Algae Monitoring Report

Sacramento Municipal Utility District

Hydro License Implementation • June 2017
Upper American River Project
FERC Project No. 2101

Powering forward. Together.

SMUD®

Contents

1.0 Overview and Background 1
2.0 Objectives 1
2.1 Algae Species Identification and Monitoring Objectives..................................... 1
2.2 Algae Growth Monitoring Objectives.. 2
3.0 Monitoring Locations and Schedules... 2
3.1 Algae Species Identification and Monitoring 2
3.2 Algae Growth 3
4.0 Methods.. 4
4.1 Sample Collection Methodology.. 4
4.1.1 Algae Species Identification and Monitoring 4
4.1.2 Algae Growth... 5
4.2 Analysis Methodology 6
4.2.1 Algae Species Identification and Monitoring 6
4.2.2 Algae Growth... 6
5.0 Results 7
5.1 Algae Species Identification and Monitoring Results 7
5.2 Algae Growth Results 11
6.0 Discussion 12
6.1 Algae Species Identification and Monitoring Discussion.................................. 12
6.2 Algae Growth Discussion.. 13
7.0 Conclusions.. 16
8.0 Works Cited 18
Appendix A. Algae Sampling Locations.................... Error! Bookmark not defined.
Appendix B. Qualitative Algae Results 23
B.1 South Fork Rubicon below Gerle Creek Confluence 24
B.2 Silver Creek above Camino Reservoir.. 26
B.3 South Fork American River above White Rock Powerhouse............................... 28
B.4 Silver Creek above South Fork American River Confluence 30
Appendix C. Physical Habitat Parameters – Quantitative Sampling................. 32

Appendix D. Selection of photo-documentation from algae sampling............ 51
Appendix E. Algae ID Lab – Technical Summary 57
Appendix F. Chlorophyll-a Analysis Reports.. 60

Figures

Figure 1: Overlapping species observed across the various stream reaches. 8
Figure 2: Response of algae presence to various continuous environmental variables. 15
Figure 3: Algae presence response to categorical environmental variables.................. 16

Tables

Table 1: Dates of qualitative algae sampling.. 3
Table 2: Dates of qualitative algae sampling.. 3
Table 3: Numeric variability of unique species counted within each stream reach. 7
Table 4: Results of instantaneous in-situ parameters taken at the time of algae sampling. 9
Table 5: Summarized results of quantitative algae monitoring. 11

1.0 Overview and Background

This Algae Monitoring Report (Report) addresses monitoring requirements set forth in Sacramento Municipal Utility District's (SMUD) Algae Monitoring Plan (SMUD 2015). The requirements for this Plan are found in State Water Resources Control Board (SWRCB) Conditions 8.F and 9.G, and U.S. Forest Service (USFS) 4(e) Conditions 31.6 and 32.7, located in Appendices A and B, respectively, of the Federal Energy Regulatory Commission's (FERC) Order Issuing New License for the Upper American River Project (UARP), dated July 23, 2014. The Plan was developed in consultation with the SWRCB, USFS, California Department of Fish and Wildlife, and U.S. Fish and Wildlife Services. FERC approved the Plan on December 18, 2015. This Report presents the results of implementing the Plan in 2015 and 2016. Monitoring locations, schedules, and methodologies were all performed in accordance with the approved Algae Monitoring Plan.

The UARP lies within El Dorado and Sacramento counties, primarily within lands of the Eldorado National Forest. The project is built within the American River watershed, and incorporates drainage from the South Fork American River, Rubicon River and Silver Creek sub-basins. The UARP consists of three major storage reservoirs—Loon Lake, Union Valley and Ice House (with a combined capacity of 379,622 acre-feet), eight smaller regulating or diversion reservoirs, and eight powerhouses. SMUD began hydroelectric operations of the UARP in 1961 and has a generating capacity of approximately 688 megawatts (MW).

2.0 Objectives

2.1 Algae Species Identification and Monitoring Objectives

Algae community structure can be an important indicator of water quality and stream health. Assessment of this indicator is the principle component of the rationale leading to the Plan:

> *"The algae in Silver Creek below Junction Reservoir Dam is a water quality concern and may be an indicator of water temperature, nitrate, or other imbalance issues. Additionally, documentation of baseline algal species in South Fork Rubicon River below Robbs Peak Reservoir Dam, Silver Creek below Camino Reservoir Dam, and SFAR below Slab Creek Reservoir Dam will allow assessment of the distribution and possible adverse effects in Project-*

> *affected reaches. Identification to species would determine whether this algae is a native or invasive species."*

Sampling, identifying, and archiving samples of all available algae among these areas of concern within the UARP were performed to characterize this water quality metric.

2.2 Algae Growth Monitoring Objectives

During Relicensing, there were two areas of concern that were deemed susceptible to algal blooms, and an adaptive management condition was created to monitor these sections. Rationale leading to the license condition and Algae Monitoring Plan is as follows:

> *"If the new streamflow regime does not control algal growth in Silver Creek below Junction Reservoir Dam and SF Rubicon River below Robbs Peak Reservoir Dam within two years of License issuance, the Licensee shall control or eliminate the algae using a method approved by the Deputy Director, after consultation with USFS, USFWS, and CDFW."*

To describe algal growth and inform applicable adaptive management measures, SMUD also performed quantitative measurements via chlorophyll-a analysis to inform this condition.

3.0 Monitoring Locations and Schedules

3.1 Algae Species Identification and Monitoring

As indicated in the Algae Monitoring Plan samples were taken in 4 stream channels:

- Silver Creek above Camino Reservoir Dam
- SF Rubicon River below Gerle Creek Confluence
- Silver Creek below above South Fork American River Confluence
- SF American River above White Rock Powerhouse

See Attachment 1 for a map of these locations relative to other landmark locations within the UARP. Also in Attachment 1 are explicit locations from each stream reach that were selected and sampled.

The sampling dates occurred in a time-frame prescribed by the Algae Monitoring Plan. The specific dates are stated in Table 1:

Table 1: Dates of qualitative algae sampling

Site	Sampling Date
South Fork Rubicon below Gerle Confluence	9/1/16
Silver Creek above Camino Reservoir	9/15/16
South Fork American above White Rock PH	9/20/16
Silver Creek above South Fork American River	9/21/16

3.2 Algae Growth

Quantitative algae growth monitoring occurred in two reaches, as described in the Algae Monitoring Plan. These locations were:

- Silver Creek above Camino Reservoir dam
- South Fork Rubicon River below Gerle Creek confluence

See Attachment 1 for a map of these locations relative to other landmark locations within the UARP. Also in Attachment 1 are explicit locations from each stream reach that were selected and sampled.

The sampling dates occurred in a time-frame prescribed by the Algae Monitoring Plan. The specific dates are stated in Table 2.

An initial quantitative algae assessment occurred October 29, 2014 and November 11, 2014. As described in Section 3.2 of the Algae Monitoring Plan, this sampling occurred prior to the completion of the Algae Monitoring Plan (although used the same methodology), as it was necessary to measure a base-line level to compare quantitative samples that were taken after the new streamflow schedule had taken effect, thereby constructing a metric of algae growth. The results of this initial assessment are summarized within this Report.

Table 2: Dates of qualitative algae sampling

Site	Sampling Date
Silver Creek above Camino Reservoir	10/29/14
South Fork Rubicon below Gerle Reservoir	11/5/14
Silver Creek above Camino Reservoir	7/12/16
South Fork Rubicon below Gerle Reservoir	7/13/16
Silver Creek above Camino Reservoir	10/19/16
South Fork Rubicon below Gerle Reservoir	10/26/16

4.0 Methods

4.1 Sample Collection Methodology

Algae collection was performed pursuant to the Algae Monitoring Plan, which largely drew upon the “Reachwide Benthos Sampling of Algae” design as described in Sections 3 and 4 of the *Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California* (Fetscher et al., 2010) [*SWAMP SOP’s henceforth*].

4.1.1 Algae Species Identification and Monitoring

SMUD surveyors used the “Reachwide Benthos Sampling of Algae” (SWAMP SOP’s Sec 4), to collect and process the sample, as described in the “Procedure for Collecting Qualitative Algal Samples” (SWAMP SOP’s Sec 5.4). In particular, sample collection involved the following actions:

- Delineate and document the monitoring reach. A reach length of 820 feet is determined, and the beginning and end of the reach is flagged. Notable field conditions in this monitoring section are noted. Photo-documentation and GPS coordinates at the beginning and end of the reach are recorded.
- Throughout the monitoring reach, algal specimens of all different types are collected, sampling from as many distinct locations and substrates as possible. Photo-documentation and GPS coordinates are recorded at all collection sites.
- Methodology to collect samples is dependent on the substrate type at the determined collection site. There are several tools available to accomplish this task, including razor knives or suction devices. The most appropriate tool is used, and this is noted in the field notes. Algae collected will be collected into a container recommended by the laboratory taxonomist. Samples will be placed on ice away from any light source.
- *In-situ* water quality parameters (dissolved oxygen, conductivity, temperature, turbidity, and pH) are recorded at the top and bottom of each sampling reach, using a standard multi-parameter instrument (YSI or equivalent). Sampling of these parameters and corresponding instrument calibration is performed pursuant to EPA approved general-purpose water sampling protocols.

Sample containers and preservative were provided by the ID laboratory (Rhithron Associates). Each sampling reach produced two algae containers for qualitative analysis; one to identify soft-bodied algae (unfixed), and another to identify diatoms (fixed with gluteraldahyde). Each container was labeled with sample type and sampling information for each location. After sample collection, the containers were packaged with ice packs and sent via overnight shipment to the laboratory. A standard “Chain-of-Custody” form accompanied the sample containers throughout the entire sampling and shipping process.

Procedures and technical information from the ID laboratory are included in Appendix E.

4.1.2 Algae Growth

This sampling protocol also drew from the SWAMP SOP’s. Since this particular section of the study was of a quantitative assessment, SMUD surveyors used a form of the “Reachwide Benthos Sampling of Algae” (SWAMP SOP’s Sec 4), and processed the sample as described in the “Procedure for Collection of Quantitative Algal Samples” (SWAMP SOP’s Sec 4.2). Chlorophyll-a analysis was used to quantify this metric of algal growth. In particular, sample collection involved the following actions:

- Delineate and document the monitoring reach, which is at the same location in which qualitative algae sampling is conducted. A reach length of 820 feet is divided into 11 transects, divided as equidistant as possible. These transects are marked with flagging and will be labeled A-K, beginning with the most downstream section. Notable field conditions in this monitoring section are noted. Photo-documentation and GPS coordinates at each transect will be recorded.
- Algae samples will be collected according to a “left-center-right” scheme, working upstream; that is, Transect A will be collected at the 25% wetted width portion (left edge), Transect B will be collected at 50% of wetted width (center), Transect C will be collected at 75% of wetted width (right edge), and this pattern repeats through transect K. Care is taken not to disturb the selected site before sampling.
- Methodology to collect samples is dependent on the substrate type at the determined collection site. There are several tools available to accomplish this task (see SWAMP SOPS’s, Attachment C). The most appropriate tool shall be used, and this should be noted in the field notes. Algae collected will be composited in a field tub and kept as cool and dark as possible. All equipment is rinsed with stream water after each collection to ensure that all material is composited into the tub.
- Several physical habitat characteristics are recorded at each transect, including depth, substrate, and algae cover at 5 points along each transect (10%, 25%, 50%, 75%, 90%). Wetted width is recorded.
- *In-situ* water quality parameters (dissolved oxygen, conductivity, temperature, turbidity, and pH) will be recorded at the top and bottom of each sampling reach, using a standard multi-parameter instrument (YSI or equivalent). Sampling of

these parameters and corresponding instrument calibration is performed pursuant to EPA approved general-purpose water sampling protocols.

After sample collection, the composite liquid was deposited into an opaque container and kept in a dark container to avoid any light. Each container was labeled with site ID's and collection times. After sample collection, the containers were immediately transported to a nearby water quality lab and submitted to laboratory processing within 4 hours of collection. A standard "Chain-of-Custody" form accompanied the sample containers throughout the entire sampling and shipping process.

Reports from the laboratories conducting the chlorophyll-a analysis are included as Appendix F of this report.

4.2 Analysis Methodology

4.2.1 Algae Species Identification and Monitoring

After the species list was obtained, a literature review was conducted to determine if species have been historically identified as nuisance, invasive, bloom-forming, etc. Presence and absence of these species is noted in Section 6. The existing literature suggesting that the presence of species is "good" or "bad" is highly incomplete, with the mention of many species being secluded to taxonomy texts.

Water quality data measured during algae collection was compared against other measurements that have occurred in the UARP.

4.2.2 Algae Growth

Chlorophyll-a is the primary response variable being used in this study to characterize Algae Growth. Often Chlorophyll-a is characterized as biomass, which normalizes the amount of chlorophyll found over a unit area (e.g. mg/in^2). Unfortunately, during the initial sampling period in 2014 (precluding the Algae Monitoring Plan), an official sampling protocol had not yet been well studied; while this sampling event mostly followed the SWAMP SOP's, the crew did not accurately measure a final sample volume of the composited sample. This prevents the analysis from concluding biomass; the laboratory provides sample results in concentration (e.g. mg/L). Since biomass cannot be a uniform metric across the various sampling periods for algae growth, this Report uses the notion of "Algae Presence" which normalizes concentration over unit area (e.g. mg/L·in^2). Although there is an extra level of abstraction, this unit of measurement allows the chlorophyll-a samples from the various sampling periods to be compared against each other using a uniform metric.

Several explanatory variables are produced and used to show patterns in the Algae Presence data. Some variables are averaged over a prior time-period (e.g. flow, air temperature) to create a predictor that demonstrates immediate antecedent conditions. This time period was chosen to be 30 days; response to changes of environmental parameters can be quick, as exponential growth and decline is characteristic to a majority of algae species (Lewin 1972).

Other explanatory variables (e.g. mean depth, mean width) are averaged over an entire transect for one site during one particular sampling event. These values are taken from the Physical Habitat data measured during sampling (Appendix C).

