4.1.21 Pyramid Reach Benthic Macroinvertebrates Study

4.1.21.1 Project Nexus

Continued Project O&M have the potential to affect benthic macroinvertebrates (BMI) in Pyramid reach.

4.1.21.2 Existing Information and Need for Additional Information

Existing, relevant, and reasonably available information regarding BMIs in Pyramid reach is provided in Section 4.5.7 of the Licensees' PAD. As a summary, historical sampling identified 19 orders and 50 families of BMIs over five sampling sites in Pyramid reach.

Additional information, which will be provided by this *Pyramid Reach Benthic Macroinvertebrate Study*, is needed to determine the presence and locations of BMIs that occur in Pyramid reach that could be affected by the Project.

4.1.21.3 Study Goals and Objectives

The goal of this *Pyramid Reach Benthic Macroinvertebrate Study* is to characterize BMI assemblages within the Pyramid reach using the SWAMP protocol for BMI and physical habitat sampling (Ode et al. 2016). The objective of this *Pyramid Reach Benthic Macroinvertebrate Study* is to fill recognized gaps in existing information on BMIs in the Pyramid reach.

4.1.21.4 Study Methods

Study Area

The *Pyramid Reach Benthic Macroinvertebrate Study* area includes Pyramid reach as shown in Figure 4.1-29 below. Three representative sample sites will be selected in coordination with the *Pyramid Reach Fish Population Study* site selection process including one in the 2-mile-long section of Pyramid reach between Pyramid Dam and the concrete structure upstream of Frenchman's Flat (stream segment 1); one within a mile downstream of Frenchman's Flat, within the stream segment from the concrete structure upstream of Frenchman's Flat to the confluence of Fish Creek (stream segment 2); and one just upstream of the confluence with Agua Blanca Creek within the stream segment from Fish Creek to the NMWSE of Lake Piru (stream segment 3). The sites will be selected at locations accessible to field crews and will represent the overall habitat ratios found in the reach using the mesohabitat mapping data created for the reach.

Prior to site selection in the field, preliminary sites will be selected using existing aerial imagery and habitat mapping data. Final sampling sites will be selected in consultation with USFS, USFWS, SWRCB, and CDFW. The Licensees will make a good faith effort to schedule the consultation on a day or days convenient to the Licensees and

interested relicensing stakeholders, and will provide an email notice at least 30 days in advance of the meeting or site visit.

General Concepts and Procedures

- Personal safety is the most important consideration of each fieldwork team. Fieldwork will only occur in safely accessible areas and under conditions deemed safe by the field crews. Locations within the study area that cannot be accessed in a safe manner (e.g., locations containing dense vegetation or unsafe slopes) and areas inundated when the surveys are performed, will not be surveyed; these areas will be identified in the data summary and an explanation for survey exclusion will be provided.

- The *Pyramid Reach Benthic Macroinvertebrate Study* will begin after FERC issues its Study Plan Determination.

- The *Pyramid Reach Benthic Macroinvertebrate Study* does not include the development of requirements for the new license, which will be addressed outside the study.

- The *Pyramid Reach Benthic Macroinvertebrate Study* focuses specifically on BMI communities within Pyramid reach, but the study area is specific to locations that can support that resource.

- If required for the performance of the *Pyramid Reach Benthic Macroinvertebrate Study*, the Licensees will make a good faith effort to obtain permission to access private property well in advance of initiating the study. The Licensees will only enter private property if permission has been provided by the landowner.

- The Licensees will acquire all necessary agency permits and approvals prior to beginning fieldwork for the *Pyramid Reach Benthic Macroinvertebrate Study*.

- Field crews may make variances to the *Pyramid Reach Benthic Macroinvertebrate Study* in the field to accommodate actual field conditions and unforeseen problems. Any variances in the *Pyramid Reach Benthic Macroinvertebrate Study* will be noted in the data resulting from the *Pyramid Reach Benthic Macroinvertebrate Study*.

