

### 3.1 Aquatic Bioassessment Study Plan

This study is designed to provide information regarding overall water quality and the biological integrity of the stream ecosystem using the California Stream Bioassessment Procedure, or CSBP, downstream of Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. The overall approach is to collect information regarding benthic macroinvertebrate habitat and assemblages on all affected stream reaches and agreed-upon reference sites in 2002, 2003 and 2004, calculate CSBP indices, and assess the overall quality of the macroinvertebrate habitat and populations using the indices and data from the reference sites. Sampling may be eliminated or modified in 2003 and 2004 based on the results of the 2002 data or if the water year types are such that additional data collection would not provide additional valuable information.

#### 3.1.1 Pertinent Issue Questions

The Aquatic Bioassessment Study Plan will be used, in part, to address the following Aquatics/Water Issue Question:

54. What is the health of existing macroinvertebrate communities in diverted reaches as an indicator of water quality?

This study, in concert with the Water Quality (direct measurements of water quality parameters), Water Temperature (direct measurements of water temperature), Channel Morphology (assessment of sediment in stream channels) and Project Sources of Sediment (assessment of project sources of sediment that may enter the river and reservoirs) will be used to assess the condition of water quality in the area of the projects.

#### 3.1.2 Background

Since hydro projects affect stream flow, there is a potential influence on water quality. The CSBP (Harrington 1999), developed by the Department of Fish and Game (CDFG), is a preferred water quality monitoring tool used by the CDFG and the State Water Resources Control Board (SWRCB) to evaluate effects of pollutant discharge and to monitor the affects of various alterations to natural stream flow regimes. It is a rapid bioassessment procedure that utilizes measures of stream benthic macroinvertebrate community and physical/habitat characteristics to evaluate the biological integrity of stream ecosystems. This water quality assessment tool is used in concert with fishery, water chemistry, water temperature and other studies to evaluate the chemical, physical and biological health of a specified water body.

Historic information regarding benthic macroinvertebrates is available in the Project area from upstream of Robbs Peak Reservoir, upstream of Union Valley Reservoir, upstream of Ice House Reservoir, and the Ice House Dam Reach. This information is summarized in SMUD's Initial Information Package (SMUD 2001) and repeated below for reference.

- South Fork Rubicon River Upstream of Robbs Peak Reservoir - As part of the South Fork Rubicon Diversion application for a UARP license amendment (SMUD 1981), a benthic macroinvertebrate study was conducted on three reaches within the unregulated part of the South Fork Rubicon River upstream of Robbs Peak Reservoir. Presence of chironomids, Ephemeroptera, Plecoptera, and Trichoptera were documented. The study concluded that, overall, benthic macroinvertebrate abundance was generally lower in the reaches studied than in some comparable mountain streams (EA 1982a). More recently, the South Fork Rubicon River was sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-26 and 27.)
- South Fork Silver Creek in Ice House Dam Reach - As part of the Jones Fork Hydroelectric Development Final EIR (EA 1982b), a benthic macroinvertebrate study was conducted at two sites of SFSC between Ice House Reservoir and Junction Reservoir. The site closer to Ice House Reservoir differed strikingly from

the reach further downstream with respect to chironomids. Chironomidae larvae were very abundant in the upstream study area (177.33/ft<sup>2</sup>). The sites were similar in abundance of most other taxa. However, the upper site had relatively higher numbers of Ephemeroptera, primarily *Baetis* spp., and oligochaete worms. The lower site was characterized by higher numbers of Trichoptera. (SMUD 2001, Page E3-27.)

- South Fork Silver Creek Upstream of Ice House Reservoir - South Fork Silver Creek and Big Hill Canyon Creek were sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in Fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-28.)
- Jones Fork Silver Creek, Big Silver Creek, and Wench Creek Upstream of Union Valley Reservoir – These three streams were sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in Fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-28.)

### 3.1.3 Study Objectives

The study objective is to use the CSBP as a bioassessment monitoring tool to evaluate the biological integrity of the stream reaches affected by the projects, and to provide insight into the general water quality in the area of the projects.

