Water Quality Monitoring Plan

Sacramento Municipal Utility District

Hydro License Implementation • March 2021

(Revision 3)

Upper American River Project

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1.0 Introduction

This Water Quality Monitoring Plan (Plan) addresses monitoring set forth in Condition 8.J of Appendix A of the Order Issuing New License issued by the Federal Energy Regulatory Commission (FERC) on July 23, 2014 (FERC 2014) and License Appendix B Condition 1-5.10 for the Upper American River Project (UARP; FERC Project 2101), owned and operated by the Sacramento Municipal Utility District (SMUD). Appendix A of the License contains the State Water Resources Control Board (SWRCB) Water Quality Certification and Appendix B of the License contains the U.S. Forest Service (USFS) 4(e) conditions. Attachments 1 and 2 contain the language from the two documents as applicable to this monitoring plan. There are small differences between these two License requirements. SMUD followed the more extensive of the two requirements. SMUD also ensured that all stipulations in both requirements were addressed.

The UARP lies within El Dorado and Sacramento counties, primarily within lands of the Eldorado National Forest. The UARP consists of three major storage reservoirs—Loon Lake, Union Valley and Ice House (with a combined capacity of approximately 379,000 acre-feet), eight smaller regulating or diversion reservoirs, and eight powerhouses. The UARP has an authorized installed capacity of 637.3 megawatts (MW). The UARP also includes recreation facilities containing over 700 campsites, five boat ramps, hiking paths, and bicycle trails at the reservoirs.

This Plan describes the regular monitoring of four general constituents of project water quality: (1) basic *in situ* parameters, (2) general water chemistry, (3) bacterial, and (4) metals bioaccumulation.

Condition 8.J of Appendix A of the FERC license requires monitoring throughout the duration of the license term, with sampling frequency varying by water quality constituent. However, as described in the Articles, the plan may be modified pursuant to adaptive management program needs following review of monitoring results. Nevertheless, the sampling frequency over the first five years of the monitoring program is dictated by the Articles and will, at a minimum, include annual sampling for *in situ* parameters and bacteria, and one-time sampling for general chemistry and metals bioaccumulation (Table 1).

At the completion of the first five years of monitoring, SMUD will consult with the State Water Resources Control Board (SWRCB), Regional Water Quality Control Board (RWQCB), California Department of Fish and Wildlife (CDFW), U.S. Forest Service (USFS), and U.S. Bureau of Land Management (BLM) to determine if the results warrant modifying the Plan.

2.0 Monitoring Plan Objectives

This monitoring plan is designed to simultaneously meet the objectives and rationale of the SWRCB Water Quality Certification Condition 8.J and Article 1-5.10 of the settlement agreement. The rationale for water quality monitoring, as described by the SWRCB Water Quality Certification, is as follows:

> *Water quality monitoring is important for determining compliance with state and federal water quality standards and examining long-term trends in water quality. The frequency of monitoring for any compound can be reduced if shown to be at background or non-detect levels for a statistically significant period of time. Fish sampling for the analysis of metal bioaccumulation allows for an evaluation of health risks to humans and wildlife and creates a long-term data set to detect trends in bioaccumulation through the license term.*

The Settlement Agreement has similar rationale statements and specifications for water quality monitoring for the UARP (see Attachment 2).

3.0 Frequency

Article 1-5 requires monitoring throughout the duration of the license term with sampling frequency varying by water quality constituent. However, as described in the Articles, the plan may be modified pursuant to adaptive management program needs following review of monitoring results. Nevertheless, the sampling frequency over the first five years of the monitoring program is dictated by the Articles and will, at a minimum, include annual sampling for *in situ* parameters and bacteria and one-time sampling for general chemistry and metals bioaccumulation (Table 1).

Table 1. Sampling frequency of four water quality constituents under the monitoring program for the UARP Project. This 5 year cycle will repeat throughout the duration of the license, except for the potential modification of General Chemistry and Bacterial schedules.

	In-Situ Parameters	General Chemistry	Bacterial	Metals Bioaccumulation
Calendar Year				
2015 (Plan Approval)				
2015 (Year 1)	X		X	
2016 (Year 2)	X		X	X
2017 (Year 3)	X	X	X	
2018 (Year 4)	X		X	
2019 (Year 5)	X		X	
Frequency within monitoring year	Seasonal (4 samples/yr)	Seasonal (4 samples/yr)	Summer only	Fall only

At the completion of the first five years of monitoring, SMUD will consult with the State Water Resources Control Board (SWRCB), Regional Water Quality Control Board (RWQCB), California Department of Fish and Wildlife (CDFW), U.S. Forest Service (USFS), and U.S. Bureau of Land Management (BLM) to determine if the results warrant modifying the Plan.

4.0 Study Area and Sampling Locations

The study area includes project reservoirs and diverted stream reaches. Reservoirs included in the monitoring program include all UARP reservoirs (Rubicon, Buck Island, Loon Lake, Gerle Creek, Ice House, Union Valley, Junction, Camino, Brush Creek, and Slab Creek) except for the relatively small Robbs Peak Reservoir (30 acre-feet). *[Note: Rockbound Lake, although associated with the UARP, is not included as a Project feature or within the FERC-defined UARP boundary.]* The diverted stream reaches included in this monitoring program represent all streams and rivers downstream of project reservoirs. Specific sampling locations within reservoirs and diverted stream reaches vary depending on the general constituent under study (*in situ*, general chemistry, bacteria, etc.), as discussed in constituent-specific methods below, and as depicted in Figures 1-7.