5.0 Results

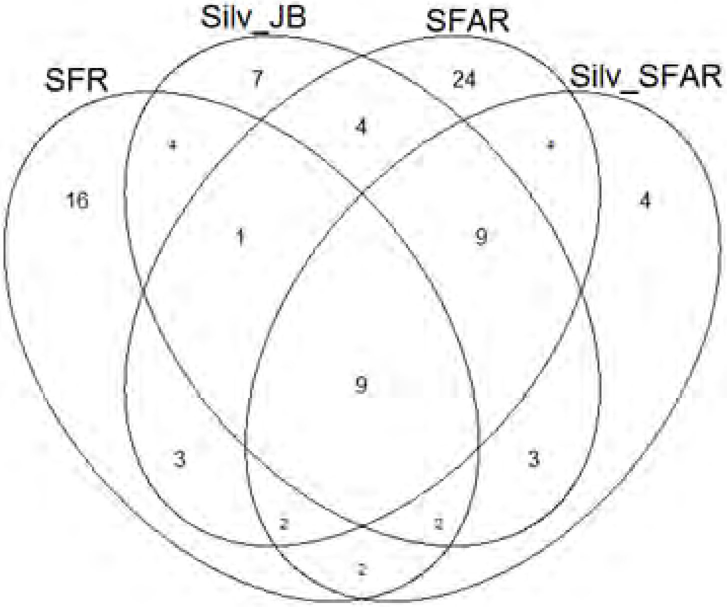
5.1 Algae Species Identification and Monitoring Results

There was a considerable breadth of species, both for soft-bodied algae and diatoms, found at all of the reaches sampled. Table 3 show the quantity of different species identified for both categories:

Table 3: Numeric variability of unique species counted within each stream reach.	Number of Distinct Species Identified		
	Soft-bodied Algae	Diatoms	Total
South Fork Rubicon below Gerle Confluence	13	39	52
Silver Creek above Camino Reservoir	5	39	44
South Fork American above White Rock PH	9	56	65
Silver Creek above South Fork American	7	35	42

There were several instances in which the same species were identified across the various stream reaches. Figure 1 enumerates these observations for both soft-bodied algae and diatoms:

Diatoms



Soft-bodied Algae

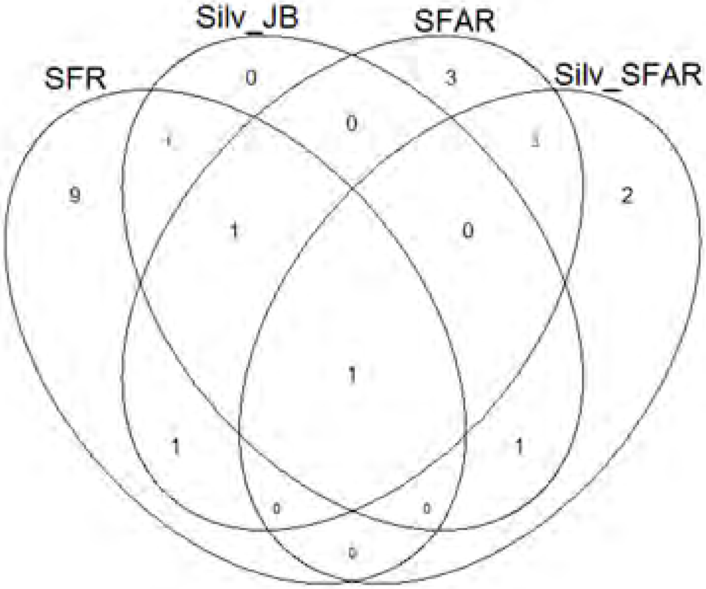


Figure 1: Overlapping species observed across the various stream reaches.

KEY: SFR=South Fork Rubicon below Gerle confluence, SILV_JB=Silver Creek above Camino Reservoir, SFAR=South Fork American River above White Rock Powerhouse, Silver_SFAR= Silver Creek above South Fork American River confluence.

Species of interest included *Didymosphenia geminate* (Didymo henceforth), which was found in all stream reaches sampled. This algae is often attributed to harmful algae blooms and is perhaps one of the most well-studied diatoms in the literature. No soft-bodied cyanobacteria ("blue-green algae") that regularly cause algae-blooms (Paerl, et al. 2001) were identified during the study. Complete lists of species identified during the qualitative sampling events are published in Appendix B.

In-situ water quality parameters were measured upstream and downstream of each qualitative sampling reach. Table 4 shows these observations at the time of sampling:

Table 4: Results of instantaneous in-situ parameters taken at the time of algae sampling.

	SFR	Silv_JB	SFAR	Silv_SFAR
	9/1/16	9/15/16	9/20/16	9/21/16
In-situ parameters				
Upstream of sampling section				
Water Temp [°C]	14.57	11.12	14.51	16.05
pH [s.u.]	5.73	6.16	6.15	6.50
Dissolved Oxygen [mg/L]	8.63	10.00	9.75	8.98
Conductivity [mS/cm]	0.011	0.018	0.027	0.026
Turbidity [NTU]	0.0	0.0	0.6	0.0
Downstream of sampling section				
Water Temp [°C]	14.27	10.96	14.69	16.14
pH [s.u.]	5.15	5.79	5.66	6.61
Dissolved Oxygen [mg/L]	8.61	9.83	9.76	9.05
Conductivity [mS/cm]	0.012	0.018	0.026	0.029
Turbidity [NTU]	0.0	0.0	0.2	0.5

KEY: SFR=South Fork Rubicon below Gerle confluence, SILV_JB=Silver Creek above Camino Reservoir, SFAR=South Fork American River above White Rock Powerhouse, Silver_SFAR= Silver Creek above South Fork American River confluence.

Photos were taken to portray unique algae types and habitat types (e.g. wood, cobble, bedrock, etc.) – see Photo 1 for an example of this documentation. Publishing the entire library of photos in this report is unpractical, so select photos that are representative of each sampling event are inserted for convenience in Appendix D. Upon request the entire library of algae monitoring photos will be transmitted digitally.

Photo 1: Example of algae collected for the qualitative monitoring effort. Algae would be scraped from the substrate with the proper implement, and batched with other samples from the reach to send to the ID laboratory.

5.2 Algae Growth Results

Algae concentration is normalized per unit area sampled to provide a metric of algal presence to determine whether algae levels are being adequately controlled by the new streamflow regime. Table 5 shows this metric as sampled from the 2 different sampling sites during the various sampling periods, along with various other parameters collected pursuant to the methodology described in Sec 4.2.

Table 5: Summarized results of quantitative algae monitoring.

	Autumn 2014		Summer 2016		Autumn 2016	
	Silver Creek	S.F. Rubicon	Silver Creek	S.F. Rubicon	Silver Creek	S.F. Rubicon
Observed parameters from algae sampling						
Area Sampled (in²)	13.06	11.12	15.97	18.55	16.94	16.94
Composite Concentration (ug/L)	410	350	120	40	356	328
Algae Presence (ug / L · in²)	31.39	31.47	7.51	2.16	21.02	19.36
Environmental parameters during sampling						
Mean Flow [cfs, prior 30 days]	10.6	12.2	51.7	25.2	18.1	29.7
Mean Air Temp [°C, prior 30 days]	12.1	10.3	16.3	16.3	11.8	10.9
Mean Depth (ft)	1.3	1.3	1.7	2.4	1.9	2.1
Mean Visual Algal Cover (%)	50	40	30	50	50	30
Mean Width (ft)	59.4	34.4	50.5	29.1	53.7	37.5
In-situ parameters						
Upstream of sampling section						
Water Temp [°C]	-	-	12.93	15.61	8.72	8.67
pH [s.u.]	-	-	5.93	6.09	6.13	6.00
Dissolved Oxygen [mg/L]	-	-	9.60	8.56	10.50	9.83
Conductivity [mS/cm]	-	-	0.017	0.015	0.021	0.018
Turbidity [NTU]	-	-	0.2	0.0	2.2	0.0
Downstream of sampling section						
Water Temp [°C]	-	-	12.58	13.81	7.85	8.25
pH [s.u.]	-	-	5.56	5.42	5.46	5.52
Dissolved Oxygen [mg/L]	-	-	9.53	8.72	10.30	9.83
Conductivity [mS/cm]	-	-	0.017	0.014	0.021	0.019
Turbidity [NTU]	-	-	0.2	0.0	1.8	0.1

Note: In-situ parameters were not collected for the initial sampling period as this monitoring predated the Algae Monitoring Plan which prescribed such data collection.

Various other physical habitat attributes were collected as part of the quantitative sampling module. Detailed sampling notes that describe these attributes and inform the summary in the table above are enclosed as Appendix C.

Three photos were taken at each transect during quantitative sampling – views from across the transect, upstream, and downstream. Publishing the entire library of photos in this report is unpractical, so select photos that are representative of each sampling event are inserted for convenience in Appendix D. Upon request the entire library of algae monitoring photos will be transmitted digitally.

Laboratory analysis of the chlorophyll-a samples are included in Appendix F. In the interest of brevity, these reports have been reduced to the 'Results' section for each narrative. Full laboratory reports (including Chain-of-Custody, QA/QC results, etc.) will be made fully available upon request.

6.0 Discussion

6.1 Algae Species Identification and Monitoring Discussion

In general, algal assemblages collected at the UARP sites seem quite complex. This can be seen as a benefit, as it is believed that species diversity can complement other factors (productivity, disturbance, etc.) to create a stable community structure (Allison 2004).

Status of various algae species can be difficult to characterize as native or non-native, and it is challenging to impossible to find an established "list" of algae that presents as detrimental to the aquatic community. To classify each species as having positive or negative effects on the stream, then, is not practical or scientifically sound.

It may be more worthwhile to be concerned with species that can cause algal blooms that exert harmful pressure on the aquatic community. Analysis performed during this monitoring can support decision-makers if such a bloom occurs by reviewing the algae assemblages currently present (and possible changes) and using this knowledge to inform any future analyses. This study suggests the main bloom danger to be of a diatomaceous nature (Didymo) and so algal concern should be discussed with this in consideration. For example, (Root and O'Reilly 2012) recommend various treatments and mitigation techniques that particularly target Didymo, as opposed to separate treatments that would be better suited for cyanobacteria.

It is important to note that no algae blooms were observed during the course of this monitoring; mean visual cover percentages recorded during the algae growth module of this study never exceeded 50% (Table 4), and the cover observed during this portion of the monitoring may have primarily been siltation (to be conservative, most cover on streambed was characterized as “algal cover” although it is often difficult to distinguish between the two).

In-situ water quality monitoring conducted upstream and downstream of each sampling location show no noticeable impact from algae, and are consistent with the remaining majority of water quality sites in the UARP (SMUD 2016). The one exception of in-situ parameters from the Sacramento-San Joaquin basin plan (California Regional Water Quality Control Board 2011) are slightly low pH values, which simply reflect the remainder of the watershed. This slight departure from normalcy has been documented throughout all water quality studies of the UARP (and throughout the Sierras) and is attributed to the highly granitic watershed not allowing water to pick up hydrogen ions along its course through the UARP.

If a point measurement for water quality in the future indicates a cause for concern through a particular parameter, this list of soft-bodied algae taxa can be consulted to provide complementary evidence of whether this issue is transitory or systemic (Potapova 2005). If the problem is indeed systemic, further discovery using this algae dataset can be accomplished; concerning environmental contaminants, the tolerance (or lack thereof) of certain species can be a clue to anthropogenic changes, and also the particular source (Agriculture, Mining, Energy Development, etc.) (Shubert 1984).

6.2 Algae Growth Discussion

The timing allowed for this study and natural variability for algal biomass makes describing algae growth particularly challenging. To elaborate on the former, the new streamflow regime was required to be implemented no later than three months after the FERC license was issued, while the Algae Monitoring Plan wasn’t required to be developed and approved for more than a year. Even without this schedule inconsistency, it would not have been feasible to develop the Plan prior to the new streamflows anyway (i.e. within three months of License issuance). SMUD staff showed due diligence by attempting to collect a metric of algae presence before the new streamflow regime had initiated, and successfully collected one data point before the new streamflows were implemented. Having one data point to compare against any future data leaves much to be desired and counters the idea of making robust, statistically sound conclusions. Acknowledging this limitation, observations and patterns can still be gleaned from the collected measurements.

Figure 2 shows the algae presence results as a function of various environmental factors. The more detailed language of the license condition and Algae Monitoring Plan (see Conclusion section) ponders whether or not the new streamflow regime controls algae growth. The new streamflow regime significantly increases minimum streamflows below all diversions of the UARP, so an appropriate follow-up proposition is whether or not higher streamflows control algal growth. The plot describing algae presence against mean streamflow would suggest that higher streamflows do maintain or lower algae presence, and to a similar degree so does algae presence against mean depth (stream depth typically increases with higher flow).

At first inspection, it may appear that algae presence decreases with mean air temperature, which would be a counter-intuitive result as primary production usually increases with more sunshine. However, note that measurements during the warmest period (Mean Air Temp > 16 °C) also occurred during the period of highest flow, and so the effect of streamflow may have been larger than that of temperature in these situations.

To further explore this idea, it can be helpful to view algae presence against categorical data in addition to the continuous data.

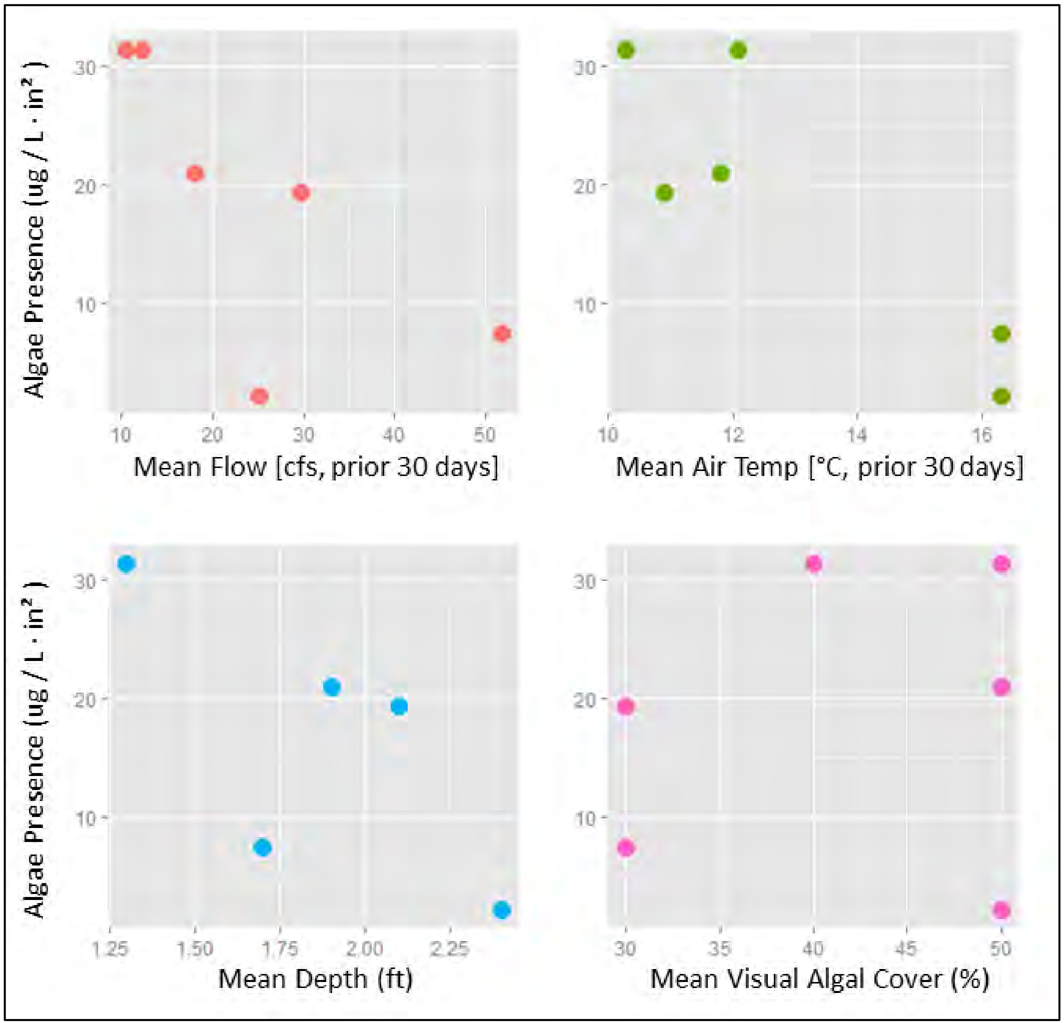


Figure 2: Response of algae presence to various continuous environmental variables.