- Licensee's field crews will record incidental observations of aquatic and terrestrial wildlife species observed during the performance of this study. The purpose of this effort is to gather incidental data during the performance of the study.

- To prevent the introduction and transmittal of amphibian chytrid fungus and invasive aquatic species (e.g., quagga mussels, zebra mussel, and Asian clams), field crews will be trained on, provided with, and use materials (e.g., Quat) for decontaminating their boots, waders, and other equipment when leaving or traveling between water-based study sites. Field crews will follow DWR's Quagga

and Zebra Mussel Rapid Response Plan and CDFW's Aquatic Invasive Species Decontamination Protocol which can be found at the following link: (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333). All boats used during the study will follow cleaning protocols, including inspections before and after use. All decontamination requirements in place at Project reservoirs including those of DWR's Quagga and Zebra Mussel Rapid Response Plan for the SWP will be strictly followed (DWR 2010).

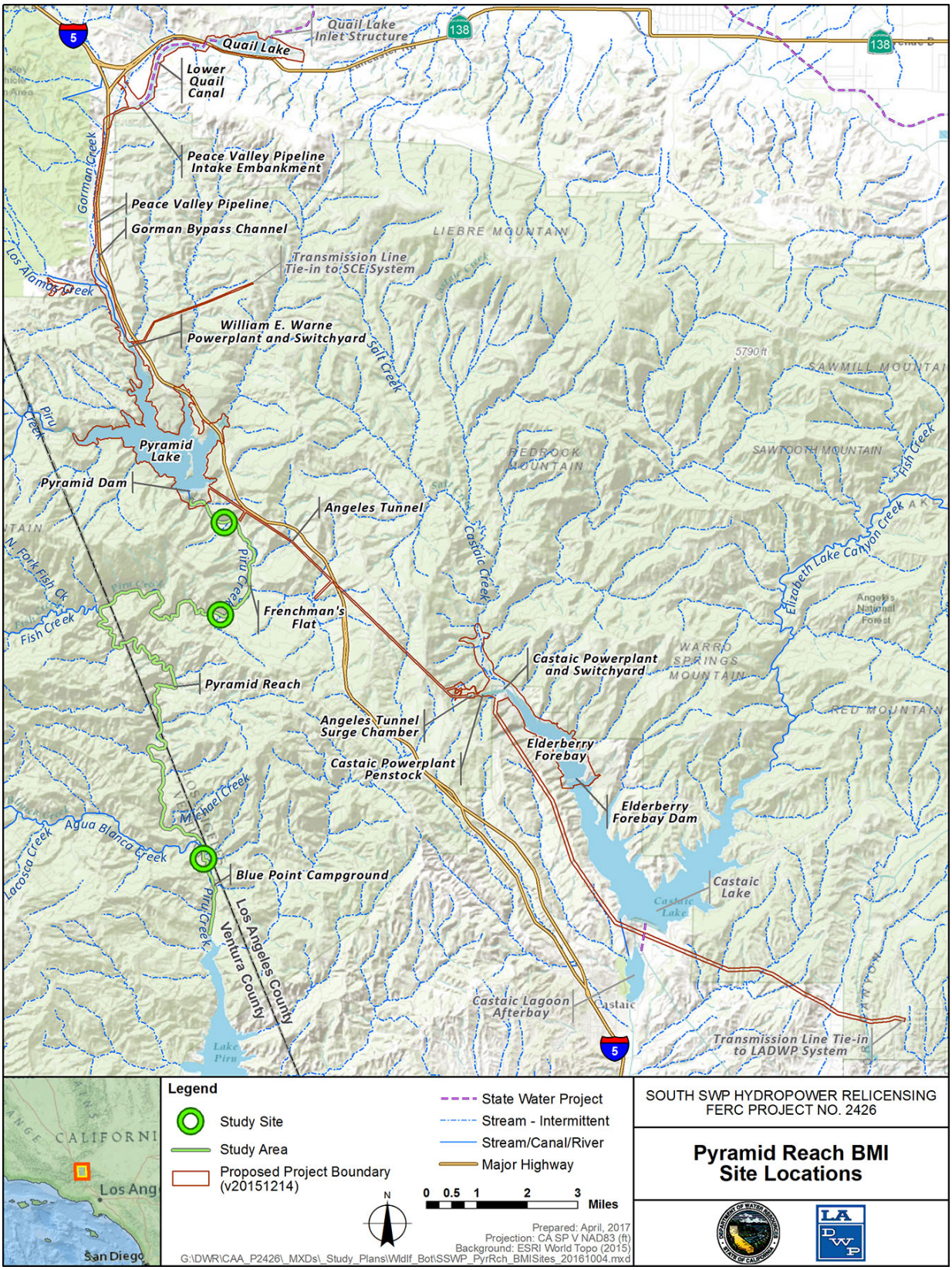

Figure 4.1-29. Pyramid Reach Benthic Macroinvertebrate Study Area and Sampling Locations

Methods

Data collection for the *Pyramid Reach Benthic Macroinvertebrate Study* will consist of three steps: (1) identify sampling locations, (2) collect SWAMP data, and (3) laboratory processing, as described below.

BMI sampling will be predicated on the Licensees obtaining necessary federal and State permits for sampling. Required permits may include a CDFW scientific collecting permit for streams that do not contain ESA-listed species and an ESA section 10(a)(1)(A) authorization from the USFWS for arroyo toad. Licensees will adhere to the permit terms and conditions during the study.

Steps 1 and 2 – Identify Sampling Segment Locations and Collect SWAMP Data.
Sampling methods will conform to the standard reach wide benthos (RWB) methods for documenting and describing BMI assemblages and physical habitat described in the SWAMP protocol (Ode et al. 2016). A summary of these methods is provided below. Data will be collected at each sampling site once in the May to July period per SWAMP protocol (Ode et al. 2016).