5.0 Methods

5.1 *In Situ* Parameters

Annual *in situ* parameter sampling will occur at 15 representative UARP reservoir locations and 19 diverted stream reach locations downstream of UARP reservoirs (Tables 2 and 3, respectively, and Figure 1). The seasonality of sampling will vary between reservoir and riverine sampling. For reservoirs, sampling will be performed once in spring (April or May) and again in fall (October or November). For riverine locations, sampling will be performed once in winter (January or February), spring (April or May), summer (August), and fall (November). Because some of the sampling sites are located in high elevations without road, winter samples will only be taken when snow and weather conditions do not compromise worker safety.

Table 2. Representative sampling locations on UARP Project reservoirs for *in situ* parameters.

Upper American River Project
Loon Lake, near dam
Loon Lake, mid-reservoir (west body)
Loon Lake, upper reservoir (northeast body)
Gerle Creek Reservoir, mid-lake
Union Valley Reservoir, near dam
Union Valley Reservoir, mid-reservoir
Union Valley Reservoir, Robbs PH tailrace zone
Union Valley Reservoir, Jones Fork Silver Creek arm
Ice House Reservoir, near dam
Ice House Reservoir, mid-reservoir
Ice House Reservoir, upper lake body
Junction Reservoir, mid-reservoir between arms
Camino Reservoir, mid-reservoir
Slab Creek Reservoir, mid-reservoir
Slab Creek Reservoir, upper-reservoir

Table 3. Representative sampling locations on diverted stream reaches downstream of UARP Project reservoirs for *in situ* and general chemistry monitoring.

Rubicon River outflow from Rubicon Reservoir
Little Rubicon River outflow from Rockbound Lake
Little Rubicon outflow from Buck Island Lake
Gerle Creek outflow from Loon Lake
Gerle Creek inflow to Gerle Creek Reservoir
Gerle Creek Canal inflow to Robbs Forebay
Gerle Creek outflow from Gerle Creek Reservoir
S.F. Rubicon downstream of Gerle Creek confluence
S.F. Rubicon upstream of Gerle Creek confluence
S.F. Silver Creek outflow from Ice House
S.F. Silver Creek inflow to Junction Reservoir
Silver Creek outflow from Junction Reservoir
Silver Creek inflow to Camino Reservoir
Silver Creek outflow from Camino Reservoir
SFAR upstream of Camino Powerhouse
Brush Creek outflow from Brush Creek Reservoir
SFAR downstream of Camino Powerhouse
SFAR downstream of Slab Creek Reservoir
SFAR upstream of White Rock Power House

In situ parameters collected will include dissolved oxygen, conductivity, temperature, turbidity, and pH. *In situ* data will be collected using standard multi-parameter instruments (YSI® or equivalent). At diverted stream reach sites, instrument readings will be obtained where sufficient stream turbulence provides good lateral and vertical mixing of the water as near as possible to the stream thalweg. In the case of reservoir sampling, SMUD will deploy boats and instrument readings will be taken at one-meter intervals down the water column. Water transparency will be measured at all reservoirs with a standard 7.9-inch-diameter Secchi disk.

In situ parameter quality control will consist of instrument calibration and comprehensive field data recording, pursuant to EPA approved general-purpose water sampling protocols. Prior to each monitoring season, instrument calibration will be performed to ensure quality of data retrieval. Parameter readings will be taken twice at each location to inspect for variability. Field or electronic data sheets will record date, time, stream/lake name, sampling location, collector's name, weather conditions and any pertinent site-specific information that may clarify data interpretation.

All *in situ* data gathered at reservoirs and diverted stream reaches will be loaded into a database for data archiving and report production.

5.2 General Chemistry

In accordance with the Water Quality Certification, general chemistry samples will be collected at 19 UARP bypass stream reach locations and 18 reservoir locations (Tables 3 and 4, respectively, and Figure 2). General chemistry samples will be collected seasonally in spring, summer, fall, and immediately following either the second or third measurable rain event of the fall-winter period. A “measurable” rain event is defined as an event resulting in 0.50” of precipitation over a 24-hr period. Given access and safety concerns of sampling at high elevations, monitoring will only occur when snow and weather conditions do not compromise worker safety. Secchi disk measurements will be collected in the summer and fall sampling periods.

Table 4. Representative sampling locations on UARP reservoirs for general chemistry monitoring.

Rubicon Reservoir, mid-lake
Buck Island Reservoir, mid-lake
Loon Lake, near dam
Loon Lake, mid-reservoir (west body)
Loon Lake, upper reservoir (northeast body)
Gerle Creek Reservoir, mid-lake
Union Valley Reservoir, near dam
Union Valley Reservoir, mid-reservoir
Union Valley Reservoir, Robbs PH tailrace zone
Union Valley Reservoir, Jones Fork Silver Creek arm
Ice House Reservoir, near dam
Ice House Reservoir, mid-reservoir
Ice House Reservoir, upper lake body
Junction Reservoir, mid-reservoir between arms
Camino Reservoir, mid-reservoir
Brush Creek Reservoir, mid-reservoir
Slab Creek Reservoir, mid-reservoir
Slab Creek Reservoir, upper-reservoir site

A list of general chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives is provided below (Table 5).

Table 5. General chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives. All metals will be analyzed for total and dissolved factions.