Figure 3 shows boxplots of two categorical variables and the response from algae presence. For the factor of seasonality, the data suggests that algae presence is higher in the autumn sampling periods. The autumn period generally presents lower streamflows with warm antecedent air and water temperatures, which can explain the larger algae presence during this general period. Despite this seasonal component, it is worth noting that the algae presence from the autumn period after the new streamflow regime was implemented was lower than the same period sampling from the prior, lower streamflow regime across all sites. Algal periodicity is a well-known phenomenon, but the interrelated dynamics of several factors (temperature, surface area, inorganic compounds, dissolved gases, etc.) make the understanding and prediction of such periods difficult (Smith 1933).

Flow magnitude is separated into two categories, where the threshold between "Low" and "High" flow magnitudes is half and in general is a good measure of centrality between the lowest and highest streamflows prescribed in the FERC license.

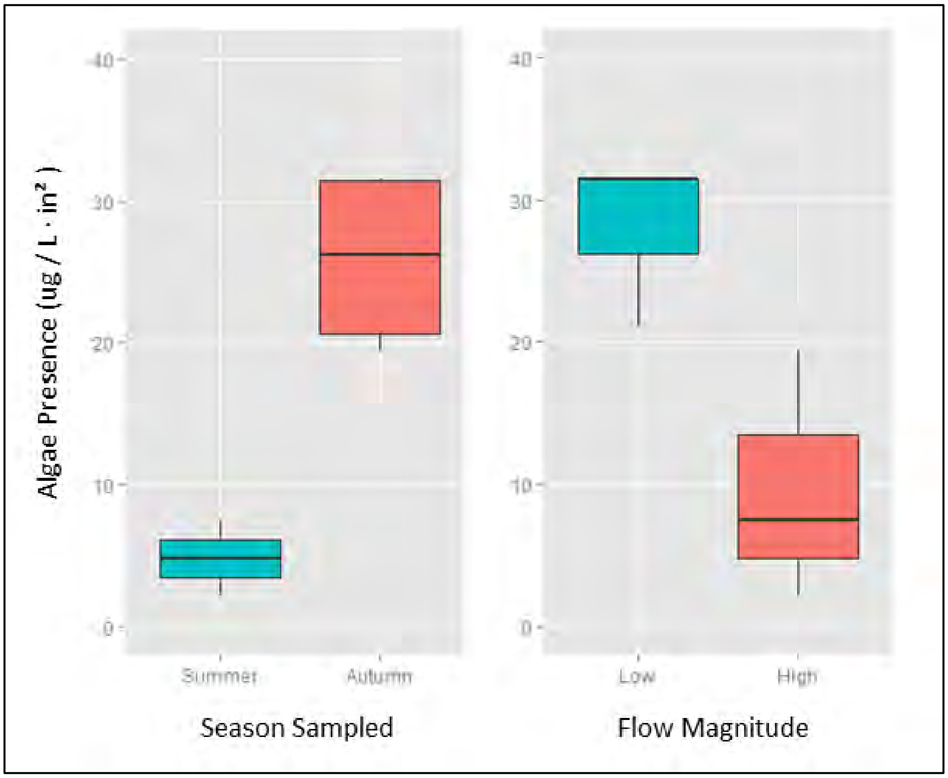


Figure 3: Algae presence response to categorical environmental variables

7.0 Conclusions

The Algae Monitoring Plan asks two explicit questions that are to be informed by this study:

1. *Are the algal species identified deemed to have negative effects upon the aquatic ecosystem? If so, what additional sampling should occur?*

Algae assemblages in the sampled UARP stream reaches were found to be quite complex. Diatoms identified included species known to be invasive (e.g. Didymo), although the simple presence of the species should not lead to the conclusion that the stream reaches are impaired; water quality has not been affected, and no algae blooms have been observed in these reaches during any ecological monitoring from the current FERC license.

2. *Has the new streamflow regime controlled algal growth in the reaches of concern? If not, what method should be utilized to control or eliminate the algae?*

A robust statistical analysis is not presented here, and such an analysis is impossible to achieve as sufficient data was not collected prior to the new streamflow regime being implemented providing higher flows throughout the UARP. Even if SMUD was to continue this quantitative sampling, it can only be compared to the one data point prior to the new streamflow regime which still does not satisfy a robust study.

With this caveat, the results do suggest that algae growth is controlled (and even removed to an extent) by higher streamflows. There does appear to be a seasonal component to the algae growth, although the effect of higher streamflows can still be observed after the factor of seasonality.

This quantitative sampling collected many physical parameters in addition to in-situ water quality measurements. None of these observations suggested that these stream reaches were impaired in any form, and it should be kept in mind that some amount of algae in the stream is natural and contributes to a healthy ecosystem.

8.0 Literature Cite

Allison, Gary. "The influence of species diversity and stress intensity on community resistance and resilience." *Ecological Monographs*, 2004: 117-134.

California Regional Water Quality Control Board. "The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region (Fourth Edition)." 2011.

Federal Energy Regulatory Commission (FERC). "Order Issuing New License, FERC Project No. 2101-084." Washington, D.C., 2014.

Fetscher, A. Elizabeth, Lilian Busse, and Peter R. Ode. *Standard operating procedures for collecting stream algae samples and associated physical habitat and chemical data for ambient bioassessments in california.* SWAMP Bioassessment SOP 002, 2010.

Lewin, Ralph A, ed. *Physiology and Biochemistry of Algae.* New York: Academic Press, 1972.

Paerl, Hans W., Rolland S. III Fulton, Pia H. Moisander, and Julianne Dyble. "Harmful Freshwater Algal Blooms, With an Emphasis on Cyanobacteria." *The Scientific World*, 2001: 76-113.

Potapova, Marina. *Relationships of soft-bodied algae to water-quality and habitat characteristics in U.S. rivers: Analysis of the National Water-Quality Asessment (NAWQA) Program data set.* Philadelphia: The Academy of Natural Sciences, 2005.

Root, Samantha, and Catherine M. O'Reilly. "Didymo Control: Increasing the Effectiveness of Decontamination Strategies and Reducing Spread." *Fisheries*, 2012: 440-448.

Sacramento Municipal Utilities District. "Relicensing Settlement Agreement for the Upper American River Project and Chili Bar Hydroelectric Project." January 2007.

Shubert, L. Ellior. *Algae as Ecological Indicators.* Orlando: Academic Press Inc., 1984.

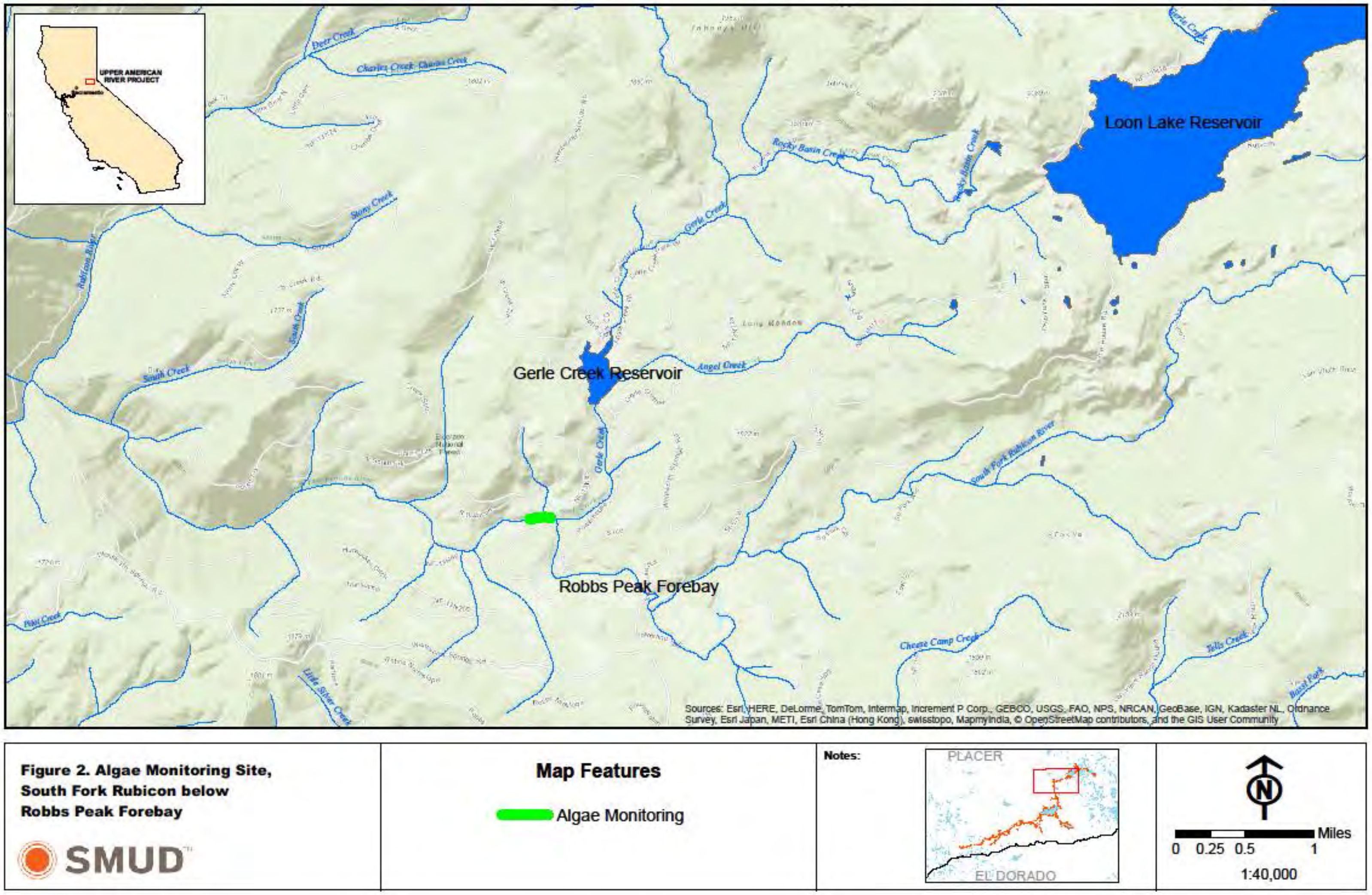
Smith, Gilbert M. *Freshwater Algae of the United Stated.* New York: McGraw Hill Book Company, 1933.

SMUD. "Water Quality Monitoring Plan (Rev 2)." Sacramento, CA, 2016.

State Water Resources Control Board. "Federal Permit or License, FERC Project No. 2101." *Water Quality Certification.* California, 2013.

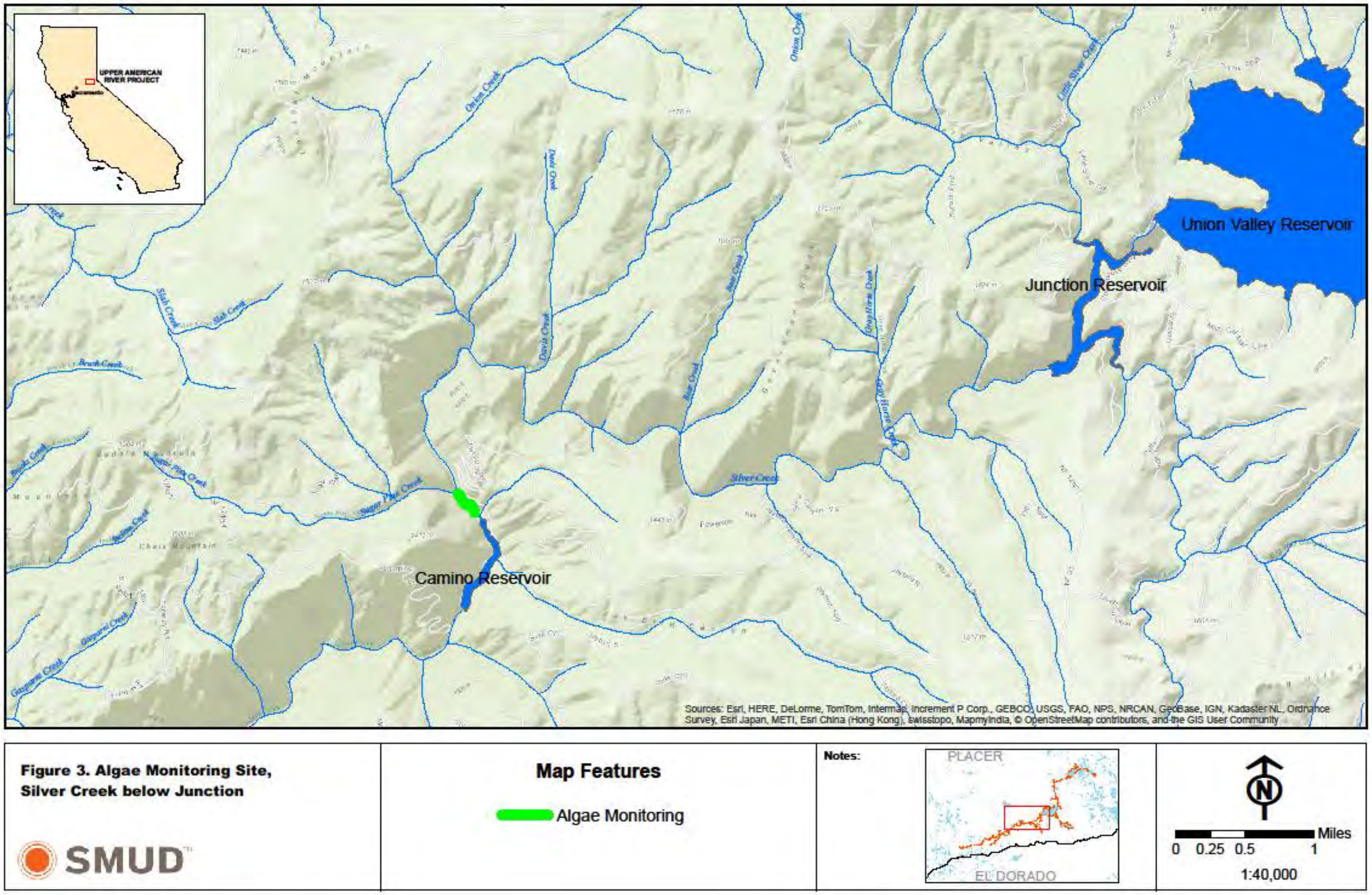
United States Geological Survey. "Protocols for the analysis of algal samples collected as part of the U.S. Geological Survey ." National Water-Quality Assessment Program, Philadelphia, 2002.

