4.1.17 Fish Entrainment Risk Assessment Study

4.1.17.1 Project Nexus

Continued Project O&M activities have the potential to affect fish in Pyramid Lake due to entrainment into the Angeles Tunnel intake and Pyramid Dam low level outlet to Pyramid reach.

4.1.17.2 Existing Information and Need for Additional Information

Existing, relevant, and reasonably available information regarding Pyramid Lake and its operations, fishes in Pyramid Lake, the Pyramid Dam low level outlet, and the Angeles Tunnel intake are described in the Licensees' PAD. As a summary, at its NMWSE, Pyramid Lake has a normal maximum capacity of 169,902 acre-feet and a maximum depth of 280 feet near Pyramid Dam.

Pyramid Dam low level outlet is a 15-foot-diameter, concrete-lined tunnel approximately 1,350 feet long and is located at the right abutment of Pyramid Dam. The tunnel can release up to 18,000 cfs into Pyramid reach. The lake outlet at the tunnel entrance is a submerged, 119-foot-high, 15-foot-diameter, reinforced concrete tower with an 18-foot-high trashrack. The tower lip is at elevation 2,340 feet, 238 feet below the NMWSE of Pyramid Lake.

The Angeles Tunnel intake structure, located at the north portal of the Angeles Tunnel, is a multiple-compartmented structure (four, 22-foot by 22-foot horizontal openings) with trashracks, which transitions to a 30-foot-diameter tunnel. The Angeles Tunnel intake draws water from Pyramid Lake down to elevation 2,335 feet, 243 feet below the NMWSE of Pyramid Lake. The Angeles Tunnel has a maximum capacity of 18,400 cfs. (Section 3.2 of the PAD.)

CDFW annually stocks 20,000 pounds of catchable size rainbow trout (*O. mykiss*) in the lake (Section 4.5.4.5 of the PAD), and based on sampling in 2013, CDFW considers the Pyramid Lake fish populations to be in good condition. CDFW found 12 fish species, and the catch was numerically dominated by largemouth bass (*Micropterus salmoides*). CDFW advised the Licensees that it intends to repeat its 2013 fish population sampling in Pyramid Lake in 2017. In addition, Environmental Science Associates, Inc. under contract with DWR conducts creel surveys in Pyramid Lake, with the most recent creel surveys in 2015 and 2016. (Section 4.5 of the PAD.)

4.1.17.3 Study Goals and Objectives

The goal of the *Fish Entrainment Risk Assessment Study* is to assess the potential for fish in Pyramid Lake to be entrained into the Pyramid Dam low level outlet or entrained into the Angeles Tunnel intake. The objective of this *Fish Entrainment Risk Assessment Study* is to gather sufficient information necessary to fill recognized information gaps regarding the potential for fish entrainment. The *Fish Entrainment Risk Assessment Study* will focus on two fish species: rainbow trout (adult and juvenile) and largemouth

bass (all life stages). Both fish species were selected for their recreational value and/or the Licensee's obligation to stock them for recreational purposes.

4.1.17.4 Study Methods

Study Area

The study area for the *Fish Entrainment Risk Assessment Study* will consist of Pyramid Lake (Figure 4.1-25).

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 *Fish Entrainment Risk Assessment Study* will begin after FERC issues its Study Plan Determination.

- The *Fish Entrainment Risk Assessment Study* does not include the development of requirements for the new license, which will be addressed outside the Fish Entrainment Risk Assessment Study.

- The *Fish Entrainment Risk Assessment Study* focuses specifically on Pyramid Lake, and the study area for the *Fish Entrainment Risk Assessment Study* is specific to that resource.

- If required for the performance of the *Fish Entrainment Risk Assessment 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 *Fish Entrainment Risk Assessment Study*.

- Field crews may make variances to the *Fish Entrainment Risk Assessment Study* in the field to accommodate actual field conditions and unforeseen problems. Any variances in the study will be noted in the data resulting from the *Fish Entrainment Risk Assessment Study.*