Analysis	Method	Units	Method Detection Limit (MDL)*	Method Reporting Limit (MRL)*	California Toxics Rule (CTR)	Basin Plan	National Standards	Hold Time
In Situ Parameters								
pH	Instrument	unitless	NA	NA	NA	6.5-8.5	6.5-9[i]	NA
Water Temperature	Instrument	Celsius	NA	NA	NA	[xi]	NA	NA
Dissolved Oxygen	Instrument	mg/L	NA	NA	NA	7	NA	NA
Specific Conductance	Instrument	µS/cm	NA	NA	NA	NA	NA	NA
Turbidity	Instrument	NTU	NA	NA	NA	[xii]	NA	NA
Miscellaneous								
Total Suspended Solids	EPA 160.2	mg/L	NA	5	NA	NA	NA	7 days
Total Dissolved Solids	EPA 160.1	mg/L	NA	10	NA	500[v]	NA	7 days
Total Organic Carbon	EPA 415.1	mg/L	NA	1	NA	NA	NA	28 days
Cyanide	EPA 335.2	µg/L	NA	5	22/5.2[ii, iii, vi]	NA	22/5.2[ii, iii, vi]	14 days
Oil & Grease	EPA 1664	mg/L	NA	5	NA	NA	NA	28 days

Table 5. General chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives. All metals will be analyzed for total and dissolved factions.

Analysis	Method	Units	Method Detection Limit (MDL)*	Method Reporting Limit (MRL)*	California Toxics Rule (CTR)	Basin Plan	National Standards	Hold Time
Total Petrol Hydrocarbons	SW 5030B	µg/L	NA	50	NA	NA	NA	7 days
MTBE	EPA 8260	mg/L	NA	0.5	151/51[i, vi]	5	NA	14 days
Hardness ($CaCO_3$)	EPA 130.2	mg/L	NA	1	NA	NA	NA	180 days
Total Alkalinity ($CaCO_3$)	EPA 305.1	mg/L	NA	5	NA	NA	>20[i]	14 days
Nutrients								
Nitrate/Nitrite	EPA 300.0	mg/L	NA	0.4 as N	NA	1	10[i, vii]	28 days
Total Kjeldahl Nitrogen	EPA 351.3	mg/L	NA	0.2	NA	NA	NA	28 days
Ammonia as N	EPA 350.2	mg/L	NA	0.1	NA	1.5	[iv]	28 days
Total Phosphorous	EPA 365.2	mg/L	NA	0.05	NA	NA	NA	28 days
Orthophosphate	EPA 365.3	mg/L	NA	0.15	NA	NA	NA	48 hours
Trace Elements*								
Aluminum	EPA 200.8	µg/L	1.55	20	NA	NA	750/87 [i, vi]	28 days

Table 5. General chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives. All metals will be analyzed for total and dissolved factions.

Analysis	Method	Units	Method Detection Limit (MDL)*	Method Reporting Limit (MRL)*	California Toxics Rule (CTR)	Basin Plan	National Standards	Hold Time
Arsenic	EPA 1640	µg/L	0.0018	0.0054	340/150 [i, iii, vi]	10	340/150 [i, iii, vi]	28 days
Barium	EPA 200.8	µg/L	0.14	5	NA	NA	1000 [i, vii]	28 days
Cadmium	EPA 1640	µg/L	0.0024	0.01	0.29/0.22 [iii, vi, viii]	5	0.14/0.037 [i, viii, ix]	28 days
Copper	EPA 1640	µg/L	0.024	0.1	1.0/0.9 [iii, vi, viii]	1	[i,x]	28 days
Iron	EPA 200.7	mg/L	0.00914	0.1	NA	0.3	1 [i]	28 days
Lead	EPA 1640	µg/L	0.0081	0.02	3/0.12 [iii, vi, viii]	15	3/0.12 [i, vi, viii]	28 days
Manganese	EPA 200.8	µg/L	0.05	2	NA	50	50 [i, v]	28 days
Mercury (Total)	EPA 245.7 or 1631E	µg/L	0.015	0.1	0.05 [vii]	NA	1.4/0.77[i, vi]	90 days
Methyl mercury (Total)	EPA 1630	µg/L	0.00002	0.00006	NA	NA	0.3 [vii]	6 months
Nickel	EPA 1640	µg/L	0.029	0.1	610 [iii, vii]	100	50/5 [i, vi, viii]	28 days
Selenium	EPA 200.8	µg/L	0.75	5	20/5 [iii,vi]	NA	258/5 [i, vi]	28 days
Silver	EPA 200.7	µg/L	0.0017	0.002	0.03 [iii, viii]	NA	0.03 [i, viii]	28 days
Zinc	EPA 1640	µg/L	0.32	0.96	12/12 [iii, vi, viii]	NA	12/12 [i, vi, viii]	28 days

Table 5. General chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives. All metals will be analyzed for total and dissolved factions.

Analysis	Method	Units	Method Detection Limit (MDL)*	Method Reporting Limit (MRL)*	California Toxics Rule (CTR)	Basin Plan	National Standards	Hold Time
Standard Minerals								
Calcium	EPA 200.7	mg/L	NA	1	NA	NA	NA	6 months
Chloride	SM 4500CI-B	mg/L	NA	0.5	NA	250	860/230 [i, vi]	28 days
Magnesium	EPA 200.7	mg/L	NA	1	NA	NA	NA	6 months
Potassium	EPA 200.7	mg/L	NA	1	NA	NA	NA	6 months
Sodium	EPA 200.7	mg/L	NA	1	NA	NA	NA	6 months
Sulfate	EPA 300.1	mg/L	NA	0.5	NA	250	250 [i, v]	6 months

*Method detection limits and reporting limits vary by laboratory. Contracted laboratory will be required to provide evidence that recent calibration provides a reporting limit less than or equal to the lowest threshold value for each contaminant

** Metals will be measured for both dissolved and total recoverable. The thresholds between the two differ slightly, and most are dependent on water hardness. Final thresholds will be calculated as a function of method and water hardness