Appendix A. **Algae Sampling Locations**



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapmyindia, © OpenStreetMap contributors, and the GIS User Community

Figure 2. Algae Monitoring Site, South Fork Rubicon below Robbs Peak Forebay



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 3. Algae Monitoring Site, Silver Creek below Junction

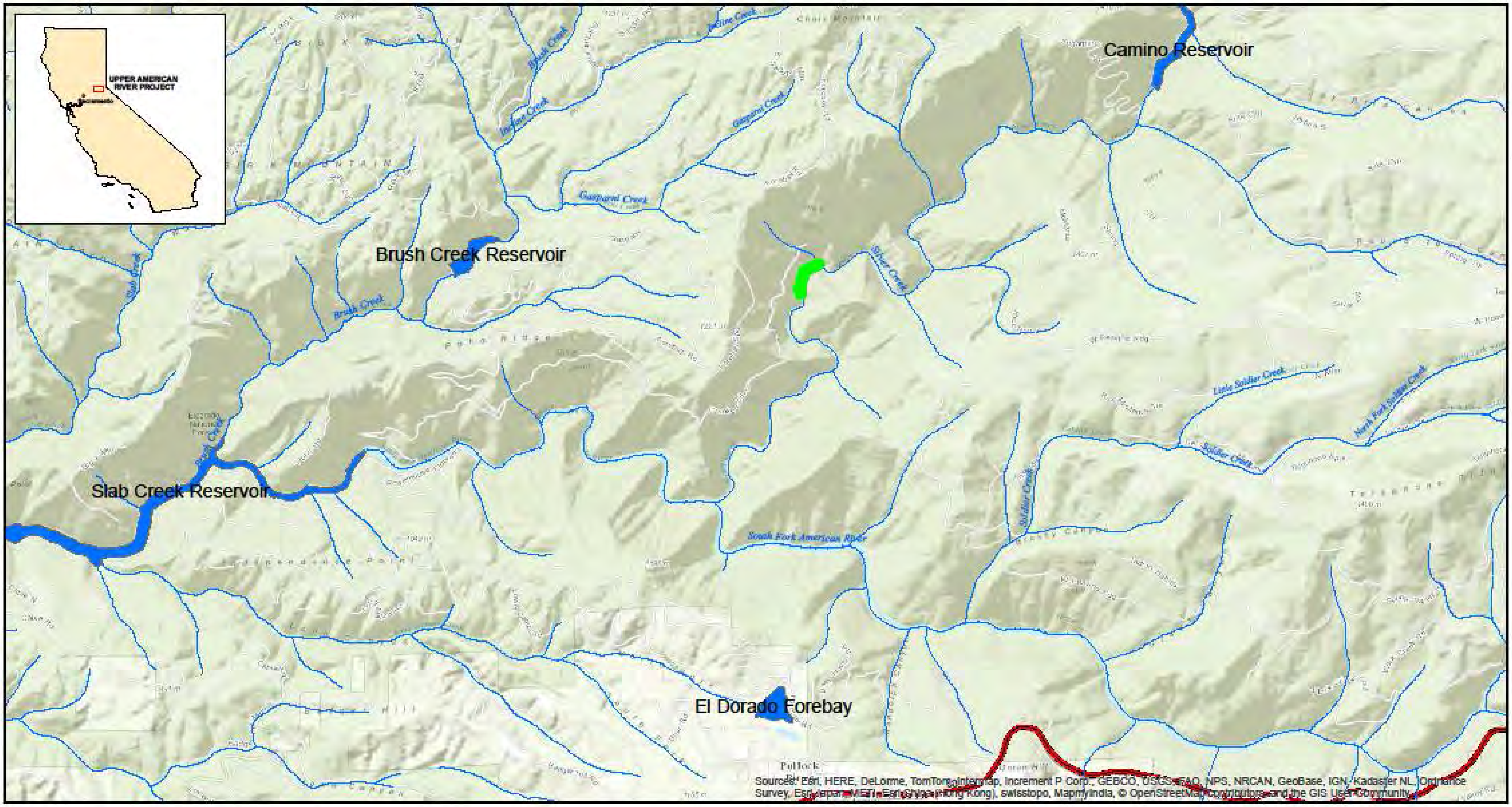
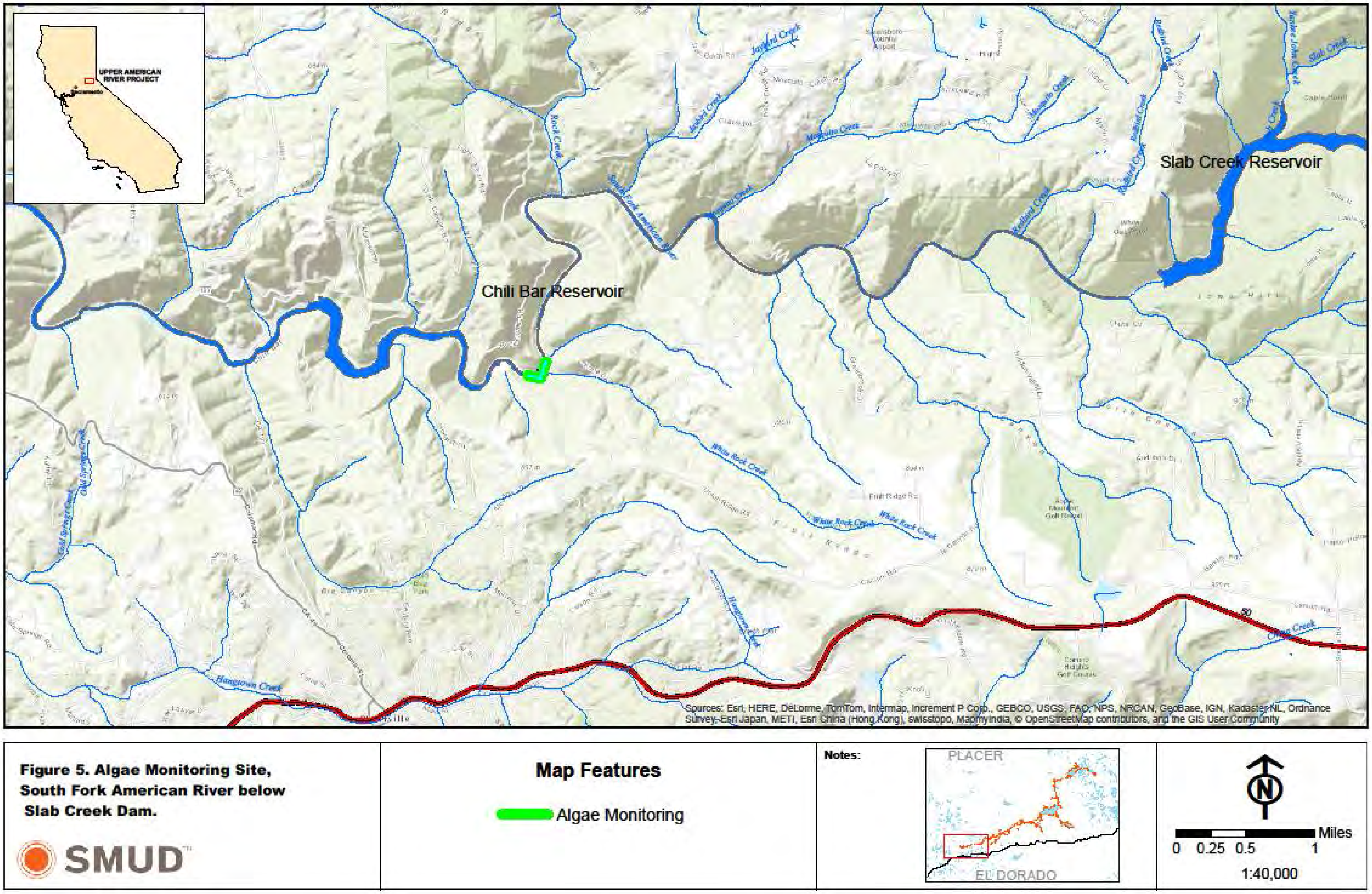


Figure 4. Algae Monitoring Site, Silver Creek below Camino

SMUD™



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 5. Algae Monitoring Site, South Fork American River below Slab Creek Dam.

Appendix B. Qualitative Algae Results

B.1 South Fork Rubicon below Gerle Creek Confluence

Sample Date: 9/1/2016

Sample Type	Qualitative ID	Lab Comment
Algae	Calothrix	
Algae	Chlorophyta 1	
Algae	Chroococcus minutus	
Algae	Cosmarium	Cosmarium cf praecisum var. suecicum
Algae	Cryptomonas	
Algae	Heteroleibleinia kossinskajae	
Algae	Leptolyngbya	
Algae	Monoraphidium tortile	
Algae	Mougeotia	
Algae	Scenedesmus	
Algae	Scenedesmus acutus	
Algae	Scenedesmus circumfusus	
Algae	Scenedesmus serratus	
Diatoms	Achnanthidium minutissimum	
Diatoms	Achnanthidium rivulare	
Diatoms	Aulacoseira alpigena	valve view
Diatoms	Brachysira brebissonii	
Diatoms	Brachysira microcephala	
Diatoms	Didymosphenia geminata	
Diatoms	Encyonema latens	
Diatoms	Encyonema pergracile	
Diatoms	Encyonema silesiacum	
Diatoms	Encyonopsis microcephala	
Diatoms	Encyonopsis stafsholtii	
Diatoms	Epithemia sorex	
Diatoms	Eucocconeis flexella	
Diatoms	Eunotia bilunaris	
Diatoms	Eunotia formica	
Diatoms	Eunotia implicata	
Diatoms	Eunotia incisa	
Diatoms	Eunotia muscicola v. tridentula	
Diatoms	Fragilaria capucina v. gracilis	
Diatoms	Fragilaria vaucheriae	

Sample Type	Qualitative ID	Lab Comment
Diatoms	Frustulia amphipleuroides	
Diatoms	Gomphonema acuminatum	
Diatoms	Gomphonema exilissimum	
Diatoms	Gomphonema lagenula	
Diatoms	Gomphonema patricki	
Diatoms	Gomphonema turgidum	
Diatoms	Navicula angusta	
Diatoms	Navicula notha	
Diatoms	Nitzschia acidoclinata	
Diatoms	Nitzschia capitellata	
Diatoms	Nitzschia frustulum	
Diatoms	Nitzschia gracilis	uncertain ID
Diatoms	Nitzschia incognita	
Diatoms	Psammothidium helveticum	
Diatoms	Rossithidium nodosum	
Diatoms	Synedra rumpens	
Diatoms	Tabellaria flocculosa	
Diatoms	Ulnaria delicatissima v. angustissima	
Diatoms	Ulnaria ulna	

B.2 Silver Creek above Camino Reservoir

Sample Date: 9/15/2016

Sample Type	Qualitative ID	Lab Comment
Algae	Cosmarium	Cosmarium cf subtumidum var. minutum
Algae	Cosmarium	Cosmarium cf polygonum
Algae	Heteroleibleinia kossinskajae	
Algae	Phormidium	
Algae	Scenedesmus	Scenedesmus cf lunatus
Diatoms	Achnanthidium deflexum	
Diatoms	Achnanthidium gracillimum	
Diatoms	Achnanthidium latecephalum	
Diatoms	Achnanthidium minutissimum	
Diatoms	Achnanthidium rivulare	
Diatoms	Aulacoseira alpigena	
Diatoms	Brachysira microcephala	
Diatoms	Cocconeis placentula sensu lato	
Diatoms	Delicata delicatula	
Diatoms	Diatoma mesodon	
Diatoms	Didymosphenia geminata	
Diatoms	Encyonema latens	
Diatoms	Encyonopsis cesatiformis	
Diatoms	Encyonopsis microcephala	
Diatoms	Eunotia minor	
Diatoms	Fragilaria capucina v. gracilis	
Diatoms	Fragilaria capucina v. perminuta	
Diatoms	Fragilaria crotonensis	
Diatoms	Fragilaria socia	
Diatoms	Fragilaria vaucheriae	
Diatoms	Gomphonema kobayasii	
Diatoms	Gomphonema patricki	
Diatoms	Hannaea arcus	
Diatoms	Navicula angusta	

Sample Type	Qualitative ID	Lab Comment
Diatoms	Navicula cryptocephala	
Diatoms	Navicula notha	
Diatoms	Navicula schmassmannii	
Diatoms	Nitzschia archibaldii	
Diatoms	Nitzschia dissipata	
Diatoms	Nitzschia frustulum	
Diatoms	Nitzschia palea	
Diatoms	Pinnularia	girdle
Diatoms	Pinnularia divergentissima	uncertain ID
Diatoms	Psammothidium didymum	
Diatoms	Rossithidium nodosum	
Diatoms	Staurosira construens v. venter	
Diatoms	Synedra rumpens	
Diatoms	Tabellaria flocculosa	
Diatoms	Ulnaria contracta	

B.3 South Fork American River above White Rock Powerhouse

Sample Date: 9/20/2016

Sample Type	Qualitative ID	Lab Comment
Algae	Calothrix	
Algae	Cosmarium	Cosmarium cf subtumidum
Algae	Geitlerinema	Geitlerinema cf acutissimum
Algae	Heteroleibleinia kossinskajae	
Algae	Leptolyngbya valderiana	
Algae	Oedogonium	
Algae	Scenedesmus dimorphus	
Algae	Scenedesmus ecornis	
Algae	Tribonema minus	
Diatoms	Achnanthidium deflexum	
Diatoms	Achnanthidium gracillimum	
Diatoms	Achnanthidium minutissimum	
Diatoms	Achnanthidium rivulare	
Diatoms	Amphora copulata	
Diatoms	Cocconeis placentula sensu lato	
Diatoms	Cymbella mexicana	
Diatoms	Cymbella subturgidula	
Diatoms	Delicata delicatula	
Diatoms	Denticula	girdle
Diatoms	Diatoma mesodon	
Diatoms	Didymosphenia geminata	
Diatoms	Encyonema latens	
Diatoms	Encyonema minutum	
Diatoms	Encyonema silesiacum	
Diatoms	Eunotia implicata	
Diatoms	Fragilaria capucina	
Diatoms	Fragilaria capucina v. gracilis	
Diatoms	Fragilaria recapitellata	
Diatoms	Fragilaria socia	
Diatoms	Fragilaria vaucheriae	
Diatoms	Frustulia amphipleuroides	
Diatoms	Gomphonema	Gomphonema cf incognitum
Diatoms	Gomphonema kobayasii	

Sample Type	Qualitative ID	Lab Comment
Diatoms	Gomphonema parvulum	
Diatoms	Gomphonema patricki	
Diatoms	Gomphonema rhombicum	likely Gomphonema amerhobicum (DOTUS site under development)
Diatoms	Hannaea arcus	
Diatoms	Karayevia laterostrata	
Diatoms	Melosira varians	
Diatoms	Navicula antonii	
Diatoms	Navicula cryptotenella	
Diatoms	Navicula medioconvexa	
Diatoms	Navicula notha	
Diatoms	Navicula radiosa	
Diatoms	Nitzschia acidoclinata	
Diatoms	Nitzschia archibaldii	
Diatoms	Nitzschia desertorum	
Diatoms	Nitzschia dissipata	
Diatoms	Nitzschia fonticola	
Diatoms	Nitzschia frustulum	
Diatoms	Nitzschia palea	
Diatoms	Nitzschia perminuta	
Diatoms	Nitzschia sinuata v. tabellaria	
Diatoms	Nitzschia subtilis	
Diatoms	Opephora olsenii	
Diatoms	Planothidium haynaldii	
Diatoms	Psammothidium didymum	
Diatoms	Pseudostaurosira brevistriata	mostly girdle
Diatoms	Reimeria sinuata	
Diatoms	Rhoicosphenia abbreviata	
Diatoms	Sellaphora nigri	
Diatoms	Staurosirella pinnata	
Diatoms	Synedra rumpens	
Diatoms	Ulnaria contracta	
Diatoms	Ulnaria ulna	