Reach Set Up: If the site's average wetted width is equal to or less than 10 meters (m), the site sampled will be 150 m in length; if the site's average wetted width is greater than 10 m, the site sampled will be 250 m. The standard sampling layout consists of 11 "main" transects (A-K) interspersed with 10 "inter-transects", all of which are arranged perpendicularly to the primary direction of stream flow (usually the thalweg), and placed at equal distances from one to the next. A flag will be installed at water's edge on one bank at the downstream limit of the sampling reach to indicate the first main transect ("A"). The positions of the remaining transects and inter-transects will then be established by heading upstream along the bank and using the transect tape or a segment of rope of appropriate length to measure off successive segments of 7.5 m (if sampling reach is 150 m), or 12.5 m (if it is 250 m).

Physical Habitat and Water Chemistry: Physical habitat and water chemistry will be characterized at each site. The habitat scoring criteria outlined by the SWAMP provides an effective measure of the physical integrity of a stream. The following list summarizes the quantitative measures of chemical, physical, and habitat characteristics that will be collected at each site. Refer to Ode et al. (2016) for a complete list of BMI and physical habitat data to be collected and SWAMP data sheets.

Reach-wide Parameters:

- GPS coordinates will be recorded at the top and bottom of the site.
- Water temperature, specific conductance, pH, and DO will be measured using approved standardized procedures and instruments.
- Total reach length and gradient (percent slope) as well as average width and depth will be recorded.

- Photographs will be taken at the top, middle, and bottom of the reach.
- A flow measurement will be taken within the reach.

Transect-specific Parameters:

- The wetted and bankfull widths of each transect will be taken.
- Substrate size, depth, and coarse particulate matter will be recorded at five locations along each transect.
- Cobble embeddedness for each cobble identified along the transect will be recorded. If the area contains fewer than 25 cobbles, the data will be supplemented by collecting "random" cobbles within the reach.
- Algal and macrophyte cover will be recorded at each of the sampling points.
- Bank stability, riparian vegetation, human influences, and instream habitat complexity will be recorded.
- Stream shading using a densitometer will be recorded.