### 3.1.4 Study Area and Sampling Locations

The study area includes all Project affected stream reaches and reference sites described below. Project reservoirs are not included in the study area since the CSBP method is specifically developed for wadeable stream reaches, not reservoirs. Table 1 presents an estimate of locations and samples that would be collected. It is understood that an additional 3-5 sites may be established below the UARP facilities and an additional 2-3 sites may be established below the Chili Bar Project facilities based on the recommendation of the technical specialist and changes in geomorphology and tributary inputs, as needed. It is expected that the reference reaches will reflect different elevation bands (geographic regions: e.g., Rubicon River above Rubicon Reservoir for high elevations, South Fork Silver Creek above Ice House Reservoir for mid-elevation, and a lower elevation site to be recommended by a technical specialist and reviewed by the TWG). It is understood that 1 to 2 additional reference reaches (to bring total number to 6-10) may be added, and reference sites may include those in development for the EID Project. In general, in the longer reaches (more than 3 miles long) sampling locations will be at either end of the reach and one in the middle of the reach. In shorter reaches (less than 3 miles) sampling locations will be at either end of the reach. As described later in this study plan, one composite sample (3 subsamples) will be collected from one transect in the upper one-third of each of three randomly selected riffles located within each identified stream reach. Interested Aquatic TWG and Plenary Group Participants will be invited into the field to confirm the location of the sampling locations and transects before samples are collected. Site locations will be based on 1) availability and accessibility of riffle habitat, 2) safety considerations, and 3) a goal of optimizing spatial variability.

<b>Table 1. Estimated number of CSBP samples and transects per reach for the relicensing of The Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.</b>				
<b>Reach</b>	<b>Length (miles)</b>	<b>Locations/Reach</b>	<b>Transects/Location</b>	<b>Total No. of Composite Samples</b>
Rubicon Dam	4.1	3	3	9
Fox Lake	---	1	3	3
Rockbound Dam	0.4	1	3	3
Buck Island Dam	2.8	2	3	6
Loon Lake Dam	8.9	3	3	9
Gerle Creek Dam	1.1	2	3	6
Robbs Peak Dam	5.6	2	3	6
Ice House Dam	11.5	4	3	12

<b>Reach</b>	<b>Length (miles)</b>	<b>Locations/Reach</b>	<b>Transects/Location</b>	<b>Total No. of Composite Samples</b>
Junction Dam	8.3	3	3	9
Camino Dam	6.0	3	3	9
S.F. American River <sup>1</sup>		0	0	0
Brush Creek Dam	2.1	2	3	6
Slab Creek Dam	8.0	3	3	9
Reach Downstream of Chili Bar Dam	20.0	5 <sup>2</sup>	3	15
Rubicon Reference Site <sup>3</sup>		1	3	3
S.F Silver Creek Reference Site		1	3	3
Low Elevation Reference Site		1	3	3
Additional Sites including reference reaches		6-10 <sup>4</sup>	3	18-30
<b>Total (excluding additional sites)</b>	---	---	---	111

1. Data from El Dorado Irrigation District's (EID) macroinvertebrate survey on the South Fork American may be used for this section of river and as reference data.
2. Two of the five sites will be located within 3 miles of Chili Bar Dam. The total number of samples at a given site may increase to accommodate sampling in the inundation zone.
3. Data from EID's macroinvertebrate survey within the high elevation project area (e.g., outflow from Alpine, Caples of Echo lakes) may be used a reference data.
4. Of these additional sites, it is understood that 4-7 may be applied to the reaches above Chili Bar and 2-3 to the Reach Downstream of Chili Bar.

### 3.1.5 Information Needed From Other Studies

Information needed from other studies includes: 1) Rosgen mapping from the Channel Morphology Study to assist in selecting sampling locations; 2) habitat mapping from the Instream Flow Study to identify riffle sampling sites; and 3) results from the Water Quality Study to corroborate the conclusions of the Aquatic Bioassessment Study regarding water quality. Data from the Aquatic Bioassessment Study may be useful in the Water Quality Study to determine overall compliance with portions of the Basin Plan.

### 3.1.6 Study Methods And Schedule

A CDFG scientific collecting permit will be obtained prior to collecting any macroinvertebrate specimens.

Sampling methods will conform with non-point source and spot sampling protocols of the CSBP for documenting and describing benthic macroinvertebrate assemblages and physical habitat, except where sampling sites contain scarce low gradient riffles, relatively large substrate or non-wadeable conditions within the thalweg. At those sites, a modification of the CSBP will be used. The modification will consist of delineating a high gradient riffle or high gradient riffle series into a low, middle, and upper section, and "spot sampling" each of the sections. Each site will be located using a GPS unit and the site elevation will be recorded, and water temperature, dissolved oxygen concentration, pH, and conductivity will be measured *in situ* in mid-channel. Also, each site will be characterized for macroinvertebrate habitat quality using the site-scale parameters for high gradient streams from the USEPA's Rapid Bioassessment Protocols (Barbour et al. 1999) shown in Table 2. Photographs will be taken at all selected transects. Flow data from the reach downstream of Chili Bar Dam will be recorded every 15 minutes utilizing the CDEC A49 gauge.

