A composite sample measuring four 4 ounces (ca. 125 ml) is sufficient.
            - Label the outside of the sample container with the following information: waterbody name, sampling location, transect, date, name

of collector, and type of preservative. Record this information and relevant ecological information in a field notebook. Place another label with the same information inside the sample container.

- Transport samples back to the laboratory in a cooler with ice (keep them cold and dark) and store preserved samples in the dark until they are processed. Be sure to stow samples in a way so that transport and shifting does not allow samples to leak.
- Record sample identification code, date, stream name, sampling location, transect, collector's name, sampling method, and area sampled.

Estimating Taxa Richness and Abundance

- An assessment of the relative abundances of algal taxa will be conducted for “soft" (non-diatom) algae and diatoms using a modified version of the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (Barbour, 1999).
- Five samples will be collected at each transect by collecting all the algae present at the sampling point in a 4 inch (10 cm) radius as collected using a 4.5 inch Pyrex culture dish.
- All the algae present will be removed from the substrate and all five samples will be combined into a common container.
- All genera observed in the common container will be identified to division and genus using light microscopy.
- A minimum of ten “wet’” slides per multi-habitat sample will be prepared and evaluated.
- Samples will be evaluated until no new genera are found in the container
- Abundance and species richness will be estimated by taxa based on frequency of occurrence in algal samples

Cover data on algal populations will be conducted to estimate cover by both micro- and macro-algal taxa. Ambient data on algal populations will be collected along transects using both point and line intercept sampling methods. Point intercept sampling provides an effective method to quickly estimate cover and abundance of micro-algae, but since it is a dimensionless sampling method, does not provide clear data on where mats of algae form in relation to different conditions in the littoral zone. Line intercept sampling can be completed quickly and provides additional cover information (size and location of algal mats).

Viewing Bucket Sampling

- Percent algal cover will be calculated as an algal indicator of productivity measured as algal abundance using a 50 dot viewing bucket collection methodology.
- Beginning with the downstream transect at each site, for each sampling point along the transect, the presence of algae will be recorded and identified as microalgae or macroalgae. Microalgae is defined as a “film-like coating” of algae.

- Algal cover will be the amount of microalgae coating and macroalgae taken at three representative locations along each transect. The number of occupied versus un-occupied dots will provide an estimate of percent algal cover.
- Thickness ranks will be evaluated separately for diatoms and blue-green algae.
- Measurement of microalgae thickness will follow the method identified in Fetscher, et al. 2009 and an estimate of film-like coating will follow descriptions in Table 1. Thicker microalgae layers will be measured using a ruler or rod with demarcations at 1, 5, and 20 mm.
- The number of dots occupied by macroalgae will be recorded.
- The length of the macroalgae on occupied dots will be recorded.
- Dots where no microalgae or macroalgae occur will be recorded.
- The presence/absence of attached macroalgae or unattached, floating macroalgae will also be recorded at each point.
- Photographs will be taken to document the viewing bucket analysis and generally of the periphyton at 10 foot intervals along each transect during viewing bucket sampling. These photographs will include images taken with underwater cameras and utilizing a 7 X 7 grid marked "viewing bucket".
- Measure water depth at each sampling location.
- Specifically, data collected with the viewing bucket will be used to determine algal density by calculating:
    - Total number of grid points evaluated at site
    - number of grid points over macroalgae
    - Total number of grid points over suitable substrate for microalgae
    - number of grid points over microalgae of different thickness ranks by each type of microalgae (blue-green or diatoms)
    - average percent cover of the habitat by each type of macroalgae
    - maximum length of each macroalgae
    - mean density of each type of macroalgae on suitable substrate

Table 1. Microalgal thickness codes and descriptions.