BMI Field Collection: At each delineated sampling segment, samples will be collected at the 11 "main" transects by rubbing cobble and boulder substrates and disturbing finer substrate upstream of a D-frame kicknet fitted with a 0.02-inch (in.) diameter mesh net. For the RWB method, the sub-sampling position alternates between left, center, and right portions of the main transects, as one proceeds upstream from one transect to the next. These sampling locations are defined as the points at 25 percent ("left"), 50 percent ("center") and 75 percent ("right") across the wetted width in most systems.

At each sample location the net will be held in position on the substrate and field personnel will visually define a square area on the stream bottom upstream of the net opening, approximately one net-width wide and one net-width long. Because standard D-nets are 12 inches wide, the area within the plot will be 1 square foot (0.09 m2).

Working backward from the upstream edge of the sampling plot, field personnel will check the sampling plot for heavy organisms such as mussels, caddis cases, and snails. Field personnel will remove these organisms from the substrate by hand and place them into the net. Next, samplers will carefully pick up and rub stones directly in front of the net to remove attached benthic invertebrates. Rocks larger than a golf ball within the sampling plot will be cleaned such that all the organisms attached to them are washed downstream into the net. These rocks will be placed outside the sampling plot after they have been cleaned. Large rocks that protrude less than halfway into the sampling area will be pushed aside. If the substrate is consolidated, bedrock, or comprised of large, heavy rocks, field personnel will kick and dislodge the substrate (with the feet) to displace BMIs into the net. If a rock cannot be removed from the stream bottom, it will be rubbed with hands or feet (concentrating on cracks or

indentations), thereby loosening any attached insects. As the plot is disturbed, water current will carry all loosened material into the net. A brush will not be used to dislodge organisms from substrates.

Once the coarser substrates have been removed from the sampling plot, field personnel will dig through the remaining underlying material with hands to a depth of about 10 cm, where gravels and finer particles are often dominant. Field personnel will thoroughly manipulate the substrates in the plot to encourage flow to dislodge any resistant organisms. To the extent practical, field personnel will reduce the amount of sand particles in the net, as they damage organisms and degrade taxonomic data quality.

The subsamples will be combined in a jar, preserved with 95 percent ethanol, and labeled to form a single composite sample for that study site.

Step 3 – Laboratory Processing. Each composite sample will be rinsed in a standard no. 35 sieve (0.5 mm) and transferred to a tray with twenty, 4-inch square grids for sub-sampling. Sub-sampling will be performed using a stereomicroscope with magnifications of 10 to 20 times magnification.

Subsamples will be transferred from randomly selected grids to Petri dishes where the BMIs will be removed indiscriminately with the aid of a stereomicroscope and placed in vials containing 70 percent ethanol and 2 percent glycerol. In cases where BMI abundance exceeds 100 organisms per grid, half grids will be delineated to assure that a minimum of three discreet areas within the tray of benthic material will be subsampled. At least 600 BMIs will be subsampled from a minimum of five grids, or five half grids.

The debris from the processed grids will be placed in a remnant jar and preserved in 70 percent ethanol for later quality control testing. Subsampled BMIs will be identified by a taxonomist approved by the CDFW for EPA evaluations using standard aquatic macroinvertebrate identification keys (e.g., Kathman and Brinkhurst 1998, Merritt and Cummins 1996, Stewart and Stark 1993, Thorp and Covich 2001, Wiggins 1996) and other appropriate references.

All BMIs retained on a 0.5-mm screen will be removed from the subsample and a standard level 2a taxonomic effort will be used as specified in the Southwestern Association of Freshwater Invertebrate Taxonomists (SAFIT) in 2015 (Richards and Rogers 2011).

Quality Assurance and Quality Control

Field data gathered during this *Pyramid Reach Benthic Macroinvertebrate Study* will be collected in a manner that promotes high quality results, and will be subject to appropriate QA/QC for sample collection equipment, procedures, and cross-checking of data. As part of the QA/QC procedures, extreme care will be taken to ensure the data collected is accurate and maintained in a safe environment.