[i] National Recommended Water Quality Criteria for Freshwater Aquatic Life Protection

[ii] U.S. Environmental Protection Agency, Federal Register, Volume 57, No. 246

[iii] U.S. Environmental Protection Agency, Federal Register, Vol. 65 No. 97

[iv] Aquatic Life Ambient Water Quality for Ammonia – Freshwater 2013

[v] This threshold is based off a "secondary" Maximum Contaminant Level that is primarily concerned with taste and odor

[vi] Values correspond to 1-hour Average/4-day Average

[vii] National Recommended Water Quality Criteria for Human Health & Welfare Protection (Water & Fish Consumption)

[viii] Hardness dependent. Value(s) are approximated based on an average hardness value of 6.5 mg/L, taken during FERC re-licensing. Actual thresholds will be computed based on the water hardness of the sample

[ix] Values correspond to 24-hour Average/ 4-day Average

[x] See U.S. Environmental Protection Agency, Aquatic Life Ambient Freshwater Quality Criteria – Copper

Table 5. General chemistry constituents, laboratory methods, detection/reporting limits, and water quality objectives. All metals will be analyzed for total and dissolved factions.

Analysis	Method	Units	Method Detection Limit (MDL)*	Method Reporting Limit (MRL)*	California Toxics Rule (CTR)	Basin Plan	National Standards	Hold Time

[xi] Per the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River basins: "At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5° F above natural receiving water temperature."
[xii] See Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River basins for narrative of turbidity requirements.

Water column sampling procedures in reservoirs will vary depending on thermal stratification, which will be determined using the in-situ methods described above prior to collecting water samples. During periods of reservoir stratification, samples will be collected within the upper epilimnion layer and also in the hypolimnion layer a few feet above the reservoir bottom. When the reservoir is isothermal, or mixed, samples will be collected at a point below the water surface equivalent to approximately one-third of water depth. Thermal stratification is defined as temperature change of more than 1.0°C per 1.0 meter of depth in the reservoir, which is referred to as the location of the thermocline (Horne and Goldman, 1994).

Procedures used for the purpose of collecting, preserving and analyzing samples will follow established USEPA approved general-purpose protocols. All water samples will be collected manually into certified pre-cleaned Nalgene or glass containers provided by the laboratory and placed on ice during transport to the laboratory. At stream reach sites, a single grab sample will be obtained where sufficient turbulence provides good lateral and vertical mixing and when possible near the approximate thalweg of the stream. Reservoir samples will be obtained from a boat using a deepwater water quality sampling device. Reservoir transparency will be measured with a standard 7.9-inch-diameter Secchi disk.

5.3 QA/QC

All samples will be collected, handled and delivered to the lab consistent with specific EPA methods (Table 5) or other approved sampling/handling protocols including, but not limited to, Standard Methods for the Examination of Water and Wastewater. Appropriate QA/QC methods and documentation will be followed. Field QA/QC methods may vary somewhat by chemical constituents, but certain methods will be uniformly applied to all field sampling. Clean sampling techniques will be applied throughout the sampling effort. This includes the use of disposable gloves for all field crew members. All sample bottles will be prepared by a California state-certified laboratory (ELAP) approved by the SWRCB and will be wrapped with clean parafilm around the top when samples have been collected. The laboratory will prepare all sample bottles and, where necessary, place the appropriate amount and type of preservative in sample bottles. All sample collection devices (e.g., grab samplers) will be rinsed between sampling events with de-ionized water and then rinsed with water from the water body to be collected from. The labeled samples will be placed in closed, lightproof coolers filled with ice. Samples will be delivered to the laboratory in accordance with maximum holding times. QA/QC in the field will be assured by accurate and thoroughly completed sample labels, field sheets, chain of custody and sample log forms. Sample labels will include sample identification code, date, time, stream/lake name, sampling location, collector's name, sample type and preservative if applicable.

5.4 Laboratory Reporting

The analytical laboratory will for each sample achieve the lowest method detection limits (MDL) and reporting limits (RL) practicable for the water quality samples. These will be at or below the level of analytical resolution needed to assess regulatory compliance with the Sacramento and San Joaquin River Basin Plan (Basin Plan) numerical water quality objectives. Method Detection Limit (MDL) is a measure of the method sensitivity and represents the minimum concentration of an analyte that undergoes the entire analytical process and can be reported with a 99 percent level of confidence that the analyte concentration is greater than zero. Reporting Limit (RL) is the lowest quantifiable concentration (vs. estimated) that the laboratory can determine. The RL should be equal to or lower than the regulatory compliance minimum identified in the Basin Plan.

5.5 Bacteria

Bacteria monitoring will consist of collecting water samples for fecal coliform and *E. coli* analysis at eight UARP reservoirs. The monitoring program will include sampling at a minimum of four annually-rotating stations at Union Valley Reservoir swim areas and a minimum of two beach locations each at Buck Island Reservoir, Loon Lake, Ice House Reservoir, and Gerle Creek Reservoir, along with three other selected stations (Table 6 and Figures 3 - 7), resulting in a total of fifteen stations sampled annually. Each year, five independent samples will be collected over a 30-day period at each of the fifteen stations. SMUD will consult with USFS, SWRCB, USFWS, and other listed parties for final determination of the locations to be sampled no later than May 31 of each designated sampling year and shall submit the list of sampling locations to the Deputy Director for approval. Sampling will be targeted so that the midpoint of the 30-day period falls near a holiday of high recreational use, centering on Independence Day for the middle elevation UARP reservoirs and Labor Day for upper elevation UARP reservoirs (e.g., Loon Lake and Buck Island). All water samples will be collected near-shore in shallow water, placed on ice and processed within 8 hours of collection by a California certified laboratory approved by the SWRCB, using EPA method SM 9221E for fecal coliform and SM 9223B for *E. coli*.