B.4 Silver Creek above South Fork American River Confluence

Sample Date: 9/21/2016

Sample Type	Qualitative ID	Lab Comment
Algae	Geitlerinema	Geitlerinema cf acutissimum
Algae	Heteroleibleinia kossinskajae	
Algae	Leptolyngbya tenuis	
Algae	Oedogonium	
Algae	Phormidium	
Algae	Scenedesmus sp 2	
Algae	Tribonema minus	
Diatoms	Achnanthidium deflexum	
Diatoms	Achnanthidium latecephalum	
Diatoms	Achnanthidium minutissimum	
Diatoms	Achnanthidium rivulare	
Diatoms	Brachysira microcephala	
Diatoms	Chamaepinnularia evanida	
Diatoms	Cocconeis placentula sensu lato	
Diatoms	Cymbella subturgidula	
Diatoms	Didymosphenia geminata	
Diatoms	Encyonema latens	
Diatoms	Encyonema silesiacum	
Diatoms	Encyonopsis cesatiformis	
Diatoms	Encyonopsis microcephala	
Diatoms	Eunotia muscicola v. tridentula	
Diatoms	Fragilaria capucina v. gracilis	
Diatoms	Fragilaria recapitellata	
Diatoms	Fragilaria socia	
Diatoms	Fragilaria vaucheriae	
Diatoms	Gomphonema exilissimum	
Diatoms	Gomphonema kobayasii	
Diatoms	Gomphonema minutum	
Diatoms	Gomphonema rhombicum	likely Gomphonema amerhobicum (DOTUS site under development)
Diatoms	Navicula notha	
Diatoms	Navicula schmassmannii	
Diatoms	Nitzschia archibaldii	
Diatoms	Nitzschia dissipata	
Diatoms	Nitzschia frustulum	
Diatoms	Nitzschia palea	

Sample Type	Qualitative ID	Lab Comment
Diatoms	Planothidium frequentissimum	
Diatoms	Psammothidium didymum	
Diatoms	Psammothidium marginulatum	
Diatoms	Sellaphora nigri	
Diatoms	Synedra rumpens	
Diatoms	Ulnaria contracta	
Diatoms	Ulnaria ulna	

Appendix C. Physical Habitat Parameters – Quantitative Sampling

Site:	**Silver Creek above Camino Reservoir**	Date:	**10/29/2014**	Party :	**M. Swisher and T. Belarde**

Transect:	**A**		Width:	**46 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**1.3**	**0.9**	**1.9**	**1.8**		
Substrate:	**CB**	**GC**	**RS**	**SB**	**SB**		
% Algae Cover:	**50**	**20**	**90**	**90**	**80**		

Transect:	**B**		Width:	**41 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**3.1**	**2.9**	**1.2**	**1.5**		
Substrate:	**RS**	**CB**	**RS**	**CB**	**CB**		
% Algae Cover:	**30**	**20**	**70**	**20**	**20**		

Transect:	**C**		Width:	**55 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.4**	**0.5**	**0.6**	**0.9**	**0.5**		
Substrate:	**CB**	**CB**	**SB**	**XB**	**CB**		
% Algae Cover:	**10**	**40**	**10**	**30**	**60**		

Transect:	**D**		Width:	**74 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.5**	**0.9**	**1.2**	**0.5**	**0.7**		
Substrate:	**CB**	**SB**	**CB**	**SB**	**CB**		
% Algae Cover:	**30**	**15**	**20**	**60**	**30**		

Transect:	**E**		Width:	**64 ft**		GPS:
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**0.9**	**0.3**	**1.4**	**DRY**	**0.9**	
Substrate:	**CB**	**GC**	**GF**	**XB**	**CB**	
% Algae Cover:	**70**	**50**	**30**	**0**	**40**	

Transect:	**F**		Width:	**67 ft**		GPS:
	Right	Center-Right	Center	Center-Left	Left	Notes: **Braided channel. 67 feet is the total wetted with along this transect.**
Depth (ft):	**0.6**	**0.7**	**0.6**	**2.7**	**2.5**	
Substrate:	**GF**	**SB**	**XB**	**CB**	**XB**	
% Algae Cover:	**10**	**10**	**10**	**30**	**80**	

Transect:	**G**		Width:	**75 feet**		GPS:
	Right	Center-Right	Center	Center-Left	Left	Notes: **Braided channel. 75 feet is the total wetted with along this transect.**
Depth (ft):	**0.8**	**0.9**	**0.5**	**1.7**	**1**	
Substrate:	**XB**	**XB**	**CB**	**RS**	**XB**	
% Algae Cover:	**80**	**60**	**70**	**40**	**10**	

Transect:	**H**		Width:	**77 feet**		GPS:
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**0.9**	**0.6**	**1**	**0.7**	**1.4**	
Substrate:	**CB**	**GC**	**GC**	**XB**	**RS**	
% Algae Cover:	**40**	**10**	**40**	**80**	**70**	

Transect:	**I**		Width:	**54 feet**		GPS:
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**1.2**	**1.1**	**1.7**	**1.2**	**0.6**	
Substrate:	**GC**	**GC**	**SB**	**CB**	**GC**	

% Algae Cover:	**20**	**10**	**80**	**80**	**60**		

Transect:	**J**		Width:	**42 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.2**	**1.6**	**1**	**2.2**	**1.4**		
Substrate:	**CB**	**RS**	**RS**	**CB**	**CB**		
% Algae Cover:	**75**	**75**	**75**	**75**	**75**		

Transect:	**K**		Width:	**58 feet**		GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.5**	**2.5**	**2.5**	**2.5**	**2**		
Substrate:	**XB**	**CB**	**XB**	**CB**	**XB**		
% Algae Cover:	**80**	**80**	**80**	**80**	**80**		

Site:	**South Fork Rubicon below Robbs/Gerle Gaging site**	Date:	**11/5/2014**	Party:	**G. Winslow and T. Belarde**

Transect:	**A**		Width:	**36 feet**	GPS:	**0725059 E, 4314897 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**1.1**	**0.2**	**2.1**	**1.2**	**0.8**	
Substrate:	**SB**	**XB**	**CB**	**SB**	**GC**	
% Algae Cover:	**50**	**10**	**60**	**20**	**10**	

Transect:	**B**		Width:	**32 feet**	GPS:	**0725075 E, 4314910 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**1.6**	**DRY**	**0.7**	**DRY**	**0.1**	
Substrate:	**SB**	**SB**	**XB**	**XB**	**RS**	
% Algae Cover:	**90**	**0**	**20**	**0**	**40**	

Transect:	**C**		Width:	**33 feet**	GPS:	**0725083 E, 4314897 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**0.9**	**1.4**	**2.7**	**1.7**	**2**	
Substrate:	**GF**	**GF**	**GC**	**RS**	**GF**	
% Algae Cover:	**70**	**70**	**40**	**30**	**30**	

Transect:	**D**		Width:	**25 feet**	GPS:	**0725104 E, 4314920 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:
Depth (ft):	**0.5**	**0.5**	**1**	**1**	**1**	
Substrate:	**RS**	**RS**	**SB**	**RS**	**RS**	
% Algae Cover:	**10**	**80**	**40**	**10**	**10**	

Transect:	**E**		Width:	**34 feet**		GPS:	**0725216 E, 4314722 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.5**	**1**	**0.8**	**1**	**0.4**		
Substrate:	**RS**	**SB**	**SB**	**GC**	**GC**		
% Algae Cover:	**100**	**20**	**10**	**10**	**20**		

Transect:	**F**		Width:	**61 feet**		GPS:	**0725219 E, 4314722 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.2**	**1.6**	**2.8**	**4.5**	**3.7**		
Substrate:	**SB**	**RS**	**GF**	**XB**	**XB**		
% Algae Cover:	**80**	**80**	**80**	**50**	**90**		

Transect:	**G**		Width:	**30 feet**		GPS:	**0725233 E, 4314731 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.6**	**1.8**	**2.7**	**1.6**	**0.6**		
Substrate:	**GC**	**GC**	**GC**	**SB**	**SB**		
% Algae Cover:	**10**	**10**	**10**	**20**	**30**		

Transect:	**H**		Width:	**37 feet**		GPS:	**0725271 E, 4314726 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.8**	**1.3**	**1.3**	**1.1**	**1.1**		
Substrate:	**CB**	**CB**	**CB**	**RS**	**RS**		
% Algae Cover:	**80**	**90**	**100**	**60**	**80**		

Transect:	**I**		Width:	**21 feet**		GPS:	**07255285 E, 4314717 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.7**	**0.8**	**1.4**	**0.6**	**1.1**		
Substrate:	**RS**	**CB**	**CB**	**XB**	**GC**		

% Algae Cover:	**30**	**20**	**50**	**20**	**10**	

Transect:	**J**		Width:	**44 feet**		GPS:	**0725295 E, 4314720 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.7**	**DRY**	**0.3**	**0.4**	**1.1**		
Substrate:	**CB**	**XB**	**XB**	**GC**	**SB**		
% Algae Cover:	**40**	**0**	**30**	**0**	**40**		

Transect:	**K**		Width:	**25 feet**		GPS:	**0725312 E, 4314717 N**
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.1**	**1.1**	**1.1**	**1**	**0.5**		
Substrate:	**RS**	**RS**	**CB**	**SB**	**SB**		
% Algae Cover:	**80**	**90**	**90**	**90**	**90**		

Site:	**Silver Creek above Camino Reservoir**	Date:	**7/12/2016**	Party:	**G. Winslow and T. Belarde**

Transect:	**A**		Width (ft.):	**63**		GPS:	0714080, 4301434 ± 12
	Right	Center-Right	Center	Center-Left	Left	Notes: Difficult to differentiate between silt and algae	
Depth (ft):	**1.6**	**2.2**	**2.2**	**2.2**	**0.9**		
Substrate:	**GC**	**CB**	**CB**	**SB**	**GC**		
% Algae Cover:	**80**	**10**	**10**	**20**	**10**		

Transect:	**B**		Width (ft.):	**54**		GPS:	714079, 4301466 ± 19
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.4**	**3.6**	**3**	**1**	**1.1**		
Substrate:	**SB**	**XB**	**SB**	**XB**	**GC**		
% Algae Cover:	**10**	**20**	**10**	**10**	**50**		

Transect:	**C**		Width (ft.):	**43**		GPS:	0714067, 4301463
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.4**	**4.1**	**2.6**	**2.4**	**1.9**		
Substrate:	**SB**	**RS**	**SB**	**SB**	**SB**		
% Algae Cover:	**40**	**30**	**20**	**10**	**80**		

Transect:	**D**		Width (ft.):	**60**		GPS:	0714076, 4301509 ± 9
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.6**	**0.6**	**1**	**1.3**	**0.9**		
Substrate:	**CB**	**CB**	**CB**	**SB**	**SB**		
% Algae Cover:	**10**	**10**	**10**	**10**	**10**		

Transect:	**E**		Width (ft.):	**29, 14**		GPS:	0714058, 4301511 ± 11
	Right	Center-Right	Center	Center-Left	Left	Notes: Two channels	
Depth (ft):	**0.9**	**0.4**	**1.3**	**1.6**	**1.8**		
Substrate:	**SB**	**GC**	**GC**	**SB**	**SB**		
% Algae Cover:	**20**	**40**	**10**	**10**	**10**		

Transect:	**F**		Width (ft.):	**44, 20**		GPS:	0714064, 4301558 ± 11
	Right	Center-Right	Center	Center-Left	Left	Notes: Two channels	
Depth (ft):	**1.4**	**1**	**1.3**	**0.7**	**1.9**		
Substrate:	**SB**	**CB**	**RS**	**SB**	**XB**		
% Algae Cover:	**30**	**10**	**20**	**20**	**10**		

Transect:	**G**		Width (ft.):	**Missing**		GPS:	0714068, 4301582 ± 9 ft
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.7**	**1.8**	**1**	**0.9**	**2.1**		
Substrate:	**GC**	**XB**	**XB**	**GC**	**SB**		
% Algae Cover:	**90**	**0**	**90**	**70**	**50**		

Transect:	**H**		Width (ft.):	**44**		GPS:	0714035, 4301607 ± 17
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.4**	**1.6**	**1.2**	**2.6**	**1.3**		
Substrate:	**SB**	**SB**	**CB**	**SB**	**CB**		
% Algae Cover:	**80**	**10**	**30**	**10**	**90**		

Transect:	**I**		Width (ft.):	**48**		GPS:	0714023, 4301636 ± 12
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.8**	**2.9**	**2.7**	**2.9**	**1.1**		
Substrate:	**GC**	**SB**	**XB**	**XB**	**SB**		

% Algae Cover:	**20**	**10**	**80**	**90**	**90**	

Transect:	**J**		Width (ft.):	**46**		GPS:	0714012, 4301649 ± 17
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.2**	**0.6**	**1.7**	**1.6**	**2.1**		
Substrate:	**SB**	**XB**	**SB**	**SB**	**CB**		
% Algae Cover:	**10**	**10**	**10**	**10**	**10**		

Transect:	**K**		Width (ft.):	**40**		GPS:	0713981, 4301609 ± 32
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.3**	**1.5**	**2.2**	**2.2**	**1.4**		
Substrate:	**XB**	**XB**	**XB**	**XB**	**GC**		
% Algae Cover:	**40**	**10**	**20**	**50**	**90**		

Site:	**SF Rubicon blw Gerle Confluence**	Date:	**7/13/2016**	Party:	**G. Winslow and T. Belarde**

Transect:	**A**		Width (ft.):	**21**		GPS:	0724998, 4314873 ± 9
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.4**	**0.6**	**1.1**	**1.6**	**1.6**		
Substrate:	**GC**	**XB**	**XB**	**XB**	**RS**		
% Algae Cover:	**50**	**50**	**90**	**60**	**100**		

Transect:	**B**		Width (ft.):	**33**		GPS:	0725002, 4314866 ± 15
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.2**	**2.6**	**2.6**	**2.1**	**2.5**		
Substrate:	**RS**	**RS**	**RS**	**RS**	**GC**		
% Algae Cover:	**80**	**90**	**80**	**80**	**10**		

Transect:	**C**		Width (ft.):	**22**		GPS:	0725031, 4314883 ± 9
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**3**	**2.8**	**2.2**	**2**	**2.8**		
Substrate:	**SB**	**SB**	**SB**	**SB**	**SB**		
% Algae Cover:	**60**	**60**	**60**	**80**	**80**		

Transect:	**D**		Width (ft.):	**30**		GPS:	0725058, 4314899 ± 8
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.5**	**20**	**2.5**	**3.1**	**1.2**		
Substrate:	**RS**	**RS**	**XB**	**CB**	**SB**		
% Algae Cover:	**10**	**70**	**90**	**90**	**70**		

Transect:	**E**		Width (ft.):	**17**		GPS:	0725709, 4314902 ± 8
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**3.2**	**2.5**	**3.2**	**3.5**		
Substrate:	**SB**	**XB**	**XB**	**XB**	**SB**		
% Algae Cover:	**50**	**80**	**30**	**30**	**30**		