Specific sampling locations at each site will be randomized by identifying at least five areas (riffle habitat if low gradient riffles dominated the site) of potential sampling locations within each section of the site and then randomly selecting three of the five areas for sampling. Riffle length will be determined and a transect will be randomly established within the upper third of the riffle. Each transect will be characterized using the transect-scale parameters described in the CSBP for characterizing habitat at the specific sampling locations (Table 2).

Three macroinvertebrate subsamples, one near the bank, one at intermediate depth, and a third near the thalweg, will be collected along each transect. Subsamples will be collected by rubbing cobble and boulder substrates and disturbing finer substrates within a 2-square foot area upstream of a D-frame kicknet fitted with a 0.02-inch diameter (0.5 mm) mesh net. The three subsamples along the transect will be combined in a jar, preserved with 95 percent ethanol, and labeled to form a single composite sample for that transect.

**Table 2. Habitat quality and transect scale parameters to be recorded during CSBP sampling for relicensing of the Sacramento Municipal Utility District's Upper American River Project.**

Habitat Quality Site Scale		Transect Scale	
Parameter	Units	Parameter	Units
Epifaunal Substrate/Available Cover	Rank (0–20)	Average Wetted Width	Feet
Embeddedness	Rank (0–20)	Average Depth	Feet
Velocity/Depth Regime	Rank (0–20)	Average Velocity	Feet per Second
Sediment Deposition	Rank (0–20)	Average Canopy Cover	Percent over Transect
Channel Flow Status	Rank (0–20)	Substrate Complexity	Rank (0–20)
Channel Alteration	Rank (0–20)	Embeddedness	Rank (0–20)
Frequency of Riffles (or bends)	Rank (0–20)	Fines	Percent of Transect
Bank Stability	Rank (0–20)	Gravel	Percent of Transect
Vegetative Protection	Rank (0–20)	Cobble	Percent of Transect
Riparian Vegetative Zone Width	Rank (0–20)	Boulder	Percent of Transect
-	-	Bedrock	Percent
-	-	Substrate Consolidation	Loose, moderate, compact
-	-	Gradient	Percent

At a laboratory, each composite sample will be rinsed in a standard #35 sieve (0.5 mm) and transferred to a tray with multiple grids for subsampling. Subsamples will be transferred from randomly selected grids to petri dishes where the macroinvertebrates will be removed indiscriminately with the aid of a stereomicroscope and placed in vials containing 70 percent ethanol and 2 percent glycerol. The debris from the processed grids will be placed in a remnant jar and preserved in 70% ethanol for later quality control testing. Subsamples will be processed until 300 macroinvertebrates are obtained representing one composite sample. Subsampled benthic macroinvertebrates will be identified using standard macroinvertebrate identification keys and other appropriate references. A standard level of taxonomic effort will be used as specified in the draft California Aquatic Macroinvertebrate Laboratory Network short list of taxonomic effort. Exceptions may be made for some early instar taxonomic groups, such as capniids, leuctrids, and some dipterans, which may only be identified to family and for blackflies, which may only be identified as “*Simulium/Prosimulium*.”

For quality control, twenty percent of the processed composite samples will be randomly selected and submitted to CDFG for independent verification of the identification and number of benthic macroinvertebrates. Following CSBP protocol, the contents of the remnant jar will be examined for organisms that may have been overlooked during subsampling. Since the Licensee has no control over how long it takes CDFG to conduct its independent verification, the results from the study will be presented in a timely fashion and amended when CDFG’s verification is complete, if needed.

In 2002, it is expected that the sampling sites and transect locations will be selected in July or August, depending on weather. Interested Aquatic TWG Participants will be invited to confirm/modify the sampling sites and transects in August. Sampling will occur in late September/early October, data analysis will occur in October and November, and the results of the study will be presented to the Aquatic TWG in December 2002. Sampling may be eliminated or modified in 2003 and/or 2004 if the 2002 data demonstrate that macroinvertebrate habitat and populations are not impaired as described above and/or if the water year types are such that additional data collection would not provide additional valuable information. This study plan will be amended to include the additional sampling.