Bacterial monitoring will be conducted annually for the first five years after license issuance, after which it may be decreased in frequency to every other year at reservoir locations where no exceedances of Basin Plan objectives for protection of REC-1 designated waters have been identified during Years 1 - 5. SMUD will notify the Central Valley Regional Water Board if monitoring data demonstrate bacterial concentrations that present risks to human health at specific reservoir(s) or riverine sites. SMUD will continue annual monitoring at those sites until agreement is reached between SMUD, the SWRCB and the USFS (and any other interested parties) that the monitoring frequency can be reduced and the SWRCB Deputy Director has approved the agreement. [Note: pursuant to the clause above, sampling frequency at some sites was reduced in 2021 (see Table 6)].

Table 6. Bacteria sampling locations at UARP Project reservoirs.
Union Valley Reservoir (4 annually rotating stations)
At Fashoda Beach
Near Camino Cove Campground[1]
Near Yellowjacket Campground
Near Wench Creek Campground[1]
Buck Island Reservoir
On northshore, near dam and OHV camping[1]
On southshore, near Rubicon Hiking Trail[1]
Loon Lake Reservoir
West of main dam, near Red Fir Campground[1]
West of Loon Lake Campground, near boat launch[1]
Gerle Creek Reservoir
Near Gerle Creek Campground[1]
Near Angel Creek picnic area[1]
Ice House Reservoir
Northshore near private campground access[1]
East of boat launch and picnic area
Other UARP Locations
Junction Reservoir, near boat launch
Brush Creek Reservoir, near boat launch[1]
Slab Creek Reservoir, near boat launch

[1] From 2021 forward, bacterial monitoring at these sites will only be conducted during even years (i.e. 2022, 2024, 2026, …) since no exceedances of Basin Plan objectives for protection of REC-1 designated waters were identified during the 2015-2020 monitoring period (SMUD 2020, 2021).

5.6 Metals Bioaccumulation

Fish tissues will be sampled to assess potential bioaccumulation of metals in resident fish within specific reservoirs of the UARP Project. Resident fish will be collected from locations within Loon Lake, Gerle, Ice House, Union Valley, Camino, and Slab Creek reservoirs, in accordance with protocols of the SWRCB Surface Water Ambient Monitoring Program (SWAMP).

Fish collection will be conducted using gill netting, electrofishing, or other fish collection techniques approved by the CDFW. Target species include brown trout (*Salmo trutta*), smallmouth bass (*Micropterus dolomieu*), rainbow trout (*Oncorhynchus mykiss*) and Sacramento pikeminnow (*Ptychocheilus grandis)*. Collection effort will target a minimum of three fish per species. As hardhead (Mylopharodon conocephalus) are a "near-threatened" species, SMUD will make a good-faith effort to returning these fish to the pool unharmed. However, actual species and number of fish collected will vary between reservoirs, based on population density, collection success, and species present. All collected fish will be initially preserved in wet ice for transport, and then transferred to an ultra-cold freezer.

At the laboratory each fish will be assigned an identification number and a sample identification code based on the fish fork length, total length, and species. The analytical laboratory will analyze muscle tissue from each fish for concentrations of heavy metals and methyl mercury in accordance with the General Protocol for Sport Fish Sampling and Analysis developed by the Cal EPA and with methods used at the CDFW Marine Pollution Studies Laboratory at Moss Landing. Tissue samples will be developed by removing skin from an area above the lateral line then extracting a 9-13 gram "plug" of tissue. Samples will be weighed for percent moisture analysis and metal analyses will employ EPA Methods 7473, or EPA Methods 2052 and 200.8 (Table 7). Results will be reported on both a dry and wet weight basis with percent moisture.

Table 7. Metals, method, detection and reporting limits for fish tissue analysis

Analyte	EPA Method	MDL (wet weight)	RL (wet weight)	MDL (dry weight)	RL (dry weight)
Mercury	EPA 7473†	0.004 ug/g ww	0.012 ug/g ww	0.015 ug/g dw	0.046 ug/g dw
Copper	EPA 2052 and 200.8††	0.06 ug/g ww	0.20 ug/g ww	0.34 ug/g dw	1.00 ug/g dw
Lead	EPA 2052 and 200.8††	0.002 ug/g ww	0.005 ug/g ww	0.01 ug/g dw	0.03 ug/g dw
Silver	EPA 2052 and 200.8††	0.003 ug/g ww	0.01 ug/g ww	0.02 ug/g dw	0.06 ug/g dw

† Total mercury is proxy for methyl mercury in fish (Wiener et al. 2007).
†† Digestion and Analysis of Total Copper, Lead and Silver.

6.0 Analysis

6.1 Study Output

All data collected from this plan will be stored in a SWAMP-compatible database (Microsoft SQL Server). Study output will consist of a written report covering the UARP. The report will include a list and description of sampling locations, methods, laboratory reports and QA/QC, analysis, and results. A summary of results will be provided in tabular format that will include specific method detection limits for each constituent and analytical data reported. This report will also include relevant graphs depicting the seasonal relationship between DO, temperature and pH at sampling locations. Additional graphs will be provided, as appropriate, to more clearly demonstrate any changes in specific water quality parameters over time, depth, or longitudinal movement of flow through the system. All monitoring data will be summarized to characterize existing water quality conditions, and will be compared to regulatory criteria, standards and goals as identified by the SWRCB. Discussion appropriate to results and supportive of analyses and conclusions will be provided.