Transect:	**F**		Width (ft.):	**21**		GPS:	0725111, 4314915 ± 9
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**1.8**	**2**	**1**	**1.8**		
Substrate:	**GC**	**GC**	**CB**	**SB**	**GC**		
% Algae Cover:	**10**	**10**	**10**	**30**	**20**		

Transect:	**G**		Width (ft.):	**47**		GPS:	0725117, 4314919 ± 12
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.6**	**3.4**	**2.1**	**2.4**	**2.8**		
Substrate:	**RS**	**RS**	**SB**	**SB**	**XB**		
% Algae Cover:	**100**	**90**	**90**	**90**	**70**		

Transect:	**H**		Width (ft.):	**28**		GPS:	0725123, 4314932 ± 14
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.2**	**2.3**	**1.8**	**4**	**2.1**		
Substrate:	**GC**	**SB**	**XB**	**XB**	**RS**		
% Algae Cover:	**10**	**90**	**90**	**30**	**60**		

Transect:	**I**		Width (ft.):	**37**		GPS:	0725169, 4314920 ± 14
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.4**	**2.1**	**1.9**	**1.7**	**1.3**		
Substrate:	**GC**	**SA**	**CB**	**RS**	**RS**		

% Algae Cover:	**10**	**0**	**80**	**30**	**70**	

Transect:	**J**		Width (ft.):	**44**		GPS:	0725192, 4314912 ± 13
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**0.9**	**1.5**	**1.3**	**1.1**	**2.3**		
Substrate:	**CB**	**SB**	**XB**	**XB**	**GC**		
% Algae Cover:	**10**	**10**	**30**	**20**	**50**		

Transect:	**K**		Width (ft.):	**20**		GPS:	0725205, 4314882 ± 14
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.5**	**2**	**3**	**2.3**	**1.9**		
Substrate:	**XB**	**XB**	**CB**	**RS**	**RS**		
% Algae Cover:	**80**	**80**	**10**	**80**	**70**		

Site:	**Silver Creek above Camino Reservoir**	Date:	**10/19/2016**	Party:	**K. Bednar and T. Belarde**

Transect:	**A**		Width (ft.):	**66**		GPS:	0714088, 4301941 ± 12
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.7**	**2.5**	**2.3**	**2.3**	**1.3**		
Substrate:	**GC**	**GC**	**CB**	**SB**	**GC**		
% Algae Cover:	**80**	**80**	**70**	**40**	**60**		

Transect:	**B**		Width (ft.):	**56**		GPS:	0714090, 4301459 ± 18
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.7**	**2.5**	**2.5**	**1.3**	**1.2**		
Substrate:	**XB**	**RS**	**RS**	**CB**	**RS**		
% Algae Cover:	**10**	**20**	**50**	**60**	**10**		

Transect:	**C**		Width (ft.):	**50**		GPS:	0714085, 4301486 ± 15
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.6**	**3.3**	**4.6**	**3.3**	**2.4**		
Substrate:	**SB**	**XB**	**SB**	**SB**	**SB**		
% Algae Cover:	**70**	**80**	**50**	**30**	**10**		

Transect:	**D**		Width (ft.):	**62**		GPS:	0714051, 4301516 ± 15
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**1.3**	**1.2**	**1.6**	**1.6**		
Substrate:	**SB**	**CB**	**SB**	**SB**	**GC**		
% Algae Cover:	**50**	**30**	**10**	**10**	**30**		

Transect:	**E**		Width (ft.):	**48**		GPS:	0714048, 4301521 ± 16
	Right	Center-Right	Center	Center-Left	Left	Notes: Two channels	
Depth (ft):	**1.1**	**0.5**	**0.6**	**1.3**	**2**		
Substrate:	**GF**	**RS**	**GF**	**XB**	**SB**		
% Algae Cover:	**10**	**10**	**50**	**10**	**0**		

Transect:	**F**		Width (ft.):	**70**		GPS:	0714014, 4301531 ± 15
	Right	Center-Right	Center	Center-Left	Left	Notes: Two channels	
Depth (ft):	**0.9**	**0.7**	**1.5**	**1**	**1.3**		
Substrate:	**GF**	**CB**	**XB**	**GF**	**XB**		
% Algae Cover:	**20**	**20**	**10**	**20**	**20**		

Transect:	**G**		Width (ft.):	**67**		GPS:	0714046, 4301552 ± 25
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.4**	**2.7**	**2**	**1.1**	**2.5**		
Substrate:	**SB**	**XB**	**SB**	**GC**	**SB**		
% Algae Cover:	**70**	**90**	**80**	**90**	**80**		

Transect:	**H**		Width (ft.):	**39**		GPS:	0714081, 4301630 ± 24
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.9**	**2.5**	**1.7**	**2.1**	**2.3**		
Substrate:	**SB**	**SB**	**XB**	**GC**	**CB**		
% Algae Cover:	**90**	**90**	**60**	**30**	**70**		

Transect:	**I**		Width (ft.):	**44**		GPS:	0714038, 4301630 ± 15
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.3**	**1.9**	**2.7**	**1.8**	**2.5**		
Substrate:	**CB**	**CB**	**SB**	**XB**	**XB**		

% Algae Cover:	**10**	**10**	**50**	**80**	**70**	

Transect:	**J**		Width (ft.):	**47**		GPS:	0714040, 4301663 ± 16
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**3.1**	**1.5**	**2**	**2.1**	**2.8**		
Substrate:	**XB**	**CB**	**SB**	**CB**	**CB**		
% Algae Cover:	**50**	**30**	**40**	**40**	**90**		

Transect:	**K**		Width (ft.):	**42**		GPS:	0714011, 4301671 ± 10
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.7**	**2.5**	**3**	**1.5**	**1.8**		
Substrate:	**SB**	**XB**	**XB**	**XB**	**CB**		
% Algae Cover:	**50**	**10**	**60**	**50**	**90**		

Site:	**South Fork Rubicon below Robbs/Gerle Gaging site**	Date:	**10/26/2016**	Party:	**K. Bednar and T. Belarde**

Transect:	**A**		Width (ft.):	**30**		GPS:	0724995, 4314872 ± 13
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1**	**1.3**	**2.7**	**1.7**	**1.3**		
Substrate:	**XB**	**XB**	**XB**	**XB**	**RS**		
% Algae Cover:	**10**	**20**	**20**	**10**	**10**		

Transect:	**B**		Width (ft.):	**35**		GPS:	0725014, 4314873 ± 9
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.1**	**2.4**	**2.7**	**1.2**	**2.8**		
Substrate:	**RS**	**RS**	**SB**	**XB**	**CB**		
% Algae Cover:	**20**	**50**	**30**	**10**	**20**		

Transect:	**C**		Width (ft.):	**33**		GPS:	0725059, 4314897
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.2**	**2**	**1.9**	**3**	**1.3**		
Substrate:	**CB**	**XB**	**XB**	**SB**	**XB**		
% Algae Cover:	**10**	**20**	**10**	**10**	**10**		

Transect:	**D**		Width (ft.):	**42**		GPS:	0725068, 4314891 ± 14
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.5**	**3.2**	**3.4**	**2.8**	**3.1**		
Substrate:	**CB**	**CB**	**RS**	**RS**	**XB**		
% Algae Cover:	**30**	**10**	**20**	**20**	**10**		

Transect:	E		Width (ft.):			GPS:	
	Right	Center-Right	Center	Center-Left	Left	Notes: This transect was missed during this sampling event	
Depth (ft):							
Substrate:							
% Algae Cover:							

Transect:	**F**		Width (ft.):	**21**		GPS:	0725118, 4314912 ± 13
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.6**	**1.9**	**2**	**1.8**	**1.5**		
Substrate:	**GC**	**XB**	**CB**	**CB**	**GC**		
% Algae Cover:	**0**	**10**	**0**	**0**	**0**		

Transect:	**G**		Width (ft.):	**50**		GPS:	0725129, 4314908 ± 10
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**2.9**	**3.2**	**3.5**	**2.4**	**1.9**		
Substrate:	**SB**	**RS**	**GF**	**XB**	**XB**		
% Algae Cover:	**90**	**80**	**60**	**50**	**70**		

Transect:	**H**		Width (ft.):	**50**		GPS:	0725145, 4314915 ± 10
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.8**	**2**	**1.5**	**3.7**	**3.2**		
Substrate:	**SA**	**RS**	**XB**	**XB**	**RS**		
% Algae Cover:	**10**	**50**	**30**	**30**	**30**		

Transect:	**I**		Width (ft.):	**34**		GPS:	0725173, 4314916 ± 14
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.1**	**2.3**	**1.9**	**0.6**	**2**		

Substrate:	**XB**	**SA**	**CB**	**RS**	**RS**	
% Algae Cover:	**40**	**0**	**30**	**60**	**60**	

Transect:	**J**		Width (ft.):	**50**		GPS:	0725195, 4314899 ± 17
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.1**	**0.8**	**1.8**	**1.7**	**1.5**		
Substrate:	**CB**	**RS**	**XB**	**SB**	**CB**		
% Algae Cover:	**30**	**30**	**10**	**10**	**10**		

Transect:	**K**		Width (ft.):	**30**		GPS:	0725224, 4314902 ± 16
	Right	Center-Right	Center	Center-Left	Left	Notes:	
Depth (ft):	**1.5**	**2.2**	**1.2**	**2.7**	**1.3**		
Substrate:	**SB**	**XB**	**XB**	**XB**	**XB**		
% Algae Cover:	**70**	**80**	**80**	**80**	**80**		

Appendix D. Selection of photo-documentation from algae sampling

Silver Creek above Camino Reservoir – Sample Date: 10/29/2014

South Fork Rubicon below Gerle Confluence – Sample Date: 11/5/2014

Silver Creek above Camino Reservoir – Sample Date: 7/12/2016

South Fork Rubicon below Gerle Confluence – Sample Date: 7/13/2016

South Fork Rubicon below Gerle Confluence – Sample Date: 9/1/2016

Silver Creek above Camino Reservoir – Sample Date: 9/15/2016

South Fork American River above White Rock – Sample Date: 9/20/2016

Silver Creek above South Fork American Confluence – Sample Date: 9/21/2016

Silver Creek above Camino Reservoir – Sample Date: 10/19/2016

South Fork Rubicon below Gerle Confluence – Sample Date: 10/26/2016

Appendix E. Algae ID Lab – Technical Summary

Analysis of biological samples:
Technical summary of methods
Prepared for Sacramento Municipal Utility District
Tyler Belarde, Project Manager
December 2, 2016

By W. Bollman, Chief Biologist
Rhithron Associates, Inc.
Missoula, Montana

METHODS

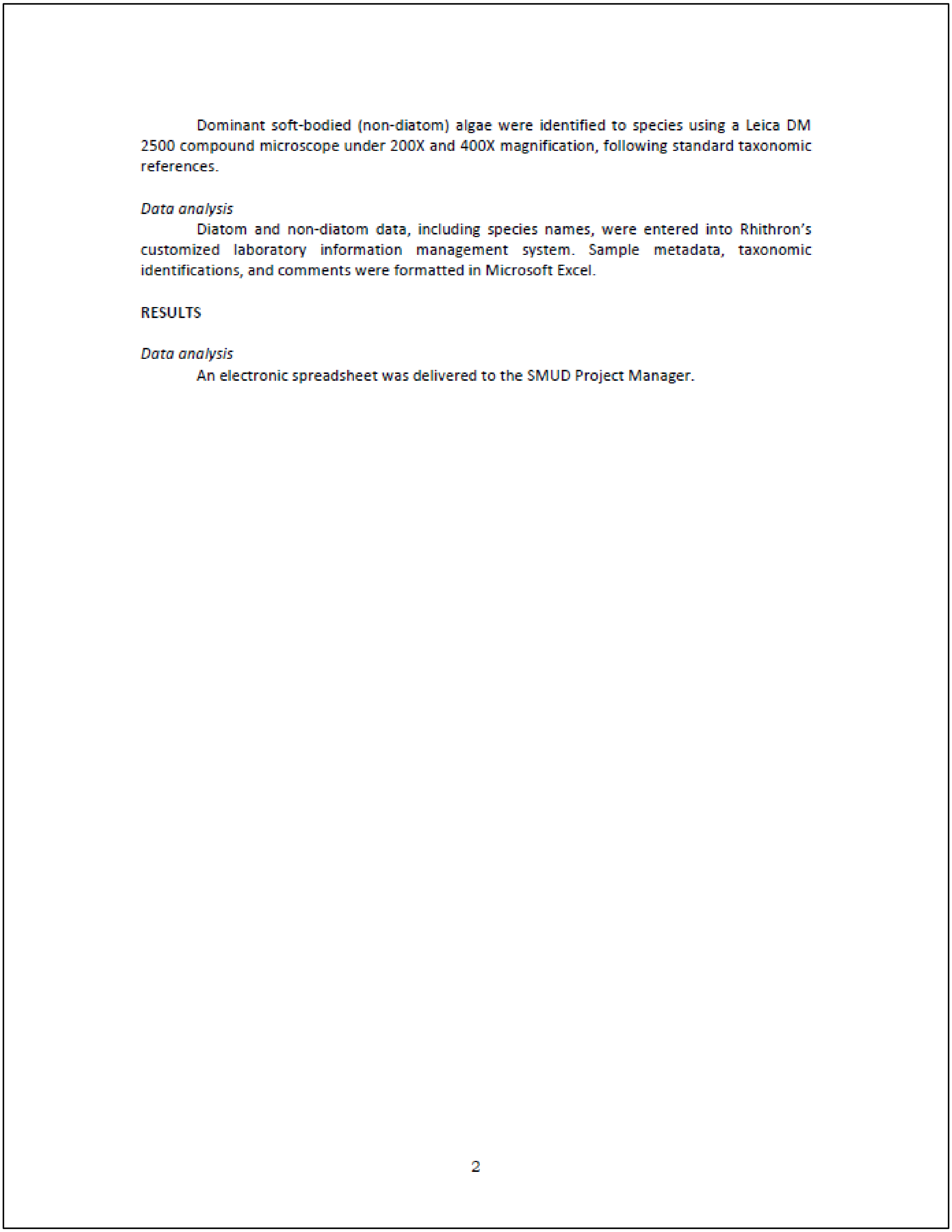
Sample processing

A total of 4 periphyton samples were delivered to Rhithron's laboratory facility in Missoula, Montana. Samples arrived in 4 deliveries including one sample each on the following dates: September 2, 16, 21 and 22, 2016. Samples were collected by personnel of the Sacramento Municipal Utility District (SMUD). All samples arrived in good condition. A chain of custody document containing sample identification information for each sample was provided by the SMUD Project Manager. Upon arrival, samples were unpacked and examined, and checked against the SMUD chain of custody. An inventory spreadsheet was created. This spreadsheet included project code and internal laboratory identification numbers and was uploaded into the Rhithron database prior to sample processing.