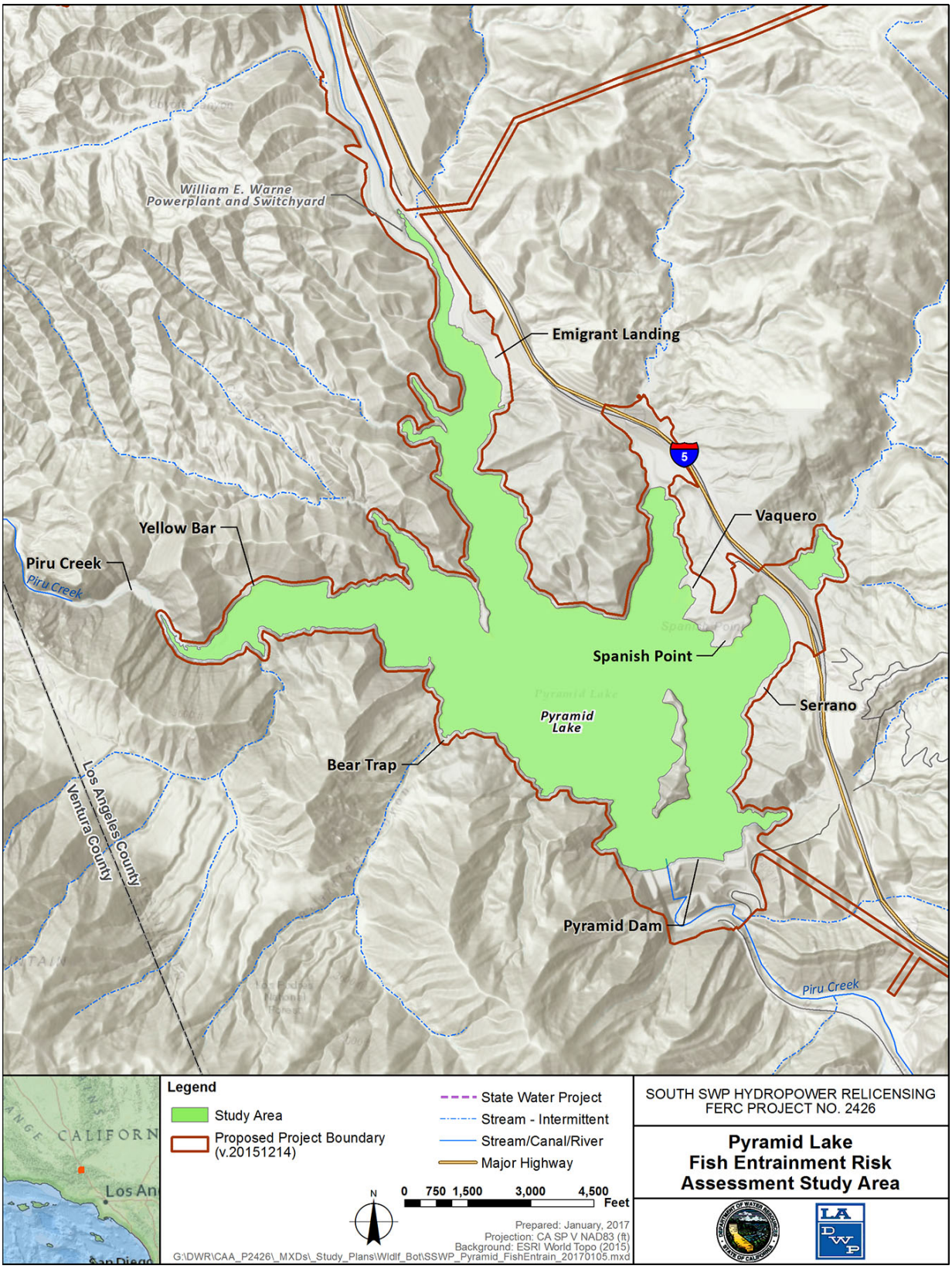

Figure 4.1-25. Pyramid Lake Fish Entrainment Risk Assessment Study Area and Site

Methods

This *Fish Entrainment Risk Assessment Study* will consist of four steps: (1) characterize each outlet through which Pyramid Lake water is released (i.e., the Angeles Tunnel intake and Pyramid Dam Low Level Outlet); (2) determine the likelihood that reservoir fish would be near the outlets; (3) determine swim speeds for fish life stages likely to be near the outlets; and (4) compare swim speeds and outlet water velocities. These steps are described below:

Step 1 – Characterize Each Outlet. The Licensees will examine existing Exhibit F and L Design Drawings and operations of Pyramid Lake and the two outlets to characterize for each outlet the typical outlet depth, dimensions, and flows. Using this information, the Licensees will calculate typical approach velocities near and at each outlet, and at various distances from the outlet. Approach velocities will be calculated by examining the cross sectional area of the tunnel intake structures and the median, 10 percent, and 90 percent exceedance discharges. These values will be compared with the annual inflow/outflow hydrographs to evaluate the temporal risk of entrainment to fish. Seasonal water quality and physical habitat characteristics will be described using all available information and included in the ISR, USR, DLA, and FLA.

Step 2 – Determine Likelihood That Reservoir Fish Would be Near the Outlets. Using the information developed in Step 1, existing information regarding the fish species in Pyramid Lake and information in existing literature regarding the fish species' life history, the Licensees will determine which of the species' life stages has a reasonable potential to be near the outlets and when.