The CDFW Aquatic Bioassessment Laboratory (ABL) will be contracted to perform an external quality control review of the sample identification. Fifteen to 20 percent of the samples collected will be randomly selected for quality control by the taxonomist and sent to the CDFW ABL.

Analysis

Analytical methods will conform to the standard methods describing BMI assemblages and physical habitat outlined by SWAMP. Standard biological metrics, plus additional relevant metrics, will be calculated for each site (Table 4.1-15) and presented in graphical or tabular form.

Table 4.1-15. Biological Metrics Calculated to Assess BMI Assemblages

BMI Metrics	Description
RICHNESS MEASURES	
Taxonomic Richness	Total number of individual taxa
No. EPT Taxa	Number of taxa in the insect orders Ephemeroptera, Plecoptera, and Trichoptera
Ephemeroptera Taxa	Number of mayfly taxa
Plecoptera Taxa	Number of stonefly taxa
Trichoptera Taxa	Number of caddisfly taxa
Coleoptera Taxa	Number of beetle taxa
COMPOSITION MEASURES	
percent EPT	Percent of the composite of mayfly, stonefly, and caddisfly larvae
percent Ephemeroptera	Percent of mayfly nymphs
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness
TOLERANCE/INTOLERANCE MEASURES	
California Tolerance Value (CTV)	CTVs between 0 and 10 weighed for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values)
No. of Intolerant taxa	Taxa richness of those organisms considered to be sensitive to perturbation
percent Tolerant Organisms	Percent of macrobenthos considered to be tolerant of various types of perturbation
percent Dominant Taxon	Measures the dominance of the single most abundant taxon. Can be calculated as dominant 2, 3, 4, or 5 taxa
FEEDING MEASURES	
percent CF+CG Individuals	Percentage of BMIs within the collector-filterer and collector gatherer functional feeding groups
percent Scrapers	Percent of macroinvertebrates that graze upon periphyton
percent Non-gastropoda Scrapers	Percentage of BMIs within the scraper functional feeding group excluding gastropod scrapers
percent Predators	Percent of macroinvertebrates that prey on living organisms
percent Shredders	Percent of macroinvertebrates that shred leaf litter

Aquatic macroinvertebrates will be identified to Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) level 2 (Richards and Rogers 2011), and metrics outlined in Rehn et al. (2007) will be calculated. Metrics will be used to formulate the Hydropower Index of Biotic Integrity described by Rehn (2009). The results from each site will also be scored utilizing the California Stream Condition Index (CSCI) to translate BMI metrics into a measure of overall stream health (Rehn et al. 2015).

Reporting

Pyramid Reach Benthic Macroinvertebrate Study results will be included, to the extent completed and ready for inclusion, in the Licensees' ISR, USR, DLA, and FLA.

4.1.21.5 Consistency of Methodology with Generally Accepted Scientific Practices

The methods are consistent with the methods used for recent FERC hydroelectric relicensing efforts in California, including the Drum-Spaulding Project (FERC Project No. 2310), the Yuba-Bear Hydroelectric Project (FERC Project No. 2266), and the Yuba River Development Project (FERC Project No. 2246).

4.1.21.6 Schedule

The *Pyramid Reach Benthic Macroinvertebrate Study* will begin after FERC issues its Study Plan Determination. Licensees anticipate the schedule below will be followed to complete the *Pyramid Reach Benthic Macroinvertebrate Study*.

Fieldwork Preparation	March 2018 – May 2018
Site Selection	May 2018 – June 2018
Fieldwork	May 2018 – July 2018
Data QA/QC	August – October 2018
Data Analysis and Reporting	November 2017 – December 2018

4.1.21.7 Level of Effort and Cost

Based on the work effort described above, the Licensees estimate the current cost to complete this *Pyramid Reach Benthic Macroinvertebrate Study* is between $35,000 and $50,000.

4.1.21.8 References

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