Diatom samples were preserved with glutaraldehyde. The total volume of each sample was measured to the nearest milliliter, and volumes were recorded. All samples were thoroughly mixed by shaking. Permanent diatom slides were prepared: diatom subsamples were taken and treated with 70% Nitric acid (HNO_3) and digested using a closed-vessel microwave digestion system (Milestone Ethos EZ), following the method developed by the Academy of Natural Sciences, Philadelphia (ANSP 2002). Samples were neutralized by rinses with distilled water, and subsample volumes were adjusted to obtain adequate densities. Small amounts of each sample were dried onto 22-mm square coverslips. Coverslips were mounted on slides using Naphrax diatom mount. To ensure a high quality mount for identification and to make replicates available for archives, 3 slide mounts were made from each sample. One of the replicates was selected from each sample batch for identification. Sample remnants, after slide mounting, were preserved in 100% ethanol. All materials were retained and stored at the Rhithron laboratory.

Diamond scribe marks were made to define transect lines on the cover slip, and diatom valves were identified along the transect marks. A Leica DM 2500 compound microscope, Nomarski contrast, and 1000x magnification were used for identifications. Diatoms were identified to the lowest possible taxonomic level, generally species, following standard taxonomic references. The entire slide was read for dominant, unique taxa, and a large and rare search was also completed at 40x magnification.

For soft-bodied (non-diatom) algae samples, the raw periphyton sample was manually homogenized and emptied into a porcelain evaporating dish. A small, random sub-sample of algal material was pipetted onto a standard Palmer-Maloney microscope slide using a disposable pasture pipette. Visible (macroscopic) algae were also sub-sampled, in proportion to their estimated abundance relative to the total volume of algal material in the sample, and added to the liquid fraction on the slide. The Palmer-Maloney cell was then covered with a 22 x 30 mm coverslip.



Dominant soft-bodied (non-diatom) algae were identified to species using a Leica DM 2500 compound microscope under 200X and 400X magnification, following standard taxonomic references.

Data analysis

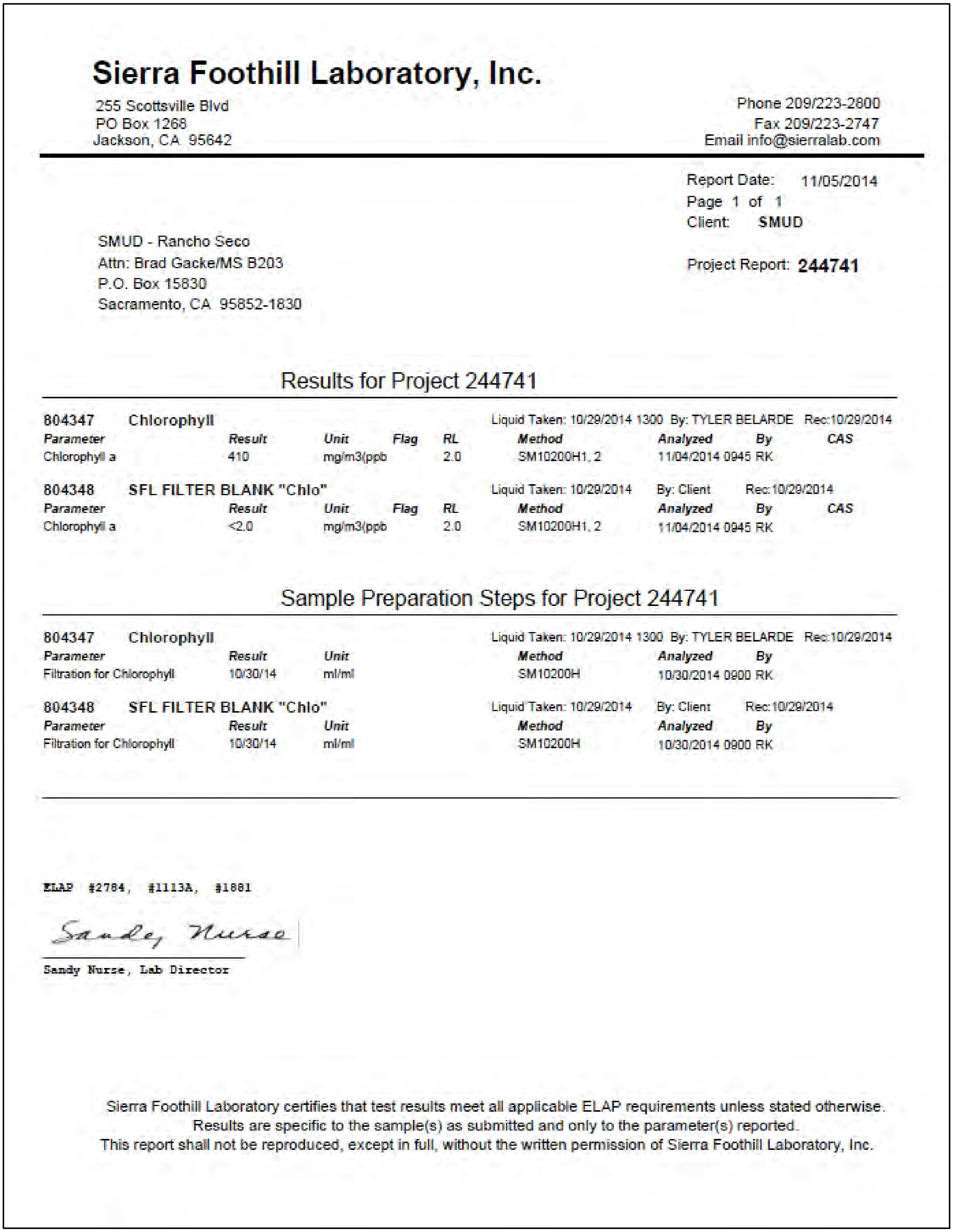
Diatom and non-diatom data, including species names, were entered into Rhithron's customized laboratory information management system. Sample metadata, taxonomic identifications, and comments were formatted in Microsoft Excel.

RESULTS

Data analysis

An electronic spreadsheet was delivered to the SMUD Project Manager.

Appendix F. Chlorophyll-a Analysis Reports



Sierra Foothill Laboratory, Inc.

255 Scottsville Blvd
PO Box 1268
Jackson, CA 95642

Phone 209/223-2800
Fax 209/223-2747
Email info@sierralab.com

Report Date: 11/05/2014
Page 1 of 1
Client: **SMUD**

Project Report: **244741**

SMUD - Rancho Seco
Attn: Brad Gacke/MS B203
P.O. Box 15830
Sacramento, CA 95852-1830

Results for Project 244741

804347 Chlorophyll Liquid Taken: 10/29/2014 1300 By: TYLER BELARDE Rec:10/29/2014

Parameter	*Result*	*Unit*	*Flag*	*RL*	*Method*	*Analyzed*	*By*	*CAS*
Chlorophyll a	410	mg/m3(ppb		2.0	SM10200H1, 2	11/04/2014 0945	RK	

804348 SFL FILTER BLANK "Chlo" Liquid Taken: 10/29/2014 By: Client Rec:10/29/2014

Parameter	*Result*	*Unit*	*Flag*	*RL*	*Method*	*Analyzed*	*By*	*CAS*
Chlorophyll a	<2.0	mg/m3(ppb		2.0	SM10200H1, 2	11/04/2014 0945	RK	

Sample Preparation Steps for Project 244741

804347 Chlorophyll Liquid Taken: 10/29/2014 1300 By: TYLER BELARDE Rec:10/29/2014

Parameter	*Result*	*Unit*	*Method*	*Analyzed*	*By*
Filtration for Chlorophyll	10/30/14	ml/ml	SM10200H	10/30/2014 0900	RK

804348 SFL FILTER BLANK "Chlo" Liquid Taken: 10/29/2014 By: Client Rec:10/29/2014

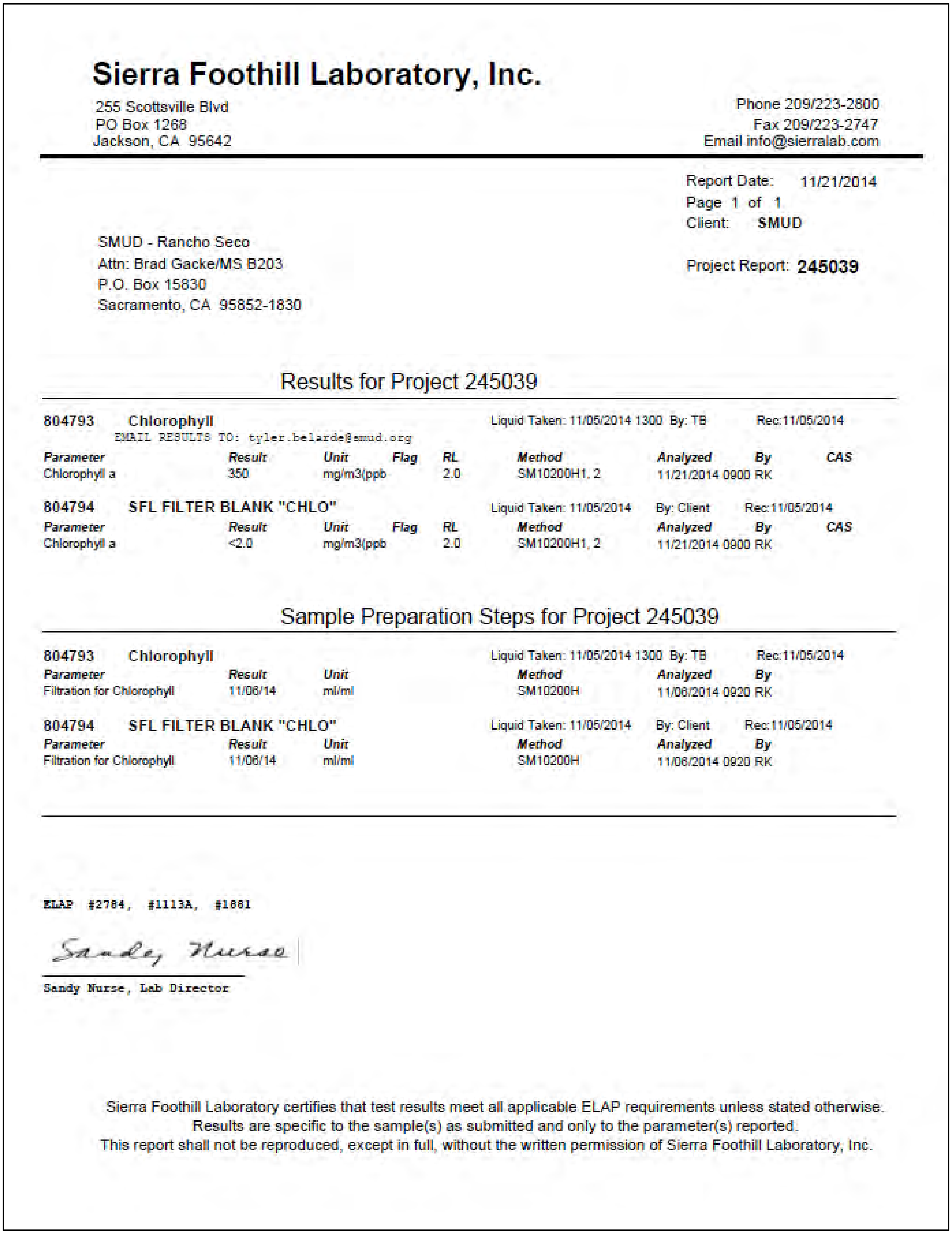
Parameter	*Result*	*Unit*	*Method*	*Analyzed*	*By*
Filtration for Chlorophyll	10/30/14	ml/ml	SM10200H	10/30/2014 0900	RK

ELAP #2784, #1113A, #1881

Sandy Nurse

Sandy Nurse, Lab Director

Sierra Foothill Laboratory certifies that test results meet all applicable ELAP requirements unless stated otherwise.
Results are specific to the sample(s) as submitted and only to the parameter(s) reported.
This report shall not be reproduced, except in full, without the written permission of Sierra Foothill Laboratory, Inc.



Sierra Foothill Laboratory, Inc.

255 Scottsville Blvd
PO Box 1268
Jackson, CA 95642

Phone 209/223-2800
Fax 209/223-2747
Email info@sierralab.com

Report Date: 11/21/2014
Page 1 of 1
Client: **SMUD**

SMUD - Rancho Seco
Attn: Brad Gacke/MS B203
P.O. Box 15830
Sacramento, CA 95852-1830

Project Report: **245039**

Results for Project 245039

804793 Chlorophyll Liquid Taken: 11/05/2014 1300 By: TB Rec:11/05/2014

`EMAIL RESULTS TO: tyler.belarde@smud.org`

Parameter	*Result*	*Unit*	*Flag*	*RL*	*Method*	*Analyzed*	*By*	*CAS*
Chlorophyll a	350	mg/m3(ppb		2.0	SM10200H1, 2	11/21/2014 0900	RK	

804794 SFL FILTER BLANK "CHLO" Liquid Taken: 11/05/2014 By: Client Rec:11/05/2014

Parameter	*Result*	*Unit*	*Flag*	*RL*	*Method*	*Analyzed*	*By*	*CAS*
Chlorophyll a	<2.0	mg/m3(ppb		2.0	SM10200H1, 2	11/21/2014 0900	RK	

Sample Preparation Steps for Project 245039

804793 Chlorophyll Liquid Taken: 11/05/2014 1300 By: TB Rec:11/05/2014

Parameter	*Result*	*Unit*	*Method*	*Analyzed*	*By*
Filtration for Chlorophyll	11/06/14	ml/ml	SM10200H	11/06/2014 0920	RK