As stated above, two fish species and life stages will be evaluated: rainbow trout (juvenile and adult) and largemouth bass (all life stages). Both species will be assessed for potential risk of entrainment for under both stratified and non-stratified lake conditions. The seasonality of stratification and its effect on species presence near the intakes will be described from available information.

Rainbow trout are native to California and have adapted to a broad variety of habitats throughout their California range. A review of the literature indicates that when water temperatures are suitable, rainbow trout are normally found near the surface of large reservoirs due to preferences for temperature, DO, food, and cover. Fast (1973), May (1973), and Hess (1974) state that adult rainbow trout normally are found at depths less than or equal to the 18ºC isotherm in reservoirs where DO levels are greater than 3 mg/l. Moyle (2002) reports that optimal temperatures for growth of rainbow trout are 15–18ºC, but they can tolerate temperatures between 0ºC and 27ºC. They can also tolerate DO levels as low as 1.5–2.0 mg/l at low temperatures.

Largemouth bass is a recreationally important species throughout California. Largemouth bass are an opportunistic piscivorous species. Warm, shallow (<6 m) waters of moderate clarity and beds of aquatic plants are the usual habitat of largemouth bass (Moyle 2002). Optimal water temperatures for largemouth bass are 25-30ºC, although, largemouth bass may persist in a much wider temperature range.

Largemouth bass begin to spawn when water temperatures warm to 15-16ºC, usually occurring from April through June (Moyle 2002). Nests are generally shallow depressions up to 1 m in diameter created by males in sand, gravel, or debris-littered bottoms at depths of 0.5-2 m (Moyle 2002). Nests are often built next to submerged objects, such as logs or boulders. Young of the year and yearling bass tend to stay close to shore and congregate in schools as they swim near or above beds of aquatic plants (Moyle 2002). Juvenile largemouth bass prefer warm shallow waters (30-32ºC) where forage is prevalent to ensure rapid growth (Moyle 2002).

Step 3 – Determine Swim Speeds for Fish Life Stages Likely to be Near the Outlets. A literature review will be conducted to evaluate the existing understanding of fish swimming capabilities of both rainbow trout and largemouth bass. Using this information, the Licensees will determine the swim speeds of fish and their respective life stages that have the potential to be proximal to the tunnel intakes as determined in Step 2. A fish's ability to avoid entrainment is related to its swimming ability, which is a function of its size. Researchers have developed a general fish length-swim speed relationship, which states that a fish is able to maintain a cruising speed equal to about four fish-lengths per second for long periods, and speeds of about ten fish-lengths per second for short bursts (Alexander 1967, Clay 1961).

Step 4 – Compare Swim Speeds and Outlet Velocities. The Licensees will compare the outlet velocities calculated in Step 1 with the swim speeds calculated in Step 3, and assess the potential for fish entrainment at the two outlets.

Quality Assurance and Quality Control

All data collected during this *Fish Entrainment Risk Assessment Study* will be collected in a manner that promotes high quality results, and will be subject to appropriate QA/QC procedures including checking all data for accuracy and completeness.

Analysis

The Licensees will compare the outlet velocities calculated in Step 1 with the swim speeds calculated in Step 3 to determine the risk for fish entrainment.

Reporting

The *Fish Entrainment Risk Assessment Study* methods and results will be prepared and included, to the extent completed and ready for inclusion, in the Licensees' ISR, USR, DLA, and FLA.

4.1.17.5 Consistency of Methodology with Generally Accepted Scientific Practices

The *Fish Entrainment Risk Assessment Study* methods are generally consistent with the methods used for assessing the potential for entrainment at deep water outlets in reservoirs in recent relicensing efforts in California, including the Yuba-Bear Hydroelectric Project (FERC Project No. 2266).

4.1.17.6 Schedule

The *Fish Entrainment Risk Assessment Study* will begin after FERC issues its Study Plan Determination. The Licensees anticipate the schedule below will be followed to complete the *Fish Entrainment Risk Assessment Study*.

Characterize Each Outlet	July 2017 – October 2017
Determine Fishes Near Outlets	July 2017 – October 2017
Determine Swim Speeds	November 2017 – December 2017
Data QA/QC	January 2018
Data Analysis and Reporting	February 2018 – May 2018

4.1.17.7 Level of Effort and Cost

Based on the work effort described above, the Licensees estimate the current cost to complete this *Fish Entrainment Risk Assessment Study* will range between $20,000 and $30,000.

4.1.17.8 References

Alexander, R.M. 1967. Functional Design of Fishes. Hutchinson and Company, London.

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