SMUD will submit a draft annual water quality monitoring report to the USFS, CDFW, BLM, SWRCB, and RWRCB at the conclusion of each calendar year covering the results of seasonal sampling throughout that year. SMUD will submit the draft report to the resource agencies on or before March 1. SMUD will then convene the annual Review of Ecological Conditions meeting by April 1 of each year to discuss the draft report, after which the licensees will allow the agencies at least 30 days to review and comment on the report.

The final annual report will be filed with FERC by June 30. SMUD will include in the final report any comments and recommendations made by the agencies on the draft report. If SMUD does not adopt a recommendation, the filing shall include the SMUD's reasons based on project-specific information.

7.0 Literature Cited

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Ecosystem responses to mercury contamination: indicators of change. SETAC Press, Pensacola, Florida.

Attachment 1.

State Water Resources Control Board 401 Certification for the UARP Condition 8.J

8.J Other Water Quality Parameters

Within three months of license issuance, the Licensee shall consult with USFS, BLM, USFWS, CDFW, State Water Board and Central Valley Water Board on the development of a draft Water Quality Monitoring Program Plan (WQ Plan). The WQ Plan shall include the water quality monitoring elements listed below, and must: (1) provide detail on field sampling locations, sampling frequency, handling methods and quality assurance/quality control protocols; and (2) define the laboratory methods and associated reporting and detection limits for all constituents and parameters to be monitored in the various elements of the Monitoring Program.

Following consultation, and within six months of license issuance, the Licensee shall submit the WQ Plan to the Deputy Director for review and approval. The Licensee shall provide the Deputy Director with any comments provided by the agencies during the consultation process. The Licensee shall provide the Deputy Director with at least 60 days to review and approve the WQ Plan prior to submittal to the Commission, if applicable. The Deputy Director may require modifications as part of the approval. The Licensee shall file the Deputy Director's approval, together with any required WQ Plan modifications, with the Commission. The approved WQ Plan shall be implemented by the Licensee as described, through the life of the license and any extensions. The WQ Plan may be modified pursuant to adaptive management program needs as recommended by USFS, BLM, USFWS, CDFW, State Water Board, and/or Central Valley Water Board, and the new WQ Plan shall be implemented upon receiving all necessary approvals.

Method: The Licensee shall conduct a water quality sampling program designed to demonstrate seasonal conditions at all reservoir and stream locations affected by operation of the UARP, as described in the UARP Relicensing Water Quality Study Plan (Plenary approval, January 8, 2003) contained in the Water Quality Technical Report (May 2005). Laboratory analyses shall be conducted using USEPA analytical methods and/or standard methods adequately sensitive to detect constituent levels for determination of compliance with recognized state and federal criteria.

In Situ: In situ physical parameters (pH, water temperature, dissolved oxygen, electrical conductivity, and turbidity) shall be measured at representative locations on diverted stream reaches below all UARP reservoirs. In situ physical parameters shall be monitored at reservoir profiles collected at 1-meter depth intervals in Loon Lake, Gerle Reservoir, Ice House Reservoir, Union Valley Reservoir, Junction Reservoir, Camino Reservoir, and Slab Creek Reservoir.

Frequency: Riverine reaches: once seasonally in spring (April-May), summer (August), fall (November) and winter (January-February, as accessible) each year after license issuance through the term of the license and any extensions.

Reservoirs: once in spring (April-May) and once in fall (October-November) each year through the term of the license and any extensions. When possible, in situ water quality and water temperature monitoring may be completed coincident with amphibian, fisheries, and macroinvertebrate monitoring.

General Chemistry Monitoring

The Licensee shall monitor in situ parameters, standard minerals, hardness, nutrients, metals (total and dissolved fractions), oil and grease, and other chemical constituents. Method: Water chemistry samples shall be collected and analyzed for the set of constituents shown in Table 23. Water samples shall be collected from all UARP reservoirs and riverine locations, dam release points from reservoirs, and representative sites along all bypassed stream reaches greater than one mile in length. Reservoir samples shall be collected at the surface and near the bottom at multiple, representative locations within each impoundment. Secchi disk measurements shall be collected at Loon Lake, Ice House Reservoir, Union Valley Reservoir, and Slab Creek Reservoir.

Frequency: Water samples for chemical analysis shall be collected seasonally in spring, summer, fall, and immediately following either the second or third measurable rain event of the fall-winter period, once every five years beginning in Year 3 after license issuance. Secchi disk measurements shall be collected in summer and fall seasons once every five years after license issuance. After a minimum of three data sets are collected, if it is demonstrated that exceedances are not occurring at specific locations, the collection frequency may be reviewed to determine if it can be modified. The Licensee, CDFW, USFS or the Deputy Director may propose modifications to the sampling frequency contained in the WQ Plan. The Deputy Director must approve any revised plan prior to its implementation.

Table 23. List of Water Quality Constituents

Trace Elements*		Standard Minerals		Nutrients	
Aluminum	Manganese	Calcium	Potassium	Nitrate-Nitrite	Orthophosphate
Arsenic	Lead	Magnesium	Sodium	Ammonia as N	Total Phosphorus
Barium	Nickel	Chloride	Sulfate	TKN as N	
Cadmium	Selenium				
Copper	Silver		**Miscellaneous**		
Iron	Zinc		Oil and Grease	MTBE	TPH
Mercury	Methyl mercury		Total Organic Carbon	Total Suspended Solids	Total Dissolved Solids
* For metals, the analysis shall include quantification of both total and dissolved constituents.			Hardness	Total Alkalinity	Cyanide

Bacterial Monitoring

Method: The Licensee shall conduct bacterial monitoring for fecal coliform and *E.coli* for protection of the recreational water contact (REC-1) beneficial use28. Five near-shore samples shall be collected at each of the 15 sampling locations during the 30-day period that spans either the Independence Day holiday (June-July) or the Labor Day holiday (August-September), using the five samples in 30-day methodology or any other future protocol in an amended Basin Plan.