804794 SFL FILTER BLANK "CHLO" Liquid Taken: 11/05/2014 By: Client Rec:11/05/2014

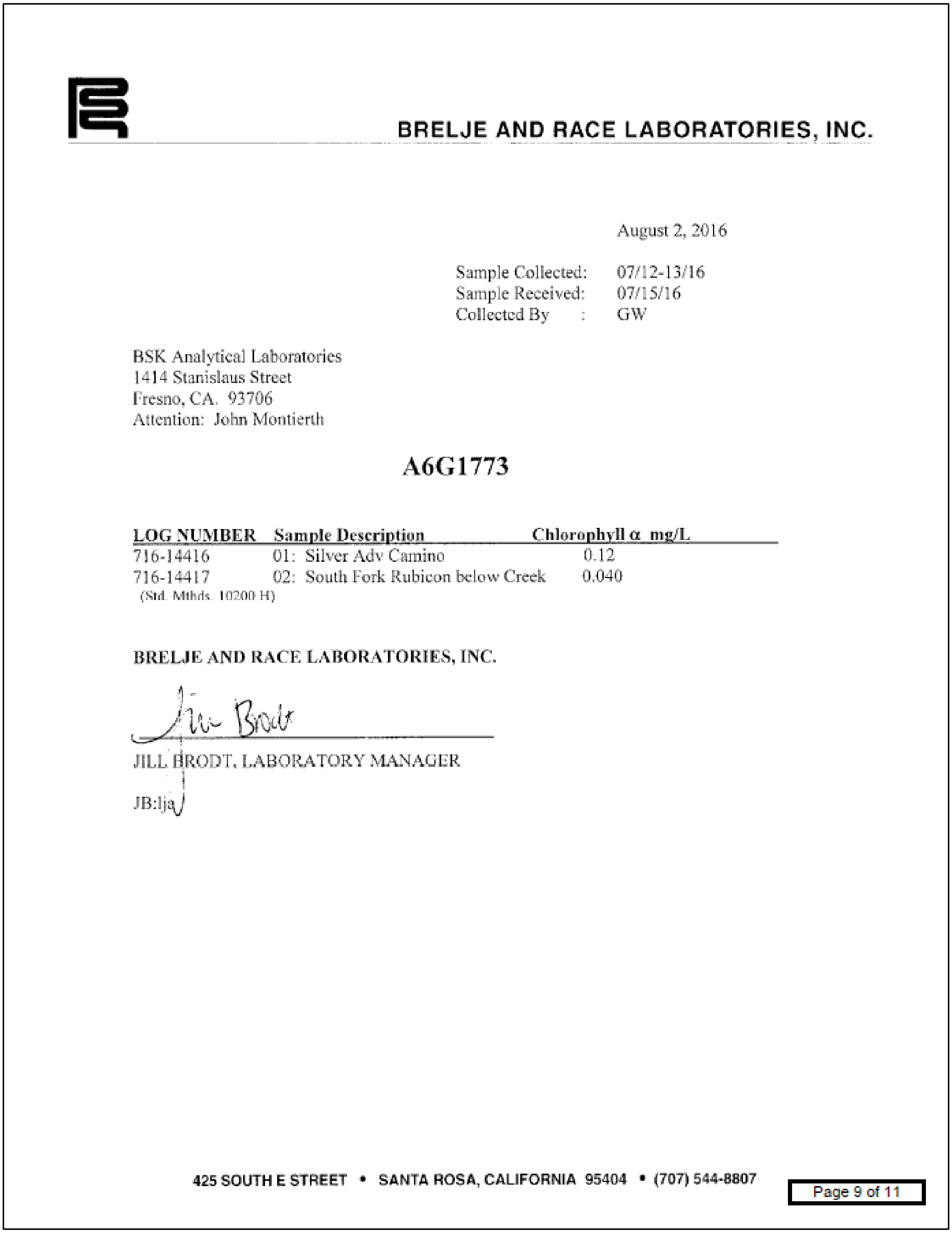
Parameter	*Result*	*Unit*	*Method*	*Analyzed*	*By*
Filtration for Chlorophyll	11/06/14	ml/ml	SM10200H	11/06/2014 0920	RK

ELAP #2784, #1113A, #1881

Sandy Nurse

Sandy Nurse, Lab Director

Sierra Foothill Laboratory certifies that test results meet all applicable ELAP requirements unless stated otherwise.
Results are specific to the sample(s) as submitted and only to the parameter(s) reported.
This report shall not be reproduced, except in full, without the written permission of Sierra Foothill Laboratory, Inc.



BRELJE AND RACE LABORATORIES, INC.

August 2, 2016

Sample Collected: 07/12-13/16
Sample Received: 07/15/16
Collected By : GW

BSK Analytical Laboratories
1414 Stanislaus Street
Fresno, CA. 93706
Attention: John Montierth

A6G1773

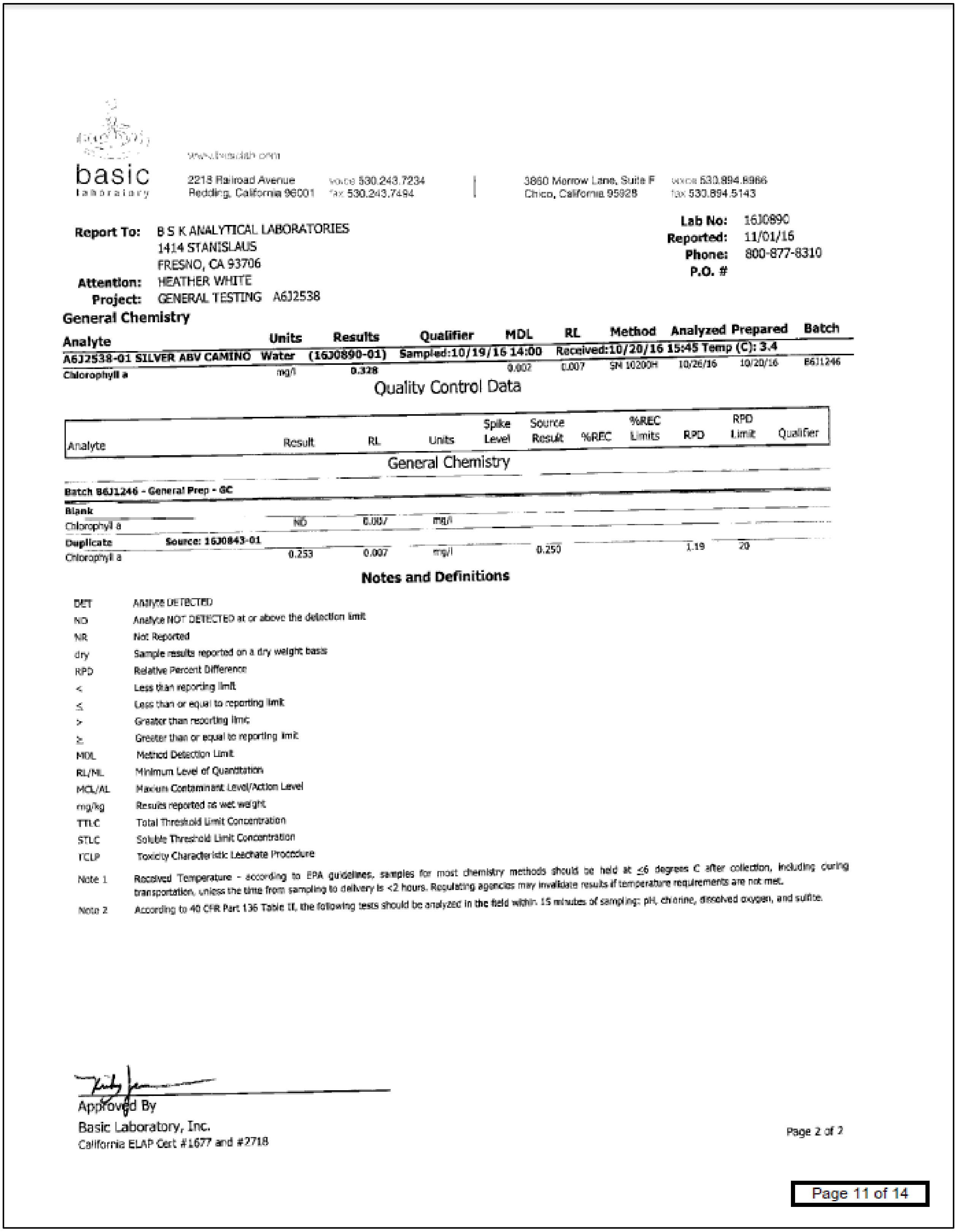
LOG NUMBER	Sample Description	Chlorophyll α mg/L
716-14416	01: Silver Adv Camino	0.12
716-14417	02: South Fork Rubicon below Creek	0.040

(Std. Mthds. 10200 H)

BRELJE AND RACE LABORATORIES, INC.

JILL BRODT, LABORATORY MANAGER

JB:lja



basic
laboratory

www.basiclab.com

2218 Railroad Avenue
Redding, California 96001
voice 530.243.7234
fax 530.243.7494

3860 Morrow Lane, Suite F
Chico, California 95928
voice 530.894.8966
fax 530.894.5143

Report To: B S K ANALYTICAL LABORATORIES
1414 STANISLAUS
FRESNO, CA 93706
Attention: HEATHER WHITE
Project: GENERAL TESTING A6J2538

Lab No: 16J0890
Reported: 11/01/16
Phone: 800-877-8310
P.O. #

General Chemistry

Analyte	Units	Results	Qualifier	MDL	RL	Method	Analyzed	Prepared	Batch
A6J2538-01 SILVER ABV CAMINO	**Water**	**(16J0890-01)**	**Sampled:10/19/16 14:00**		**Received:10/20/16 15:45 Temp (C): 3.4**				
Chlorophyll a	mg/l	**0.328**		0.002	0.007	SM 10200H	10/26/16	10/20/16	B6J1246

Quality Control Data

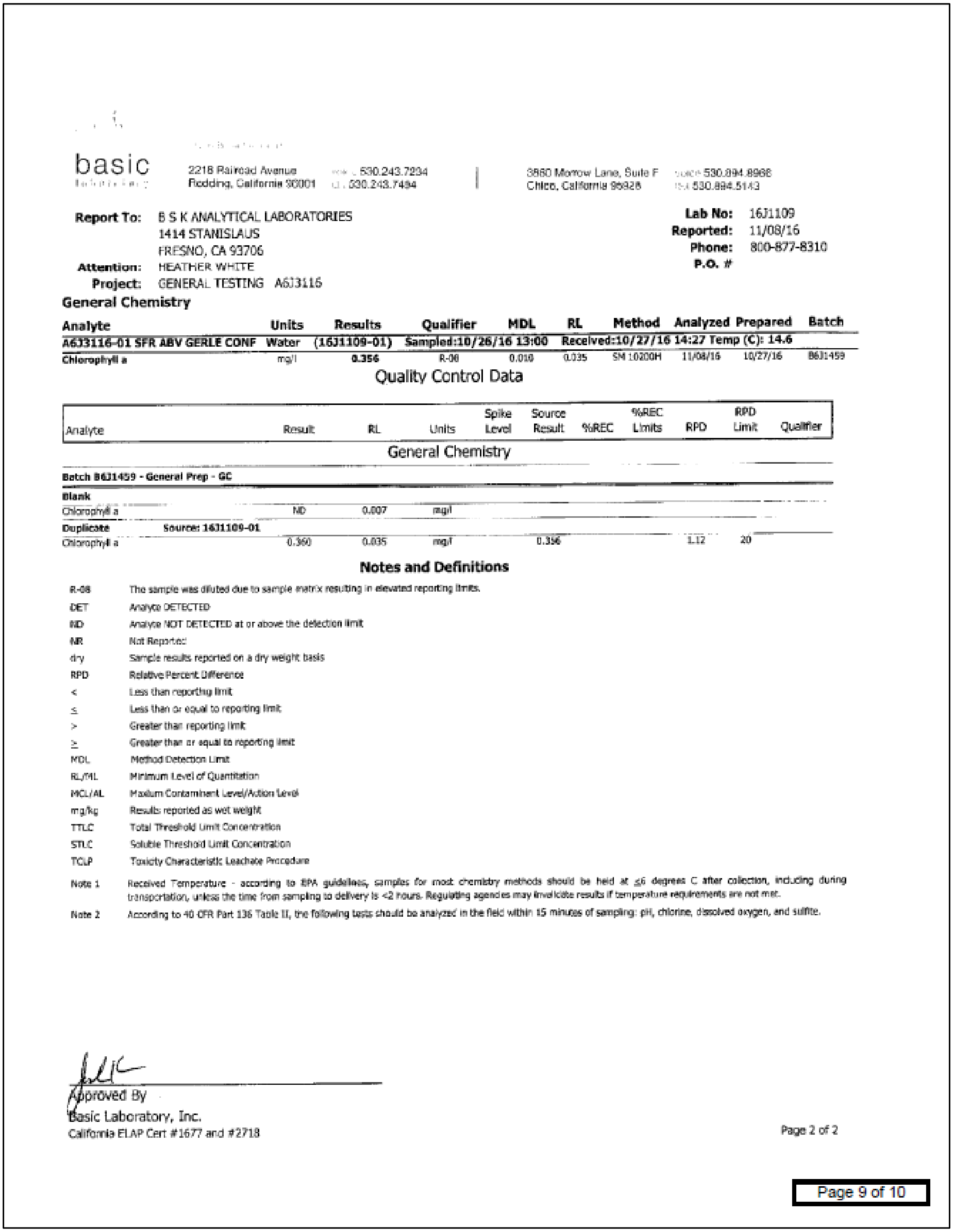
Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
General Chemistry										
Batch B6J1246 - General Prep - GC										
Blank										
Chlorophyll a	ND	0.007	mg/l							
Duplicate **Source: 16J0843-01**										
Chlorophyll a	0.253	0.007	mg/l		0.250			1.19	20	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the detection limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
<	Less than reporting limit
≤	Less than or equal to reporting limit
>	Greater than reporting limit
≥	Greater than or equal to reporting limit
MDL	Method Detection Limit
RL/ML	Minimum Level of Quantitation
MCL/AL	Maxium Contaminant Level/Action Level
mg/kg	Results reported as wet weight
TTLC	Total Threshold Limit Concentration
STLC	Soluble Threshold Limit Concentration
TCLP	Toxicity Characteristic Leachate Procedure
Note 1	Received Temperature - according to EPA guidelines, samples for most chemistry methods should be held at ≤6 degrees C after collection, including during transportation, unless the time from sampling to delivery is <2 hours. Regulating agencies may invalidate results if temperature requirements are not met.
Note 2	According to 40 CFR Part 136 Table II, the following tests should be analyzed in the field within 15 minutes of sampling: pH, chlorine, dissolved oxygen, and sulfite.

Approved By
Basic Laboratory, Inc.
California ELAP Cert #1677 and #2718

Page 2 of 2



basic

2218 Railroad Avenue
Redding, California 96001
530.243.7234
530.243.7494

3860 Morrow Lane, Suite F
Chico, California 95928
530.894.8966
530.894.5143

Report To: B S K ANALYTICAL LABORATORIES
1414 STANISLAUS
FRESNO, CA 93706
Attention: HEATHER WHITE
Project: GENERAL TESTING A6J3116

Lab No: 16J1109
Reported: 11/08/16
Phone: 800-877-8310
P.O. #

General Chemistry

Analyte	Units	Results	Qualifier	MDL	RL	Method	Analyzed	Prepared	Batch
A6J3116-01 SFR ABV GERLE CONF	**Water**	**(16J1109-01)**	**Sampled:10/26/16 13:00**		**Received:10/27/16 14:27 Temp (C): 14.6**				
Chlorophyll a	mg/l	**0.356**	R-08	0.010	0.035	SM 10200H	11/08/16	10/27/16	B6J1459

Quality Control Data

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
General Chemistry										
Batch B6J1459 - General Prep - GC										
Blank										
Chlorophyll a	ND	0.007	mg/l							
Duplicate **Source: 16J1109-01**										
Chlorophyll a	0.360	0.035	mg/l		0.356			1.12	20	

Notes and Definitions

R-08	The sample was diluted due to sample matrix resulting in elevated reporting limits.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the detection limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
<	Less than reporting limit
≤	Less than or equal to reporting limit
>	Greater than reporting limit
≥	Greater than or equal to reporting limit
MDL	Method Detection Limit
RL/ML	Minimum Level of Quantitation
MCL/AL	Maximum Contaminant Level/Action Level
mg/kg	Results reported as wet weight
TTLC	Total Threshold Limit Concentration
STLC	Soluble Threshold Limit Concentration
TCLP	Toxicity Characteristic Leachate Procedure
Note 1	Received Temperature - according to EPA guidelines, samples for most chemistry methods should be held at ≤6 degrees C after collection, including during transportation, unless the time from sampling to delivery is <2 hours. Regulating agencies may invalidate results if temperature requirements are not met.
Note 2	According to 40 CFR Part 136 Table II, the following tests should be analyzed in the field within 15 minutes of sampling: pH, chlorine, dissolved oxygen, and sulfite.

Approved By
Basic Laboratory, Inc.
California ELAP Cert #1677 and #2718

Page 2 of 2