Microalgal thickness codes and descriptions (from Fetscher, et al. 2009 and adapted from Stevenson and Rollins 2006)		
Code	**Thickness**	**Diagnostics**
0	No microalgae present	The surface of the substrate feels rough, not slimy.
1	Present, but not visible	The surface of the substrate feels slimy, but the microalgal layers is too thin to be visible.
2	<1mm	Rubbing fingers on the substrate surface produces a brownish tint on them, and scraping the substrate leaves a visible trail, but the microalgal layers is too thin to measure.
3	1-5mm	
4	5-20mm	

5	>20mm	
UD	Cannot determine if a microalgal layer is present	

Line Intercept Sampling-Cover

- Cover along transects occupied by attached macroalgae or unattached floating macroalgae, and dried and floating algal mats, will be recorded using line intercept method.
- Distance occupied by algal mats divided by total distance of the transect provides an effective measure of instantaneous absolute cover.
- Cover data on emergent and riparian canopy will be collected along each transect (if present).

Sampling Phytoplankton

- One sample will be collected along each transect at a 1-foot depth in the flowing (in active flowing channel) water column using a plankton net deployed for five minutes to assess the presence and abundance of phytoplankton.
- Samples will be placed in a cooler to protect the algae from heat and desiccation and to preserve specimen integrity.
- Species present will be identified to the lowest taxonomic level feasible given diagnostic characteristics available in the samples.
- Cell counts using the Palmer cells will also be conducted for plankton samples.
- Keenan Foster, a taxonomic botanist and Principal Environmental Specialist with the Water Agency, will be conducting the algae identification and evaluation for the presence of cyanobacteria.

Water Chemistry and Nutrient Sampling

- Water chemistry measurements will be recorded near the substrate at each transect point at the four algal monitoring sites and Cloverdale River Park using a YSI 6600 datasonde and YSI 650MDS datalogger, or similarly equipped YSI EXO2. Conditions to be measured include water temperature, dissolved oxygen, specific conductance, pH, and turbidity. Water depth will be taken using a stadia rod or similar device.
- The applicable standard operating procedures and established monitoring and sampling protocols that Sonoma Water staff, under the guidance of Senior Environmental Specialist Jeff Church, will follow as part of their Quality Assurance (QA) and Quality Control (QC) efforts are described in the Water Quality Monitoring Plan for the Russian River Estuary Management Project (SCWA, 2019).
- All YSI 6600 Datasondes used to collect real-time data during algal and nutrient sampling will be calibrated following the manufacturer's 6-Series User Manual by Sonoma Water staff.
- Water grab samples will be collected from the four algal monitoring sites and at Cloverdale River Park during algal and nutrient monitoring activities. All samples will be analyzed for nutrients and *chlorophyll a* (Table 2).

Sampling methodology and quality assurance protocols including: chain-of-custody procedures, sample labeling, storage and transport protocols, sample containers and sample collection methods, and

decontamination will follow the *National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, chapters A1-A9*, available online at http://pubs.water.usgs.gov/twri9A (USGS various) and included in the Water Quality Monitoring Plan for the Russian River Estuary Management Project (SCWA, 2019), in conjunction with protocols and procedures established by the contract laboratories (Alpha Labs and DHS Lab) and the Sonoma County Water Agency *Quality Assurance Manual, Water Quality Manual*, *July 9, 2013* (SCWA 2013), also included in SCWA, 2019.

Table 2. List of nutrient and algal indicators to be analyzed in water samples collected for the Mainstem Russian River Ambient Algae Monitoring.

Compound	Test Method	Method Detection Limit (MDL)	Laboratory Reporting Limit (LRL/PQL[1])	Units
Nitrogen, Total	SM4500-N	0.2	0.5	mg/L
Nitrogen, Total Organic	SM4500-N	0.2	0.2	mg/L
Nitrogen, ammonia as N	SM4500NH3C	0.1	0.2	mg/L
Ammonia Unionized	SFBRWQCP	0.00010	0.00050	mg/L
Nitrogen, nitrate as N	EPA300.0	0.050	0.20	mg/L
Phosphorus, total	SM4500-P E	0.020	0.10	mg/L
Chlorophyll (a)	SM10200H	0.000050	0.010	mg/L

- Alpha Labs will be reporting the results at the MDL, however the data will be subject to their reporting protocols which will require that they record the results as "Detected but below Reporting Limit; therefore, result is an estimated concentration, detected but not quantified (DNQ)".
- [1] PQL – Practical Quantitation Limit.

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