Location: Monitoring shall be conducted at a minimum of 15 shoreline recreational locations within the UARP boundary. Sampling locations shall be selected based on criteria that include: (1) where swimming and other water contact recreation activities are known to occur in the area; and (2) the existence of sources for potential introduction of pathogens to the water column in the immediate vicinity. Candidate sites for annual REC-1 bacterial monitoring will include developed recreation sites and frequently used sites at reservoir and riverine locations. The bacterial monitoring program shall include sampling at a minimum of four annually-rotating stations at Union Valley Reservoir swim areas, and a minimum of two beach locations each at Buck Island Reservoir, Loon Lake, Ice House Reservoir, and Gerle Creek Reservoir along with three other selected stations. The Licensee, in consultation with USFS, CDFW, State Water Board, USFWS, and Central Valley Water Board shall determine sampling locations for each upcoming field season. The Licensee shall consult with USFS, State Water Board, USFWS, and other listed parties to determine the locations to be sampled and shall submit the list of sampling locations to the Deputy Director for approval no later than May 31 of each designated sampling year. The Licensee shall provide the Deputy Director with any comments provided by the agencies during the consultation process. The Deputy Director may require modification as part of the approval.

Frequency: Bacterial monitoring shall be conducted annually for the first five years after license issuance, after which it may be decreased in frequency to every other year at reservoir or riverine locations where no exceedances of Basin Plan objectives for protection of REC-1 designated waters have been identified during Years 1-5. The Licensee shall notify the Central Valley Water Board if monitoring data demonstrate bacterial concentrations that present risks to human health at specific reservoir(s) or riverine sites. The Licensee shall also continue annual monitoring at those sites until the Licensee consults with the State Water Board and USFS (and any other interested parties) and agreement is reached that the monitoring frequency can be reduced. The Deputy Director must approve any change in monitoring frequency prior to implementation.

Metals Bioaccumulation Monitoring

Method: The Licensee shall monitor for potential uptake of mercury, copper, lead, and silver through the aquatic food chain in UARP-affected impoundments. Resident fish species shall be collected and analyzed to determine tissue residue levels of mercury, copper, lead, and silver. Target species, numbers of individuals, sampling strategy, and

analytical methods used shall be consistent with current State Water Board, Surface Water Ambient Monitoring Program (or any future water quality monitoring program) requirements, and shall be defined prior to each sampling event through Licensee consultation with USFS, CDFW, State Water Board, Central Valley Water Board, USFWS, and the Office of Environmental Health Hazard Assessment (OEHHA). Deputy Director approval is required prior to implementation of the metals bioaccumulation monitoring plan. The Licensee shall submit the metals bioaccumulation monitoring plan to the Deputy Director for approval, including any comments provided by the agencies during the consultation process. The Deputy Director may require modifications as part of the approval.

Location: Loon Lake Reservoir, Gerle Reservoir, Ice House Reservoir, Union Valley Reservoir, Camino Reservoir, and Slab Creek Reservoir.

Frequency: Metals bioaccumulation monitoring shall begin in Year 2 following license issuance and be performed once every five years through the term of the license and any extensions.

Attachment 2.

Settlement Agreement Article 1-5.10 Water Quality Monitoring

Within 3 months of license issuance, the licensee shall consult with FS, BLM, FWS, CDFG, SWRCB, and Regional Water Quality Control Board, Central Valley Region (RWQCB) on the development of a draft Water Quality Monitoring Program Plan (Plan). The Plan shall include the water quality monitoring elements listed below, and must (1) provide detail on field sampling locations, sampling frequency, handling methods and QA/QC; and (2) define the laboratory analyses and associated method detection limits for all constituents and parameters to be monitored in the various elements of the monitoring program. Following consultation, and within 6 months of license issuance, the licensee shall submit the draft Plan for review and approval by the Chief, Division of Water Rights, SWRCB. The final Plan shall be filed with FERC for approval. The approved Plan shall be implemented by the licensee as described, through the life of the license. The Plan may be modified pursuant to adaptive management program needs as recommended by FS, BLM, FWS, CDFG, RWQCB, and approved by the Chief, Division of Water Rights, SWRCB.

Water Chemistry Monitoring

Method: The licensee shall conduct a water chemistry sampling program designed to demonstrate seasonal conditions at all reservoir and stream locations affected by operation of the UARP, as described in the Project No. 2101 relicensing Water Quality Study Plan (Plenary approval, January 8, 2003). Laboratory analyses shall be conducted using USEPA Standard Methods adequately sensitive to detect constituent levels for determination of compliance with recognized state and federal criteria.

a. In situ physical parameters (pH, water temperature, dissolved oxygen, specific conductance, and turbidity) shall be sampled at representative locations on diverted stream reaches below all Project No. 2101 reservoirs. In situ physical parameters shall be monitored at reservoir profiles collected at 1-meter intervals in Loon Lake, Gerle Reservoir, Ice House Reservoir, Union Valley Reservoir, Junction Reservoir, Camino Reservoir, and Slab Creek Reservoir.