### 3.1.7 Analysis

Habitat quality scores for each of the sites will be calculated as described in Barbour et al. (1999). The total number of macroinvertebrates and taxa per composite sample will be calculated. Each of the samples as well as the overall site will be given a relative ranking score based on a set of macroinvertebrate assemblage metric values using the ranking method developed by the CDFG Aquatic Bioassessment Laboratory (Table 3). Nine of these 10 metrics used for the ranking score were found to be reliable responders to disturbance by Karr and Chu (1999). The Shannon-Weaver Diversity index, although not identified by Karr and Chu, will be incorporated into the suite of metrics because it integrates richness and evenness (Shannon and Weaver 1963; Magurran 1988). The coefficient of variation value for each of the metrics will be calculated. The matrices will be provided in both a multi-metric and multivariate format.

<b>Table 3. Biological metrics used to describe characteristics of benthic macroinvertebrate assemblages for relicensing of the Sacramento Municipal Utility District's Upper American River Project.</b>		
<b>BMI Metric</b>	<b>Description</b>	<b>Response to Impairment</b>
<b>Richness Measures</b>		
Taxonomic Richness	Total number of individual taxa	Decrease
Ephemeroptera Taxa	Number of mayfly taxa	Decrease
Plecoptera Taxa	Number of stonefly taxa	Decrease
Trichoptera Taxa	Number of caddisfly taxa	Decrease
<b>Composition Measures</b>		
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	Decrease
<b>Tolerance/Intolerance Measures</b>		
Tolerance Value	Tolerance values between 0–10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values).	Increase
Percent Intolerant Organisms	Percentage of organisms that are highly intolerant to water and/ or habitat quality impairment as indicated by tolerance values of 0, 1 or 2.	Decrease
Percent Tolerant Organisms	Percentage of organisms that are highly tolerant to water and/ or habitat quality impairment as indicated by tolerance values of 8, 9, or 10.	Increase
Percent Dominant Taxon	The highest percentage of organisms represented by one taxon.	Increase
<b>Feeding Functional Group</b>		
Percent Predators	Percent of macroinvertebrates that prey on living organisms	Decrease

Differences between sites will be examined using t-tests for differences in macroinvertebrate abundance, and cluster analysis (a multivariate procedure for detecting natural groupings in data) for differences in macroinvertebrate assemblages. If substantial differences are found, additional analysis (e.g., canonical correspondence analysis) or studies may occur to identify the reason for the differences as determined by the TWG.

### 3.1.8 Study Output

A status presentation on the study will be made to the Aquatics TWG and the Plenary Group in December 2002 and thereafter as appropriate. However, the ultimate study output will be a written report that includes the issues addressed, objectives, study area including sampling locations, methods, analysis, results, discussion and conclusions. The report will be prepared in a format so that it can easily be incorporated into the Licensee's draft environmental assessment that will be submitted to FERC with the Licensee's application for a new license. When the study is finalized, the data will be provided in electronic format to the DFG for incorporation into its State-wide CSBP database.

### 3.1.9 Preliminary Estimated Study Cost

A preliminary cost estimate for this study will be developed after approval by the Plenary Group.

### 3.1.10 Plenary Group Endorsement

The Aquatics TWG approved this plan on February 28, 2002. The participants at the meeting who said they could "live with" this study plan were BLM, City of Sacramento, CSPA, SWRCB, USFS and SMUD. None of the participants at the meeting said they could not "live with" this study plan. On April 11, the Plenary Group sent the plan back to the TWG to include Chili Bar. The plan was discussed at the Aquatic TWG meeting on April 25 and PG&E was requested to amend the plan for consideration by the TWG at its May 16 meeting. PG&E amended the plan and the Aquatics TWG approved the plan at the May 16, 2002 meeting. The participants at the meeting who said they could "live with" the study plan were USBLM, CSPA, SWRCB, ENF, CDFG, NMFS, PCWA, ARRA/Camp Lotus, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group approved the plan on June 5, 2002. The participants at the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, BOR, USFS, CSPA, SMUD, FOR, PG&E. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group also approved the plan on September 9, 2003. The participants at the meeting who said they could "live with" this study plan were USFS, SWRCB, NPS, CDFG, El Dorado County, Taxpayers Association of El Dorado County, Teichert

Materials, ARRA/Camp Lotus, El Dorado Irrigation District, SMUD, PCWA, City of Sacramento, FOR, and PG&E. None of the participants at the meeting said they could not “live with” this study plan.

3.1.11 Literature Cited

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

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**AQUATICS TWG NOTE:**

1. *This study area will be revisited once SMUD and the USFS reach agreement regarding responsibility for and potential Project actions in “Defense and Threat” zones as defined in the Forest Service Plan Amendment EIS and Record of Decision*