Frequency: In stream reaches, once seasonally in spring (April-May), summer (August), fall (November) and winter (January-February, as accessible) each year after license issuance. In reservoirs, in spring (April-May) and fall (October-November) each year. When possible, water quality and water temperature monitoring may be completed coincident with amphibian, fisheries, and macroinvertebrate monitoring.

Rationale: To monitor compliance with state and federal water quality standards and track potential changes in surface waters associated with Project No. 2101.

b. General chemistry monitoring. In situ parameters, minerals, nutrients, metals (total and dissolved fractions), measured hardness, and petroleum products shall be

conducted. General chemistry samples shall be collected from all Project reservoirs and in stream locations, dam release points from reservoirs, and representative sites along all diverted stream reaches greater than 1 mile in length. Reservoir samples shall be collected at the surface and near the bottom at multiple, representative locations within each impoundment. Secchi disc measurements shall be collected at Loon Lake, Ice House Reservoir, Union Valley Reservoir, and Slab Creek Reservoir.

Frequency: General chemistry samples shall be collected seasonally in spring, summer, fall, and immediately following either the second or third measurable rain event of the fall-winter period, once every 5 years beginning in Year 3 after license issuance. Secchi disk measurements shall be collected in summer and fall seasons, once every 5 years after license issuance. After a minimum of three data sets have been collected, if it is demonstrated that exceedances are not occurring at specific locations, the collection frequency may be reviewed to determine if it can be modified.

Rationale: To monitor for compliance with state and federal water quality standards and track potential changes in surface waters associated with the UARP. Monitoring at 5-year intervals will provide an index of changes in water quality conditions. Data collected will allow for the development of a long-term trend analysis in waters regulated by Project features and operations.

Bacterial Monitoring

Method: The licensee shall conduct bacterial monitoring consistent with Basin Plan objectives for protection of the REC-1 beneficial uses annually, at a minimum of 15 shoreline recreational locations within the Project boundary. Sampling locations shall be selected based on criteria that include: (1) swimming and other water contact recreation activities are known to occur in the area, and (2) there are sources for potential introduction of pathogens to the water column in the immediate vicinity. Candidate sites for annual REC-1 pathogen monitoring will include developed recreation sites and frequently used dispersed sites at reservoir and riverine locations. The bacterial monitoring program shall include sampling at a minimum of four annually rotating stations at Union Valley Reservoir swim areas, and a minimum of two beach locations each at Buck Island Reservoir, Loon Lake, Ice House Reservoir, and Gerle Creek Reservoir along with three other selected stations. Five near-shore samples shall be collected at each of the 15 sampling locations during the 30-day period that spans either the Independence Day Holiday (June-July) or the Labor Day Holiday (August-September), using the five samples in 30-day methodology or other protocol as amended in the Basin Plan. The licensee, in consultation with FS, CDFG, SWRCB, FWS, and RWQCB shall determine sampling locations for each upcoming field season. Licensee shall consult with FS, SWRCB, FWS, and other listed parties for final determination of the locations to be sampled no later than May 31 of each designated sampling year.

Frequency: Bacterial monitoring shall be conducted annually for the first 5 years after license issuance, then may be decreased in frequency to every other year at reservoirs

where no exceedances of Basin Plan objectives for protection of REC-1 designated waters have been identified during Years 1-5. If data demonstrates bacterial concentrations that present risks to human health at specific reservoir(s) or riverine sites, the program shall continue annually in the water body, through the life of the license.

Rationale: The UARP provides water contact recreational opportunities that include swimming, angling, and water skiing. Monitoring will be conducted to demonstrate summer bacterial concentrations at swim beaches affected by Project operations, to ensure that pathogen levels are recognized and do not exceed the thresholds acceptable for protection of human health.

Metals Bioaccumulation Monitoring

Method: The licensee shall monitor for potential uptake of mercury, copper, lead, and silver through the aquatic food chain resident in Project-affected impoundments. Resident fish species from Loon Lake Reservoir, Gerle Reservoir, Ice House Reservoir, Union Valley Reservoir, Camino Reservoir, and Slab Creek Reservoir shall be collected and analyzed to determine tissue residue levels of mercury, copper, lead, and silver. Target species, numbers of individuals, sampling strategy, and analytical methods used shall be consistent with current Surface Water Ambient Monitoring Program needs (SWRCB), and shall be defined prior to each sampling event through licensee consultation with FS, CDFG, SWRCB, RWQCB, FWS, and the state Office of Environmental Health Hazard Assessment. Fish tissue samples shall be collected and analyzed for rates of bioaccumulation, and monitoring shall continue through the term of the new Project License.

Frequency: Once every 5 years beginning in year 2 following license issuance.
Rationale: Reservoirs operated by the licensee have the potential to impound sediments and organic materials that may transport bound metals. Impounded metals have the potential to concentrate and become bioavailable to aquatic organisms. Metals that are bioacummulated in the aquatic prey-base may bioconcentrate up through the food chain where elevated levels could become health risks to human and wildlife consumers. Monitoring at 5-year intervals will provide an index of changes in fish body burdens of silver, mercury, copper and lead.

Overall Water Quality Program Rationale

Through the water quality monitoring program the licensee will monitor compliance with state and federal water quality standards and track potential changes in surface waters associated with the UARP and Chili Bar Hydroelectric Project operations. The monitoring program will provide data necessary to develop a long-term water quality trend assessment through the life of the FERC licenses. Data collected will provide water quality regulators the opportunity to identify trends of risk to human health and wildlife, and to design possible measures to intervene in this degradation. Water quality monitoring will focus on the identification of inorganic constituent levels and physical

parameters, along with bacterial concentrations that may impair beneficial uses designated for waters impounded by the project and releases to diverted reaches downstream of Projects' reservoirs.